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NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

STAFF APPRAISAL REPORT

MAY 1, 1984

South Asia Projects Department
Power and Transportation Division

CURRENCY EQUIVALENTS

1 Nepalese Rupee (NRs)	=	US$ .0625
1 Nepalese Rupee	=	100 Nepalese Paise
16.0 Nepalese Rupees	=	US$1.00

HMG AND MHDB Fiscal Year (FY)

Beginning July 16 and Ending July 15

WEIGHTS AND MEASURES

kW	=	Kilowatt (=1.341 horse power)
MW	=	Megawatt (thousand kilowatts)
kWh	=	Kilowatt hours (=860.42 K cals)
MWh	=	Megawatt hours (thousand kilowatt hours)
GWh	=	Gigawatt hours (million kilowatt hours)
kV	=	Kilovolts (thousand volts)
MVA	=	Megavolt-ampere (thousand kilovolt-ampere)
KOE	=	Kilogram oil equivalent (ten thousand K cals)
TOE	=	Tons oil equivalent (thousand kilogram oil equivalent)
km	=	Kilometer (0.6214 mile)
m	=	Meters (3.2808 feet)
cu m/sec	=	Cubic Meters Per Sec (61022 cu in/sec)
Mm	=	Million Cubic Meters (35.3147 million cubic feet)

PRINCIPAL ABBREVIATONS AND ACRONYMS USED

ADB	-	Asian Development Bank
CIDA	-	Canadian International Development Agency
CY	-	Calendar Year
ED	-	Electricity Department
EEC	-	European Economic Community
FY	-	Fiscal Year
GTZ	-	Deutsche Gesselschaft fuer Technische Zusammenarbeit GmbH
HMG	-	His Majesty's Government
IRR	-	Internal Rate of Return
KFAED	-	Kuwait Fund for Arab Economic Development
KfW	-	Kreditanstalt fuer Wiederaufbau
LI	-	Lahmeyer International
MASL	-	Meter Above Sea Level
MHDB	-	Marsyangdi Hydroelectric Development Board
NEC	-	Nepal Electricity Corporation
OECF	-	Overseas Economic Cooperation Fund (Japan)
OPEC	-	Organization of Petroleum Exporting Countries
SATA	-	Swiss Association of Technical Assistance
SFD	-	Saudi Fund for Development
SHDB	-	Small Hydro Development Board
SCF	-	Standard Conversion Factor
SMEC	-	Snowy Mountains Engineering Corporation
UNDP	-	United Nations Development Program

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This report is based on information obtained during an appraisal mission in November 1982 by Messrs. J.M. Vance, M.P. Manrai and Ms. L. Villa, and on updated information provided by the Electricity Department of HMG and the Nepal Electricity Corporation.

ANNEXES

CHARTS

MAP

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MARSYANGDI HYDROELECTRIC POWER PROJECT

CREDIT AND PROJECT SUMMARY

Borrower:	Kingdom of Nepal
Beneficiary:	Nepal Electricity Corporation
Amount:	SDR 100.6 million (US$107.0 million equivalent)
Terms:	Standard
Terms to Beneficiary:	30 years with interest at 12 percent per annum
Project Description:	The project seeks to meet the forecasted demand for electricity in Nepal for the medium term and to strengthen the Borrower's power sector. This would be a run-of-river hydroelectric power project, with an installed capacity of 69 MW, located on the Marsyangdi River. Major project components include diversion works and diversion weir, headrace and tailrace tunnels, powerhouse, transmission lines, substations and equipment. The project also provides for consulting engineers, technical assistance and training. A primary benefit would be derived from the generation of additional electricity for industrial, commercial and domestic consumption, and for irrigation purposes. Benefit would also be received through improvement of the distribution system, enhancement of maintenance capacity and the training of manpower. Some risk relates to possible deficient project design and construction, poor management and cost overruns. Appointment of a panel of experts to review design and construction, adequate provision for supervision in close cooperation with the consulting engineer, and assignment of a claims advisor should help minimize these risks.

Estimated Costs:

Item	US$ millions Foreign	Local	Total
1. Preliminary Cost	2.5	2.9	5.4
2. Administrative Expenditure	0.5	2.7	3.2
3. Civil Works (Lot I)	45.0	13.6	58.6
4. Civil Works (Lot II)	73.7	25.0	98.7
5. Equipment	40.8	6.9	47.7
6. Substations and Local Distribution System	8.4	2.2	10.6
7. Transmission Lines	5.5	2.8	8.3
8. Consulting Engineer	7.5	-	7.5
9. Technical Assistance	4.1	-	4.1
Total Base Costs	188.0	56.1	244.1
Physical Contingencies	25.8	7.8	33.6
Price Contingencies	34.6	11.0	45.6
TOTAL	248.4	74.9	323.3 a/

Financing Plan:

	US$ millions Foreign	Local	Total
IDA	107.0	-	107.0
Saudi Fund b/	25.0	-	25.0
Kuwait Fund b/	21.0	-	21.0
KfW b/	69.3	5.2	74.5
Government	26.1	69.7	95.8
Total	248.4	74.9	323.3

Estimated Disbursements:

Bank FY	US$ millions FY85	FY86	FY87	FY88	FY89	FY90
Annual	14.7	26.0	26.0	19.2	10.2	10.9
Cumulative	14.7	40.7	66.7	85.9	96.1	107.0

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Rate of Return: 5.9%

Map: IBRD 16928R

a/ Includes taxes and duties of US$15.81 million equivalent.
b/ Amounts are expressed in US dollar equivalents only for ease of comparison.

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MARSYANGDI HYDROELECTRIC POWER PROJECT

STAFF APPRAISAL REPORT

I. THE ENERGY SECTOR

Background

1.01 The two principal known sources of energy in Nepal are forests and extensive river systems. Though exploration for fossil fuel is continuing, thus far there have been no discoveries. Nepal realizes that unless its water resources are exploited for energy production, the depletion of its forests, which have supplied a major portion of its energy needs, will continue. One of the main objectives, therefore, outlined in the Sixth Plan (1980-85) is the development of hydro potential.

1.02 There are three ministries dealing with the energy sector in Nepal: the Ministry of Water Resources, the Ministry of Commerce and Industry, and the Ministry of Forests. The Electricity Department of the Ministry of Water Resources is responsible for power development; the Ministry of Commerce and Industry is responsible for oil, gas and coal exploration efforts through its Department of Mines and Geology; and the Ministry of Forests looks after forest resources. Realizing the importance of water resources, a Water and Energy Commission was created in 1976 under the Ministry of Water Resources to investigate and prepare plans for the development of water and energy resources.

Energy Resources

1.03 Of total energy consumed in FY83, 5.5% was from commercial sources consisting of petroleum (3.8%), coal (1.1%) and electric power (0.6%). Non-commercial sources provided the remaining 94.5%, with fuelwood being the primary source (92.2%). Other non-commercial sources such as charcoal, crop and animal waste accounted for the remaining 2.3%. The volume of commercial energy consumption is very small. In FY83 it totalled about 196,170 TOE. Per capita consumption is 9.8 KOE; this compares to 33.4 KOE in Bangladesh, 424.9 KOE in China and 144.2 KOE in India. 1/

1.04 During FY71-83, the annual growth rate of commercial energy consumption was 5.2%, compared to 2.7% for total energy. It is, however, interesting to note that the growth rate of electricity sales during the same period was about 15.5%.

1/ The comparison is on 1980 basis and is based on 1983 World Bank Publication titled "The Energy Transition in Developing Countries."

Hydro Resources

1.05 Nepal is endowed with vast hydro resources. The estimated theoretical hydroelectric potential is about 83,000 MW, of which about 25,000 MW has been investigated for development. This potential is estimated to be distributed in various river systems of Nepal as follows:

Sapt Kosi basin in Eastern Region /a /b	:	22,000 MW
Sapt Gandaki basin in Central and Western Regions	:	21,000 MW
Karnali and Mahakali basins in Far Western Region	:	36,000 MW

/a Master Plan of Hydroelectric Power Development in Nepal - Japan International Cooperation Agency, September 1974.
/b Nepal is administratively divided into 5 regions - Central, Eastern, Western, Mid Western and Far Western.

Another 4,000 MW has been identified in other rivers, including the Kankai, Kamla, West Rapti, Bagmati and Babai. A list of prospective sites is attached as Annex 1.

1.06 Some hydro projects would be of such size that export to the Indian market would be required to economically justify them. A project in which Nepal and India have shown common interest is the Karnali (Chisapani multipurpose) project. A joint committee of representatives of the two countries called the Karnali Committee has been formed to approve, inter alia, terms of reference and scope of such project and the short list of consultants to carry out a study of which the main objective is to assess the economic justification and viability. The study is to be financed by the Bank Group under a technical assistance credit to Nepal approved by the Board in March 1984.

Small Hydro Schemes

1.07 Nepal is faced with a difficult situation. Rugged terrain, difficult access, massive deforestation, high costs associated with large civil works and long transmission lines have forced HMG to focus its attention on many attractive sites where small hydros may be installed. Nepal has embarked on a program for developing these sites so as to supply electricity to isolated towns and villages. The size of these small generating units varies from 25 kW to 500 kW. So far 11 power stations with a total installed capacity of 2,179 kW have been commissioned, another 21 stations with an installed capacity of 9,750 kW are under construction, and 16 schemes with a potential of 1,786 kW are under investigation. A list of these projects is in Annex 2. Although many projects referred to have been investigated or are under various stages of implementation, the costs of investigation, construction and maintenance are high. Under financing by USAID, HMG has now engaged the services of the National Rural Electrification Cooperative Association (NRECA) of USA to advise it on such matters as possible steps in reducing the capital and maintenance cost, use of indigenous material and manpower as far as possible, use of cost effective methodology for collecting stream flow and rainfall data for the site and improvement in the load factor so as to make each project viable, etc. With the help of consultants, HMG hopes that small hydros will play a significant role in the future power development of Nepal.

Most of these small hydro stations are presently being constructed and operated by the Small Hydro Development Board (SHDB) established in 1976.

1.08 There is appreciable interest by private individuals in using water power for milling and sawing purposes, and HMG's policy supports this type of activity. About 200 locally manufactured turbines 1/ varying from 4.5 to 30.0 horse power have been installed by various individuals. These installations, unlike small hydros are cheaper and are running successfully because the spare parts of the locally manufactured equipment are easily available.

Petroleum

1.09 To date neither oil nor gas reserves have been discovered. In 1980, an IDA-financed airborne survey of the Terai area was carried out, which indicated evidence of geological structures that might be suitable for trapping oil. In June 1982, IDA agreed to finance a seismic survey and geomechanical and geological studies in the areas of interest with a credit of US$9.7 million. The total cost of the studies is estimated at US$10.9 million. The completion date of this survey project is June 30, 1985.

1.10 The Nepal Oil Corporation is responsible for importing and distributing petroleum products throughout Nepal. During the last ten years (FY73-83), consumption grew at an average annual rate of 5.5%, totalling 147,580 metric tons in FY83. Projections for the next 20 years show an average annual growth rate of about 7%. High-speed diesel, used mostly in the transport sector, accounts for the major share, about 42% of total imports, followed by kerosene, used for cooking and lighting (24%), and aviation fuel (15%). The remaining 19% consists mainly of gasoline, low-speed diesel and furnace oil. The retail and border prices of selected petroleum products (December 1983) were as follows:

	Retail Price	Border Price
	US$	
Gasoline	877 per ton	467 per ton
Kerosene	424 per ton	359 per ton
Diesel	458 per ton	344 per ton

Coal

1.11 There are no known coal resources. Consumption of coal, which is estimated at about 100,000 tons per year, is met entirely by import from India.

1/ These turbines are of a cross-flow type. The local manufacturers, under the guidance of United Mission to Nepal (UMN) and Swiss Association of Technical Assistance (SATA), have developed designs suitable for heads from 2.5 meters to 45.0 meters and rated discharge from 20 litres/second to 2,000 litres/second.

A. The Power Subsector

Evolution and Present Structure

1.12 Electricity supply was introduced in Nepal in 1911 with a 500 kW hydro power station built to supply a few selected consumers in Kathmandu. It was not until 1934 that this supply was augmented with a 640 kW hydro station, followed by a 1,700 kW diesel generating station 20 years later. The management of this rudimentary system was expatriate. As the supply capacity started to grow, the Government took over responsibility for public electricity supply.

1.13 The Nepal Electricity Corporation (NEC) was established in 1962 under the Nepal Electricity Corporation Act of 1962. It was established to enable the management of the important power system in northern part of the Central Region to be freed from the constraints characteristic of the government bureaucracy. Later, NEC also took over the operations in the remaining part of the Central Region and in some parts of the Western Region. The operations throughout the rest of Nepal, plus the major part of planning, design and construction were left to the Electricity Department of the Ministry of Water Resources. In 1974, the Eastern Electricity Corporation (EEC) was established to manage the Eastern Region. A more recent development has been the establishment of separate development boards, each with its own chairman and board members, to be responsible for the construction of larger projects.

1.14 The following bodies have been directly involved in operating the power sector:

(a) Electricity Department (ED) of the Ministry of Water Resources;

(b) Nepal Electricity Corporation (NEC);

(c) Eastern Electricity Corporation (EEC) (merged with NEC in June 1982);

(d) Butwal Power Company (BPC) (merged with NEC in 1981); and

(e) Several development boards, including those for the Kulekhani I and Marsyangdi hydroelectric projects, transmission line projects and the small hydro projects.

1.15 ED is a department within the Ministry of Water Resources. It is responsible for planning, designing and constructing new projects which, after commissioning, are handed over for operation to NEC. In the Mid and Far Western Regions, the projects are retained and operated by the ED. In practice the larger construction works are executed by autonomous, development boards set up under statute for this purpose (para 1.18).

1.16 The ED is headed by a Chief Engineer, who is appointed by a Cabinet Committee of HMG; he is directly accountable for the work of his Department to the Secretary of the Ministry. There are currently some 900 staff, including 200 engineers of which about 150 are on secondment to other organizations in the power sector. All of its revenues are transferred to

the Ministry of Finance, while funds for capital and operating expenditures are obtained through the annual budget.

1.17 NEC is a government-owned corporation with a staff of about 3,200 including about 100 engineers. It is the largest entity in the power sector, responsible for generation, transmission and distribution of electricity in the country. NEC operates and maintains power stations, transmission lines and other facilities transferred to its ownership by the ED and the development boards. It finances, designs and constructs modest reinforcements to its distribution network and extends supplies to new customers. It is also responsible for billing and collection of revenue. NEC has little contact with the ED or the development boards during planning, design and construction of new works even though the facilities are subsequently transferred to it for operation and maintenance.

1.18 The development boards are established under the Development Boards Act to execute large construction projects, which upon commissioning are handed over to other entities for operation and maintenance. Board Members, in the case of the Kulekhani I and the proposed Marsyangdi projects, include the Minister of Water Resources as Chairman, and civil servants from various ministries, including the Secretary, Ministry of Water Resources and the Chief Engineer, ED. The Project Manager is a senior engineer seconded from the ED. He is paid by the Board, is accountable to the Board and is also a member and Secretary of the Board. The boards are staffed by engineers on secondment from the ED and by others specially selected. A few engineers are attached to the staff of the consultants and contractors for the projects. Considering the early stage of power development in Nepal, and the lack of experience by the Nepalese with large projects, the Boards have relied heavily on consultants to supervise execution of the projects.

1.19 It is clear from experience that this multiplicity of bodies to operate the Nepal electricity system has not been satisfactory. HMG recognizes that in order to meet the management and technical tasks associated with the planned expansion and operation of the system, the power sector's institutional structure needed streamlining. Therefore, with the assistance of consultants, HMG has decided to reorganize the power sector into one entity (see paras 2.05-2.08 for a discussion of the reorganization.)

Planning in the Power Sector

1.20 Planning in the power sector is the responsibility of the ED and the Water and Energy Commission. The ED is responsible for system studies, load forecasting, assessing the new requirements for generation schemes, and transmission and distribution systems, and also planning for rural electrification. The Water and Energy Commission investigates new hydro resources for development of power.

1.21 The two agencies are assisted in their power planning function by a Canadian International Development Agency (CIDA) team of about twelve professionals, which has been domiciled in Nepal for the last six years.

1.22 In 1974, under Japanese technical assistance, Nippon Koei carried out a comprehensive Master Plan for hydroelectric power development. In 1979, the Gandaki river basin was studied in detail by Snowy Mountains Engineering

Corporation of Australia under technical assistance from UNDP. Other sites have also been studied by various consulting engineers (Annex 1). Recently arrangements have been made for Japan International Cooperation Agency to finance the reconnaissance of the Kosi basin to identify projects. In addition, under the finances provided by USAID, NRECA of USA is studying the role of small hydros in the power sector (para 1.07). The Water and Energy Commission intends to carry out detailed basin studies of other major rivers with funds provided by various donors. At present the sites for which feasibility/prefeasibility studies are available are limited. The new studies will increase the choice and will enable the Government to carry out a ranking study of the country's potential power projects on a wider basis.

1.23 During negotiations, an agreement was reached that reports of such studies would be made available to IDA. Thereafter, views will be exchanged between IDA and the Government to identify a future power development program in Nepal.

Previous Bank Group Involvement in the Power Sector

1.24 Bank Group involvement in the power sector has been in respect of the 60 MW Kulekhani Hydroelectric Power Project (Credit 600-NEP and Supplemental Credit 600-1-NEP, totalling US$40.8 million). This project, costing about US$120 million equivalent, was commissioned in April 1982, and to date is the largest project ever undertaken in Nepal. It approximately doubled the total generating capacity of the country. The financing was arranged through a group of colenders consisting of IDA, OECF, Kuwait Fund, OPEC, EEC, and UNDP. The original cost of the project was estimated at US$68.0 million. The reasons for cost increases were (a) increased cost of civil works, (b) imposing of local taxes by the Government at a later stage, (c) increase in the consulting engineers cost due to increase in manmonths required for supervision, (d) appreciation of the Japanese Yen against the US dollar, and (e) increase in the scope of substations and transmission lines. As a result of the lessons learned during the execution of the Kulekhani Project, adequate steps have been taken to prevent reoccurrence. A panel of experts has been appointed in the early design stages of the project, necessary site investigation has been done and adequate physical contingencies have been provided.

The Nepal Power System

1.25 The strategy of Government has been to build hydro and diesel power stations mainly in the Central Region because of the concentration of major loads in the Kathmandu valley. The present total firm plant capacity in Nepal is 133 MW, of which 115 MW is in the Central Region. Of the total 133 MW, hydro plant capacity accounts for 111 MW, and diesel plant for 22 MW, with the largest hydro power station (60 MW) located at Kulekhani and the largest diesel power station (16 MW) located at Hetauda (Annex 3). All hydro plants are run-of-river types except Kulekhani which has a live storage capacity of 73.3 million cubic meters, a catchment area of 126 sq km and a rated head of 550 meters. During the wet season Kulekhani is operated only during peak time. (For month wise energy output of various stations refer to Table 4 of Annex 23.) In the event of a shortage of energy caused by abnormally low river flows, NEC and ED rely on the regulation of stored water in Kulekhani reservoir and on full use of diesel plants.

1.26 The grid system presently is confined to the Central and part of the Western Regions and consists of 239 km of 132 kV lines and 227 km of 66 kV lines. The firm plant capacity in the grid is 130 MW, of which 111 MW is hydro. The maximum demand of the grid system was 69.1 MW in FY83, compared to the total Nepal demand of 83.2 MW (Annex 6).

1.27 The Eastern Region registered a maximum demand of 11.0 MW in FY83. This region does not form part of the grid and depends heavily on energy import from India. For example, in FY83 only 6% of the energy was generated within the region, with the remaining 94% being imported from India. The isolated network in this area consists of 188 km of 33 kV and 76 km of 11 kV lines connected to small hydros, diesels and to supply points from India.

1.28 The Mid and Far Western Regions, which registered a combined demand of 3.1 MW in FY83, are managed by the ED. This isolated network consists of 85 km of 33 kV and 52 km of 11 kV lines, also connected to small hydros, diesels and to supply points from India.

1.29 Extension of the grid to interconnect the Eastern Region through a 283 km 132 kV line from Hetauda to Biratnagar via Janakpur is being financed by ADB (completion in FY86). There are also plans to extend the grid westward by erecting 45 km of 132 kV line from Dumkibas to Butwal under French assistance, and 225 km of 132 kV line from Butwal to Nepalgunj via Shivpur and Lamahi under an ADB loan. This interconnection is likely to be commissioned in FY87 (IBRD Drawing 16928R). Details of existing and proposed transmission lines and substations in various regions are shown in Annexes 4 and 5.

Status of Supply and Access to Electricity

1.30 The electric energy consumption in Nepal is characterized by seasonal variations. Due to increased heating and lighting requirements in winter, the average monthly consumption in the Central Region, where domestic load is predominant, is more in winter than in summer. The overall annual load factor in Nepal is low at about 45% (Annex 6). Of total annual consumption, about 55% is consumed during the winter months of December through May and about 45% during the summer months of June through November. The maximum demand recorded in summer is about 80% of the maximum demand recorded in winter.

1.31 The total energy generated in Nepal in FY83 was 292 GWh (Annex 6), of which 279 GWh was hydro, 5 GWh diesel and 8 GWh was generated from captive plant (Annex 7); in addition, 63 GWh was imported from India. About 98% of hydro and 42% of diesel energy was generated in the Central Region. Energy sales within Nepal totalled 232 GWh and export to India was 6 GWh. The Central Region accounted for the largest amount of sales (72%) followed by the Eastern Region (15%), the Western Region (8%), and the Mid and Far Western Regions (5%). Of the total energy imported from India, 68% was imported into the Eastern Region (Annex 6).

1.32 The grid system in the Central and Western Regions has been beset with systematic load shedding since FY78. During the winter of 1981, when load shedding was at its worst, about 14 MW and 2 MW of load was shed during

peak time in the Central and Western Regions, respectively. It is estimated that the unserved demand for energy in FY82 was about 15 GWh, equivalent to 10% of the combined energy sold in the Central and Western Regions. Since the commissioning of Kulekhani I in April 1982, there has been no necessity for shedding load.

1.33 Applications for new connections have been accumulating since load shedding was introduced in 1978. At present, about 20,000 applications are pending, out of which 10,000 are in the Western Region and 8,000 in Central Region. All but 300 applications are for new domestic connections. Plans call for connecting about 6700 new domestic consumers annually beginning in FY84, increasing to 10,000 in FY92 (Annex 9).

1.34 At the end of FY83, the number of consumers totalled 133,672 of which 130,056 were domestic. Based on a total population of 15.4 (1982) million and assuming six persons per household, 5.0% of the population are served by electricity. Per capita production of electricity is about 16 kWh; this compares to 164 kWh in India, 26 kWh in Bangladesh and 307 kWh in China. 1/

Rural Electrification

1.35 The five administrative regions of Nepal are further divided into 14 zones and 75 districts. Each district has a headquarters. The towns and villages in the districts are grouped together and each group is either a town panchayat or a village panchayat. The total number of town panchayats is 29 and village panchayats is 2,905. To date 39 district headquarters (52%), 28 town panchayats (97%) and 137 village panchayats (5%) have been electrified. Out of a population of 15.4 million, 1.77 million are living in the electrified towns and villages. In the next 5 years, HMG plans to electrify an additional 21 district headquarters, one town panchayat and 241 village panchayats. On this basis, a total of 3.6 million people would be living in electrified towns and villages. ADB has shown an interest in rural electrification and HMG intends to carry out its program, mainly with ADB assistance.

Power Exchange with India

1.36 Over the years, the import of power from India has been increasing. In FY83 about 63 GWh was imported, equivalent to about 22% of energy generated in Nepal. The power exchange began in April 1954 when India and Nepal signed an agreement 2/ to supply up to 6.8 MW of power to Nepal for use in the Biratnagar area in the Eastern Region. In October 1970, another agreement was signed for a two-way exchange of power of up to 5,000 kW along the border. Recently, in April 1982, a third agreement was signed for Nepal to export upto 25 MVA (approximately 20 MW) of secondary power to India at Raxaul and Gandak and to import about 18 MVA from India for consumption in

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1/ The comparison is on 1980 basis and is based on 1983 World Bank Publication titled "The Energy Transition in Developing Countries."

2/ Kosi Agreement of April 1954 amended in December 1966.

the Eastern, Mid-Western and Far-Western Regions. The actual exchange of power during FY76-83 at various points is shown in Annex 8.

Load Forecast

1.37 The load growth has been hampered because (a) the existing hydro generating power stations have not been fully utilized due to operational problems (para 1.45), and (b) there is no interconnected grid system for the whole country. In spite of these constraints, the total sales in Nepal grew at an average annual rate of 18.2% during FY71-78 and 11.7% during FY76-83. From FY78 onward, load shedding was introduced and growth rates are therefore distorted. The growth rates during FY71-78 were higher because there were no restrictions and the system was developing from a small base.

1.38 A load forecast was prepared in 1981 by the Water and Energy Commission, assisted by the consultants. This forecast was based on an estimate of the sales requirement for each major category of load in each region. The generation requirement was then worked out by aggregating the sales and system losses in each region. The maximum demand of each region and of the system was calculated by assuming certain load and diversity factors. Other methods, such as extrapolation of historical trends and the use of economic indicators, were used in the above forecast as checks to verify the validity of the load forecast. During appraisal, this load forecast was reviewed and updated through FY92 in consultation with the ED and NEC. Overall, the demand is expected to increase by an average of 12.8% per annum. For details see Annex 9. A summary discussion of the load forecast in major areas is given below.

1.39 Industrial. Most existing industries are small scale, involved with the processing of agricultural commodities and to some degree also with textiles, leather and wood. However, present plans are to set up larger scale industrial plants for cement, steel foundry, paper, electrical accessories under joint enterprise with countries in the Region. In view of this, an appreciable increase in industrial load is expected (Table 2 of Annex 9).

1.40 It is expected that the industrial load would grow at an average annual rate of 15.9% during FY83-92, compared to the past growth rate of 25.4% during FY71-78 and 12.6% during FY76-83. It is expected that in FY92 the share of industrial load would be 41% of total sales in Nepal compared to 32% in FY83.

1.41 Domestic. Keeping in view the past trend and considering that the local distribution system reinforcement is already taking place in the Central and Eastern Regions (para 1.50), it is expected that a steady growth in domestic load would continue. An average annual growth rate of 6.1% during FY83-92 is expected, compared to the past growth rate of 16.2% during FY71-78 and 9.8% during FY76-83. It is estimated that the share of domestic sales would be 30% of total sales in FY92 compared to 52% in FY83.

1.42 Commercial. At present the commercial load is not being properly classified; only non-industrial load in excess of 50 kW is classified as commercial. Small hotels, lodges, offices, shops and other commercial establishments having a load of 50 kW or less are classified as domestic users.

NEC is in the process of correcting this. It is estimated that the commercial load would grow at an average annual rate of 14.8% during FY83-92 compared to the past growth rate of 16.1% during FY71-78 and 18.5% during FY76-83. It is expected that the share of commercial sales would be 11.0% in FY92 compared to 10.0% in FY83.

1.43 Irrigation and Water Supply. At present only three irrigation projects, Batter (lift irrigation), Birganj and Lumbini (tubewells) are in operation in the Central and Western Regions. HMG has embarked on a number of lift irrigation and groundwater pumped irrigation schemes. Eight of these projects, for which finance has been arranged, have been included in the load forecast (Table 3 of Annex 9). For other prospective irrigation and water supply loads, a 5% annual growth rate has been assumed. It is expected that in FY92, the share of irrigation and water supply sales would be 16.0%, compared to 3.0% in FY83.

Demand Forecast and Capacity Margin

1.44 As stated in para 1.38, the maximum demand is calculated by assuming certain annual load factors. The present load factor is about 47.5%. It is assumed that it would improve to 50% in FY86 as new tariffs are expected to levy extra demand charges. The system maximum demand, proposed installed capacity and available capacity margin is shown year-wise in Annex 10. Except for the winter of 1988 one largest unit (30 MW) would be available as reserve. Maintenance of major hydro units is planned during the summer when maximum demand is low and water flows are high. Additionally those units in a power station which cannot be fully utilized during the winter could be serviced during that time.

Maintenance of Plant

1.45 Until the recent commissioning of Kulekhani I, which alleviated the shortage of generating capacity, NEC has been postponing major repairs and maintenance of its hydro power stations. A typical example is the Trisuli Power Station, manufacturers of whose equipment have recommended the closing of the power station for immediate repairs and proper maintenance. Further problems at Trisuli include an outage of one unit for the last two years due to a burnt-out stator, and a reduction in the station's daily peaking capacity because the pondage has been filled with silt. NEC has been aware of these problems and of the urgent need to carry out plant maintenance. Realizing that this maintenance is essential for the system to have a proper capacity margin, it has recently ordered essential spares. Also, for routine maintenance of civil works at hydro power stations, the Electricity Department has purchased maintenance equipment with funds provided by OECF. Maintenance programs are essential and to ensure that this work is carried out, an agreement was reached that a plant maintenance program for rehabilitating the existing hydro plants, satisfactory to IDA, would be furnished to IDA by March 31, 1985 and thereafter taking into account the Association's comments, if any, the said program would be implemented.

System Losses

1.46 System losses in Nepal are high. In FY83 total Nepal losses 1/ amounted to 30.5% of total generation. Following is a breakdown of losses by region:

Central Region	-	31.8%
Western Region	-	31.0%
Eastern Region	-	21.3%
Mid & Far Western Regions	-	19.0%

An analysis of losses in the NEC system is as follows:

Self Consumption (including station use)	-	4.0%
Transmission	-	5.0%
Distribution	-	22.5%
Total		31.5%

1.47 ADB, in its second power loan to Nepal, provided technical assistance for a comprehensive study by a specialist, a distribution engineer from British Electricity International, UK, to analyze the incidence of high distribution loss. He has visited Nepal, completed his study and has submitted recommendations to NEC and ADB.

1.48 According to the study, most of the losses occur in the distribution system of the Bagmati Zone, which with the Naryani and Janakpur Zones form the Central Region. In terms of consumption, the Bagmati Zone accounts for 75% of the Central Region's energy, 60% of NEC's energy, and 55% of Nepal's total energy; thus, it is the major area consuming electricity. A breakdown of system losses in each zone of the Central Region operated by NEC is given below:

Bagmati Zone	-	36.0%
Naryani Zone	-	13.5%
Janakpur Zone	-	23.0%

1.49 The high losses in the distribution system of the Bagmati Zone are mainly due to improper metering and theft of electricity. Based on the recommendations of the specialist, NEC has recruited 46 appropriate staff, purchased two vehicles and 7,200 meters. Also, enactment of by-laws dealing with theft is being undertaken. NEC's program calls for metering all unmetered consumers by January 31, 1985, checking and sealing meters of all large consumers and all domestic consumers by June 30, 1988 and rectifying and recalibrating all meters by June 30, 1990. NEC has started with the Bagmati zone. During negotiations, targets for reducing losses were agreed: in the Central Region losses to be reduced to 25% by FY86 and to 20% by FY91; the overall losses in Nepal to be reduced to 24% by FY86 and to 18% by FY91. The loss reduction program would include the above items of work. It was also agreed that the above specialist would be appointed by December 1984

1/ The definition for losses is given in Annex 6.

and, after his review, a revised comprehensive program will be submitted to IDA by July 15, 1985. Funds have been provided for this specialist under the proposed project.

1.50 In order to reduce technical losses in the distribution system, NEC is strengthening and upgrading its local distribution system. Under a Japanese Government grant of 1,500 million Yen, substantial improvements have been made in the Kathmandu distribution system during FY82. Another grant of 2,100 million Yen for the second stage of improvements has been negotiated and these works are planned to be commissioned by the end of 1984 (para 3.23). Apart from the Kathmandu valley, distribution facilities are also being strengthened in other areas. ADB's Third Power Project has provided a loan of US$2.6 million for the Biratnagar (Eastern Region) distribution system and US$1.92 million for the Birganj and Janakpur areas (Central Region). These works are likely to be completed by June 1986. The strengthening of the local distribution systems of the major load centers should enable technical losses to also be reduced, making it possible to realize the targets stated above.

II. EXECUTING AGENCY AND THE BENEFICIARY

A. Executing Agency

2.01 It has been the practice of HMG to establish separate organizations, known as development boards, to execute large, complex projects requiring close coordination with contractors and engineering consultants. The Minister, Ministry Water Resources, is usually Chairman of the Board which has served to facilitate the overall execution of the project, including being able to expedite decisions through Government and to gather a cohesive project team to focus full time on the project.

2.02 The Marsyangdi Hydroelectric Development Board (MHDB) would be the executing agency responsible for constructing the proposed project. Upon completion, the facilities would be transferred to the Beneficiary (para 2.05) for operation and maintenance. The debt incurred in building the plant would also be passed on to the Beneficiary for servicing (para 4.21). This arrangement would be the same as that used in constructing the Kulekhani Hydroelectric Power Project where the Kulekhani Hydroelectric Development Board was the executing agency.

2.03 MHDB has been officially established by Gazzette Notification No. 32, dated December 8, 1981. The Board members consist of the Minister and Assistant Minister, Ministry of Water Resources as Chairman and Vice Chairman, respectively. The other seven members are representatives of the Ministries of Water Resources, Finance, and Law and Justice; a member of the National Planning Commission; the General Manager, NEC; Chief Engineer, ED and the Project Manager, MHDB as Member Secretary. Once the NEC and ED are absorbed by the new Authority (para 2.05), the General Manager, NEC and Chief Engineer, ED will be replaced in the MHDB Board by appropriate officers from the new Authority.

2.04 A Project Manager has been appointed and the staffing of MHDB is near completion. The staff will total about 280, of which 170 will be involved with the technical aspects of the work and the remainder with administration, accounts and support work. The technical staff will include 35 engineers, many of whom will be seconded from the ED or, after the reorganization, from the new entity. The organizational structure includes five divisions/ sections: (a) Project Evaluation and Planning Division; (b) Civil Works Division; (c) Electromechanical Division; (d) Accounts Section and (e) Administration, Stores and Procurement Section (see organization chart). MHDB has already started some preliminary work (para 3.20). The size and complexity of the project requires engineering consultants to be heavily involved in its execution (para 3.18). During negotiations, assurances were obtained that HMG would maintain the MHDB with adequate staff, funds, powers and responsibility in order to carry out the works under the project. Such obligation will terminate six months after the works are handed over to the new Authority.

B. The Beneficiary

2.05 The Beneficiary would be a new Authority which is in the process of being established under a reorganization of the Nepal power sector (para 1.19). It will be known as the Nepal Electricity Authority (NEA). Draft legislation calls for it to be an autonomous and corporate body. During negotiations, agreement was reached that it will absorb the operations of NEC and ED, as well as the work of the development boards, except that those Boards presently executing projects will continue with the execution through to completion, after which future work of this nature would be carried out by the new Authority. Except for large, complex power projects involving neighboring countries and those small power projects carried out under the jurisdiction of the local panchayats, the new Authority will be responsible for the power sector on a national basis and will plan, construct, operate and maintain generating stations, transmission lines, distribution systems, and all associated facilities. This consolidation will serve to improve coordination between the planning, construction and operating functions, and thereby strengthen the sector's overall operations.

2.06 Under ADB's Fourth Power Project, a Memorandum of Understanding with HMG outlines the basic organizational structure of the new Authority. It shows four functional units: (a) generation and transmission; (b) distribution and customer service; (c) rural electrification (including isolated mini-hydro projects) and (d) planning, evaluation and finance. The Board would consist of eleven members, including a Chairman on a part-time basis, supported by a full-time Vice Chairman. Four members of the Board would be the officers in charge of each of the four operating units. Other members would be determined by HMG. A condition of effectiveness of ADB's Fifth Power Project requires HMG's approving the legislation for establishing the new entity. Also, under ADB's Fifth Project HMG has agreed that NEA would commence operations by April 30, 1985.

2.07 The reorganization along the lines indicated is a sound decision for Nepal. IDA has fully supported it and has been urging HMG to move ahead with it. There has been close coordination between ADB and IDA in all aspects of

this effort. In parallel with ADB's covenant requiring that the new Authority commence operations by April 30, 1985, during negotiations agreement was reached that the new Authority will be established with the powers and functions, and organizational structure (paras 2.05 and 2.06) by such a date to enable it to commence operations by April 30, 1985.

2.08 Consultants have been assisting HMG in implementing the reorganization. Coopers and Lybrand (financed by ADB), under the first stage of their assignment, have completed the institutional and organizational review. Under the second stage, C & L have been concentrating on the internal organizational structure and the design of management and accounting systems and procedures for which operating manuals are being prepared. A team of four experts (an institutional/management specialist, two accounting/financial experts and a valuation engineer), involving 56 manmonths, has been carrying out the first and second stages of the work, assisted from time to time by specialists from the consultant's headquarters. The institutional/management specialist worked with HMG in formulating a comprehensive schedule for implementing the reorganization, including the preparation of draft legislation for the new authority. The accounting/financial specialists have been assisting in developing accounting systems appropriate for the new utility. The valuation engineer has been supervising a physical inventory of all fixed assets, materials and stocks of the NEC and ED so that an asset accounting system may be established. This will be the basis for developing appropriate depreciation schedules and also for formulating a policy for a rational valuation and, as appropriate, revaluation of assets. The second stage is now nearing completion. The third stage of C & L's work, which has been contracted and which will also be funded by ADB, consists of 22 manmonths of work in helping to implement the new systems and in training of staff prior to the new entity commencing operations. Finally, under ADB's Fifth Power Project, an additional 31 manmonths of consulting services are being made available for expatriate adviser(s) to assist the new utility at the senior level.

2.09 A program for strengthening the technical operations has been identified through a study carried out by the CIDA team in Nepal. The program is in conjunction with establishing a training center for the power sector, which is to be financed under the proposed project (paras 3.24-3.28).

Audit

2.10 Nepal's constitution stipulates that the Auditor General, who is appointed by his Majesty, is responsible for auditing the accounts of Government corporations and authorities. Under the Kulekhani project, the AG carried out the audit for the project. With respect to the MHDB project accounts, this arrangement will continue. With respect to NEC, the AG has been delegating the work of performing the audit to an independent auditing firm. This arrangement is satisfactory and is expected to continue with the new Authority once it is established. This was confirmed during negotiations. NEC completes the preparation of its accounts in about four months. The AG however takes an additional eight months, including the three months it takes for the outside independent audit, before finally approving the audited accounts. The reason given for the delay is a shortage of AG staff. During negotiations, agreement was reached that (a) project accounts of MHDB will be audited for each fiscal year by an independent auditor

acceptable to IDA, and a report of such audit furnished to IDA not later than six months of the end of the fiscal year, and (b) the audited financial statements of the new Authority together with the full audit report will be submitted to IDA within twelve months of the end of the fiscal year. In order to enable IDA to monitor the financial performance within a reasonable period, an understanding was also reached that the unaudited financial statements of the new Authority will be submitted to IDA within six months of the end of the fiscal year. These arrangements are satisfactory.

Government Arrears

2.11 Private consumers have been settling their electricity bills satisfactorily, while the Government has been delinquent in settling its accounts. Based on NEC's records, as of the end of FY83 government arrears, including those for street lighting, amounted to NRs 12.8 million, which compares to government billings for that year of about NRs 6.8 million. The government arrears amounted to 39% of NEC's total arrears though government billings are only about 8% of total billings.

2.12 The Ministry of Finance agrees that in order to solve this problem, arrangements need to be made for ensuring that government agencies and departments pay on time, including treating them like any other consumer and disconnecting service for non-payment. During negotiations, agreement was reached that by March 31, 1985, HMG will furnish to IDA for its review and comments a proposal of methods/procedures for ensuring that Government users pay their electricity bills by no later than two months after receiving the bill and, taking into account IDA's comments, commence implementing such methods and procedures in a manner satisfactory to IDA, so as to ensure that the bills will be paid within two months of receiving them. Regarding government arrears owing NEC, those arrears pertaining to government agencies and departments have now been settled, and those pertaining to street lighting will be settled by August 15, 1984.

Dividends

2.13 The new Authority will require all available funds in order to be able to meet its operating expenses, service its debt and finance a portion its capital expansion. Although in the immediate future it will not be constructing generation and transmission plant (the existing development boards will continue with this construction until their respective projects are completed--para 2.05), it should nevertheless be expected to begin contributing to the financing of such plant. These funding requirements should be met before paying any dividends. During negotiations, agreement was reached that there will be no declaration of dividends before the completion of the Marsyangdi project and then only after the aforementioned requirements for internal funding are met, including the new Authority financing not less than 30% of its capital expansion.

Insurance

2.14 An appropriate insurance program for NEC that would be consistent with sound public utility practice was discussed with the NEC General Manager. He advised that he would request the National Insurance Corporation

of Nepal to review the matter in order that a recommendation for an acceptable insurance program could be presented. Should this not prove satisfactory, the General Manager would seek outside assistance. During negotiations, agreement was reached that the new Authority will undertake to develop an insurance program consistent with sound public utility practice and that a proposal of the program will be submitted to IDA for review and comment by June 30, 1985, and thereafter, taking into account IDA's comments, implement the insurance program in a timely manner satisfactory to IDA.

Training

2.15 There is no formalized training program in the power sector. The training that does take place is more on an ad hoc basis with counterpart staff being attached to consultants and contractors working on projects, a few staff being attached to the CIDA team working in an advisory capacity to the Ministry of Water Resources, and the occasional participant selected to attend seminars abroad. HMG recognizes the need for establishing training programs to upgrade staff essential for operating and maintaining the expanding power system in Nepal. In order to establish a training function as an integral part of the power sector's operations, a facility for practical training in technologies involved in an electric power system is required. This is being provided under the project (paras 3.24-3.27).

2.16 Other training under the project would be in conjunction with the work of the consulting engineer and contractor. The draft agreement of the consulting engineer provides for ten engineers to receive training in Germany for periods of from 1 to 6 months in such subjects as assessing the feasibility of hydroelectric projects, design of hydraulic structures and civil works, construction management of hydroelectric projects, erection and installation of equipment and operation of hydroelectric projects. The contractor's contract will include a provision for training local staff at the construction site in accordance with a pre-agreed program. Provision will also be made for the training of engineers in the workshops of contractors during the manufacturing and testing of equipment. Finally, training will also be carried out in conjunction with the work of the Coopers and Lybrand consultants (para 2.08), whose assignment includes the establishing of a training program concurrently with their developing improved systems and procedures.

III. THE PROJECT

A. Project Description and Objectives

3.01 The Marsyangdi Hydroelectric Power Project is a run-of-river project, located on the Marsyangdi River, a tributory of the Trisuli River which drains the Gandaki basin in Central Nepal (IBRD map 16928R). The project is about 110 km west of Kathmandu and is accessible either from the Kathmandu-Mugling-Pokhara highway or from the Hetauda-Bharatpur-Mugling road. The project is designed to develop the potential of the Marsyangdi River on a 13 km stretch where a gross head of about 90 m is available.

3.02 The project would divert the waters of the Marsyangdi River into a tunnel for the generation of power. Being a run-of-river scheme, the project will not alter the daily volume of water flow to India. The Association is satisfied that the project would not adversely affect the interests of India. The installed generating capacity consisting of three units, each rated at 23 MW, has been designed keeping in view the low flows during dry winter months (para 7 of Annex 13). The total annual energy based on monthly average flows that would be available from the project is estimated at 462.5 GWh (Table 4 of Annex 23), out of which 357 GWh is estimated to be consumed in the system (Table 2 of Annex 23). The firm annual energy based on 95% probability would be 209 GWh. The project would meet additional peak demand of the grid system up to 69 MW during winter 1/ and 66 MW during summer. The river flow data is available only for the last 10 years. It is therefore difficult to calculate the reduction in energy on occurrence of a dry year. However, it is estimated that within a return period of 10 years, minimum 1 day duration low flow could be 33.6 cu m/sec as compared to 35.6 cu m/sec on 95% probability (Annex 13). The average annual flow could go down to 186 cu m/sec in place of normal estimated flow of 209 cu m/sec. Energy output could be reduced by about 6% in winter months. On the occurrence of a drier year, there would be further loss in energy production. Should such a situation arise, existing diesels or regulated release of stored water from Kulekhani reservoir would be able to meet the shortfall. Alternatively, load shedding could be resorted to. The extent of shortage would depend upon the drought severity. For details of the project see Annexes 11 and 12. For project details of hydrology and sedimentation, geology and seismicity related to the project, refer to Annexes 13 and 14, respectively.

Project Components

3.03 The principal components of the project are:

(a) diversion works including the settling basin which will be used as diversion channel during construction but will be required for settling of suspended sediments later on;

(b) a 98 meter wide gated overflow type diversion weir with 5 radial gates;

(c) a 44 meter wide flushing structure with 2 radial gates for flushing sediment from the settling basin;

(d) an intake structure for the headrace tunnel;

1/ Sixty-nine MW is based on 95% probability flow available during month of December and the 1.5 million cubic meters available for daily pondage. Under one unit operation, the maximum output would be 26 MW. Under three unit operation, the maximum output would be 69 MW during winter and 66 MW during summer, the output of each unit being 23 and 22 MW, respectively. The variation is due to different head losses and different tailrace levels under varying river flow conditions.

(e) a concrete-lined circular headrace tunnel 7,100 meters long with a diameter of 6.4 meters;

(f) a surge tank;

(g) a 75 meter steel-lined pressure shaft with a 5 meter diameter;

(h) three tailrace tunnels of 30, 35 and 40 meters;

(i) a semi-underground power station with 3 units of 23 MW each;

(j) an outdoor 132 kV switchyard at Marsyangdi, extension of 132 kV substations at Bharatpur, and upgrading of the 66 kV Balaju substation to 132 kV;

(k) two 132 kV transmission lines from (i) Marsyangdi to Balaju (90 km) and (ii) from Marsyangdi to Bharatpur (40 km);

(l) extension of local distribution system at Kathmandu; and

(m) consulting engineer and technical assistance.

Project Objectives

3.04 The objectives are:

(a) to meet the forecasted demand for electricity in Nepal up to FY93; and

(b) to strengthen the power sector in Nepal.

B. Background of Project Investigation and Formulation

3.05 With the assistance of various donors, there have been investigations of various potential hydroelectric sites on the Marsyangdi River since 1966. The present site was first identified by a team of Chinese engineers in 1966 who proposed a run-of-river project with a power station of about 40 MW capacity using a canal of about 6 km and a 57 meter head. This proposal was slightly modified by the ED in 1974 which proposed a power station of 36 MW using a head of 51 meters through a 4.5 km long water conveyor system consisting of canal, tunnel and pipeline. Also, there have been several additional studies in which the high dam alternatives on the Marsyangdi River were investigated.

3.06 In 1980, the Water and Energy Commission compared 13 development programs to meet load demands up to FY91. These programs included 6 possible hydro projects and also various thermal (coal, gas, diesel) options. Based on this economic comparison, the Marsyangdi run-of-river project was selected as the next project.

3.07 The feasibility report of the project was prepared by consultants LI and SMEC in 1979 (para 3.18). In 1981, HMG entrusted the task of preparation of detailed engineering designs and tender documents to the same consultants. The funds for the feasibility study were provided by GTZ, and KfW provided funds for preparing detailed engineering design and tender documents.

3.08 Before finalizing the present design, various possible sites were inspected by the consulting engineer. Three alternative weir sites and six power station sites were examined in the area of the present site. As an alternative to a tunnel, a canal was also considered. In order to be able to get additional water from Darondi Khola (a small tributory of Marsyangdi) during dry winter months, the possibility of shifting the weir to a site downstream of the confluence of the Marsyangdi River with Darondi Khola (about 10 km downstream of the present site) was also examined. The geological conditions of all sites were found to be less favorable than the site finally selected for the proposed project. The power potential at other places was also found to be lower than the proposed project site because of smaller head.

3.09 The number of generating units chosen is three, keeping in view the following considerations: limits of the heaviest single weight for transport, requirement of capacity margin for forced outage and planned maintenance, efficiency of the units under low water discharge and, finally the increase in the cost of the project with the increase in the number of units.

C. Cost Estimates

3.10 The project is estimated to cost NRs 5,173.1 million (US$323.3 million equivalent), including a foreign exchange component of US$248.4 million. Details of estimated costs are shown in Annex 15, including supporting tables, and are summarized below:

Description	Foreign	Local	Total	Foreign	Local	Total	Foreign Exchange %
	(NRs million)			(US$ million)			
Preliminary Cost & Administrative Expenditure							
1. Preliminary works including land acquisition etc.	40.3	47.0	87.3	2.5	2.9	5.4	46.1
2. Administrative expenditure by MHDB	8.0	43.4	51.4	0.5	2.7	3.2	15.5
Civil Works (Lot I)							
3. Site installation I	101.6	18.0	119.6	6.3	1.2	7.5	84.9
4. Diversion works	109.1	48.8	157.9	6.8	3.1	9.9	69.1
5. Diversion weir, flushing structure and intake structure	510.4	148.6	659.0	31.9	9.3	41.2	77.5
Civil Works (Lot II)							
6. Site Installation II	308.6	54.8	363.4	19.3	3.4	22.7	84.9
7. Head race tunnel, surge tank	700.9	265.5	966.4	43.8	16.6	60.4	72.5
8. Pressure shaft, tail race, power station, switch yard	159.7	74.7	234.4	10.0	4.6	14.6	68.1
9. Permanent roads and outdoor works	9.4	5.9	15.3	0.6	0.4	1.0	61.8
Equipment							
10. Hydraulic steel structures	232.5	30.1	262.6	14.6	1.9	16.5	88.5
11. Mechanical equipment	120.6	24.0	144.6	7.6	1.5	9.1	83.4
12. Electrical equipment	297.3	55.2	352.5	18.6	3.5	22.1	84.3
Transmission Works							
13. Transmission lines	88.0	44.8	132.8	5.5	2.8	8.3	66.3
14. Substations & Local distribution system	135.2	36.7	171.9	8.4	2.2	10.6	79.2

Description	Foreign	Local /a	Total	Foreign	Local /a	Total	Foreign Exchange
	(NRs million)			(US$ million)			%
Consulting Engineer							
15. Consulting Engineer during construction supervision	120.4	-	120.4	7.5	-	7.5	100.0
Technical Assistance							
16. Panel of Experts & Claims Specialist	17.2	-	17.2	1.1	-	1.1	100.0
17. Supervision of system loss reduction program	1.7	-	1.7	0.1	-	0.1	100.0
19. Catchment management plan	3.4	-	3.4	0.2	-	0.2	100.0
20. Training for power sector	43.0	-	43.0	2.7	-	2.7	100.0
Total Base Cost	3,007.3	897.5	3,904.8	188.0	56.1	244.1	
Contingencies							
Physical /b	413.4	124.8	538.2	25.8	7.8	33.6	
Price /c	553.8	176.3	730.1	34.6	11.0	45.6	
Total	3,974.5	1,198.6	5,173.1	248.4	74.9	323.3	

/a Duties and taxes are included in local costs and amount to NRs 253.1 million equivalent to US$15.81 million. These are based on contract taxes at 5.0% of total contract price and custom duty at 1% of CIF price of imported equipment and material.

/b Physical contingencies as a percentage of base cost are provided at 20% for head race tunnel, 15% for other civil works, 10% for equipment, transmission lines, local distribution, substations and 5% for consulting engineer.

/c Price contingencies are provided as follows:

Year	1984	1985	1986	1987	1988	1989	1980
Foreign (%)	7.7	7.2	6.5	6.0	6.0	6.0	6.0
Local (%)	9.0	8.0	7.0	6.0	6.0	6.0	6.0

3.11 Cost estimates are based on mid-1984 prices. The estimates have been prepared by the consulting engineer after detailed site investigations and have been reviewed by the panel of experts. The transmission system for connecting the proposed Marsyangdi power station with the grid has been designed after detailed system studies. Keeping in view the uncertainties involved in the geology (para 6 of Annex 14), physical contingencies of 20% for the headrace tunnel have been provided as compared to 15% for other civil works. Total physical contingencies amount to 13.8% of the base cost. Price contingencies amount to 16.4% of the base cost, including physical contingencies. Exchange rate of US$ 1 = NRs 16.0 has been assumed.

D. Project Financing

3.12 The finances arranged are shown in the following table:

Source	Amount (million)	Amount Equivalent US$(million)	Purpose
IDA	US$	101.19	i) Civil works, Lot II (foreign cost)
		1.0	ii) Consulting Engineer (see para 3.14 for details)
		4.81	iii) Technical Assistance (see para 3.14 for details)
	Sub-total	107.00	
KFW	DM 186.3	54.57 /a	i) Equipment (foreign & part of local cost)
		12.65	ii) Substations and local distribution system (foreign and local cost)
		7.30	iii) Consulting Engineer (see para 3.14 for details)
	Sub-total	74.52	
SFD	SRls 86.0	24.5	i) Civil works, Lot I (part of foreign cost)
		0.5	ii) Consulting Engineer (see para 3.14 for details)
	Sub-total	25.0	
KFAED	KD 6.0	20.5	i) Civil works, Lot I (part of foreign cost)
		0.5	ii) Consulting Engineer (see para 3.14 for details)
	Sub-total	21.0	

/a Based on exchange rate of US$1 = DM 2.5
= SRls 3.44
= KD 0.286

Source	Amount (million)	Equivalent US$(million)	Purpose
HMG	NRs	28.05	i) Civil works, Lot II (local cost)
		29.77	ii) Civil works, Lot I (local cost & part of foreign cost)
		2.08	iii) Equipment and local distribution (part of local cost)
		10.54	iv) Transmission lines (foreign and local cost)
		5.73	v) Preliminary works (foreign and local cost)
		3.81	vi) Administrative expenditure (foreign and local cost)
		15.81	vii) Local duties and taxes
	Sub-total	95.79	
	Total	323.31	

E. Procurement

3.13 The following table shows the procurement arrangements:

Project Elements	Procurement Method				
	ICB	LCB	Others /a	N.A.	Total
			US$ Million		
Preliminary works (including land acquisition)	-	5.33	0.4	0.22 /b	5.95
Administrative expenditure	-	-	-	3.81	3.81
Civil works, Lot I	74.77	-	-	3.96 /b	78.73
Civil works, Lot II	129.24 (101.19)/c	-	-	6.84 /b	136.08
Equipment	-	-	56.65	3.40 /b	60.05
Substations and local distribution	-	-	12.65	0.77 /b	13.42
Transmission lines	-	-	10.54	0.62 /b	11.16
Consulting engineer	-		9.3 (1.0)/c	-	9.3
Technical assistance	-	-	4.81 (4.81)/c		4.81
					323.31

/a Tied procurement and consulting services.
/b Local duties and taxes payable by HMG.
/c Figures in parenthesis show IDA funds.

3.14 Preliminary works consisting of offices, residences, water supply and electricity at the project site (US$5.73 million) are already under execution with the funds provided by HMG. This includes US$0.40 million which is the estimated compensation cost for land acquisition. Administrative expenditure consists of the salary and other incidental expenses of staff of MHDB and will be financed by HMG. Civil works have been split in 2 lots. The costs of Lot I, consisting of the diversion weir, flushing structure, intake structure, diversion works and site installation (required for Lot I) is estimated at US$74.77 million, out of which foreign portion is US$60.48 million. US$45 million will be cofinanced by SFD, KFAED. Cofinancing for remaining portion will be arranged by HMG. SFD, KFAED will consider increasing their cofinancing after opening of bids. The contract will be awarded on the basis of international competitive bidding (ICB) as per guidelines of SFD, KFAED. The foreign cost of Lot II, consisting mainly of the headrace tunnel, pressure shaft and permanent roads, estimated at US$101.19 million out of total cost of US$129.24 million will be financed by IDA. The contract will be awarded on the basis of ICB in accordance with the Bank's procurement guidelines. The foreign and local cost of equipment (hydraulic steel structures, mechanical equipment and electrical equipment) is estimated at US$56.65 million, of which the foreign portion is US$51.37 million. Whole of the foreign portion and part of local cost, amounting to US$54.57 million would be financed by KfW. KfW would also finance the total cost of the substations and local distribution system estimated at US$12.65 million. The contracts will be awarded after inviting bids from suppliers within the Federal Republic of Germany. HMG is arranging funds from outside sources, including ADB, for the transmission lines estimated at a total cost of US$10.54 million. During negotiations, it was agreed that HMG will obtain necessary financing for these works by not later than June 30, 1986. The fees of the consulting engineer, amounting to US$9.3 million, will be cofinanced by KfW (US$7.3 million), IDA (US$1.0 million), SFD (US$0.5 million) and KFAED (US$0.5 million). The components of technical assistance consisting of the panel of experts fees (US$1.27 million), the cost of the Marsyangdi catchment management plan (US$0.25 million), a power sector training program (US$3.16 million) and supervision of loss reduction program (US$0.13 million) will be financed by IDA in accordance with IDA guidelines. The bidders for civil works are in the process of being prequalified. A price preference of 7.5% will be given to local contractors if they apply individually or as a joint venture. The design and technical specifications to be incorporated in the bidding documents have been prepared by the consulting engineer and reviewed by the panel of experts. In addition to two bidding package for civil works, there probably will be one bidding package for each of the following items:

1. Hydraulic steel structure
2. Mechanical equipment
3. Electrical equipment
4. Substations and local distribution system
5. Transmission lines

It is estimated that the bidding documents for civil works will be ready for issue by June 1984.

Contract Review

3.15 There would be one bidding package for Lot II of the civil works, which will be financed by IDA and is estimated to to cost US$129.24 million equivalent (including contingencies). This package would be reviewed by IDA prior to award of contract. Therefore, there would be 100% review of the Lot II civil works contract. Copies of the contract for equipment, transmission lines and substations, financed out of non-IDA funds, would be sent to IDA after contract award for information.

F. Disbursement

3.16 Disbursement under the proposed IDA Credit would be in respect of Lot II of civil works, consulting engineer and for technical assistance as shown below:

Category	% of Expenditure to be Financed
1. Civil Works (Lot II)	100% of foreign expenditures
2. Consulting Engineer	10.75% of foreign expenditure
3. Technical Assistance	100% of foreign expenditure

3.17 The project implementation program prepared by the consulting engineer (Annex 16) was discussed in detail with the panel of experts, KfW and MHDB during appraisal. The Consulting Engineer suggested an implementation period of 42 months. This was considered as optimistic; therefore, a period of 52 months was adopted after detailed analysis. The most critical item in the project is a tunnel of about 7 km length for which 37 months have been allowed. Keeping in view various types of rocks likely to be encountered during tunnelling, the panel of experts had recommended a period of 763 working day (32.5 months after allowing for Sundays and holidays). This was based on an average rate of tunnelling achievable. The project schedule however provides for period of 37 months allowing for unforseen contingencies. The overall schedules of 52 months is therefore realistic. This compares with the recently commissioned Kulekhani Project where civil work contract was awarded in August 1977 and the power station was commissioned in April 1982 involving a period of 55 months. Moreover, for the Marsyangdi Project a panel of experts was appointed in the early stages of project design and substantial preliminary work has been completed at the site. The disbursement schedule is based on 52 months implementation plan. A comparison of disbursements has been made between an average profile of eighteen IDA- financed hydroelectric power projects (commissioned between FY73 to FY83) and the proposed project. This comparison is shown below:

	Cumulative Disbursement (Project) (US$ million)	Cumulative Disbursement (Project) %	Cumulative Disbursement (Average Profile) %
1984/85			
December 31, 1984	-	-	-
June 30, 1985	14.7	13.7	1.0
1985/86			
December 31, 1985	27.7	25.9	9.0
June 30, 1986	40.7	38.1	21.0
1986/87			
December 31, 1986	53.7	50.2	34.0
June 30, 1987	66.7	62.4	48.0
1987/87			
December 31, 1987	76.3	71.3	62.0
June 30, 1988	85.9	80.0	74.0
1988/89			
December 31, 1988	91.0	85.0	84.0
June 30, 1989	96.1	90.0	92.0
1989/90			
December 31, 1989	101.6	95.0	97.0
June 30, 1990	107.0	100.0	100.0

For the first 5 semesters, the proposed disbursements are expected to exceed those of the profile. Preliminary work is already taking place, including prequalification of the civil works contractor, so that payments would be made soon after credit effectiveness for such items as the civil contractor's advance payment, mobilization fee, construction of the contractor's camp. Later, the disbursements are expected to slow down and follow the profile more closely. It is expected that by about the end of 1988, when the first unit of the power station is near commissioning, about 85.0% of the Credit would have been disbursed, about 90% would be disbursed by June 1989 when all three units are commissioned. The remaining 10.0%, representing such payments as claims, payments for remaining work, outstanding payments and retention fees is likely to be disbursed by June 1990. Thus, 100% of the Credit is expected to be disbursed in eleven semesters, which compares to the profile. There have been only three IDA financed hydroelectric projects completed in South Asia. This data base is insufficient and therefore a comparison has not been made with profiles of projects in South Asia.

G. Implementation

Engineering Services

3.18 MHDB has decided that the joint venture of Lahmeyer International of the Federal Republic of Germany (LI) and Snowy Mountains Engineering Corporation (SMEC) of Australia would be the consulting engineers for construction

supervision. This joint venture carried out the feasibility studies and detailed engineering for the project, and were financed by KfW after being selected from consultants within Germany. This selection is acceptable and meets IDA's guidelines. A provision of US$7.5 million (excluding contingencies) has been made in the project estimate to cover 701 manmonths of work, of which 128 are for local consultants and 573 are for expatriates. The costs are based on a draft agreement submitted by the consulting engineer to HMG in September 1982. This agreement is now being revised.

3.19 A panel of four experts consisting of (a) a hydrologist, (b) an engineering geologist, (c) a geo-technical engineer, and (d) a civil engineer has also been established by MHDB to review the design and safety aspects of the project and to make periodic reviews during construction. This panel has met four times , twice at Kathmandu during July 1982 and October 1982 to review the design, method of construction, implementation schedule and cost estimates prepared by LI and twice at Karlsruhe University (West Germany) during May 1983 and August 1983 to review the hydraulic model test results. In order to protect itself against claims from the contractors, MHDB intends to employ a claims advisor. A provision of US$1.1 million has been made to cover the cost of the panel and the claims advisor. Agreement was reached that the claims advisor would be appointed by January 31, 1985, in accordance with IDA's procedure so that he could assist HMG during contract negotiations, and that the services of the panel and claims advisor would be retained until project completion or such period thereafter as mutually agreed.

3.20 The Marsyangdi Hydroelectric Development Board (MHDB) (paras 2.03 and 2.04) has already undertaken considerable preliminary work (land acquisition at the project site, construction of houses and offices, access roads, water supply, electricity supply, etc.) using HMG funds amounting to US$5.7 million. About 50% of this amount is budgeted to be spent by the end of FY85, when it is planned to complete the essential portion of these works before contractors begin mobilizing at the site.

Ecology and Resettlement

3.21 Various ecological aspects, such as erosion in the catchment area, inundation of agricultural land, dislocation of human population and affects on fish life cycle, have been studied in detail. It is expected that about 69 ha of land and 8 houses will have to be acquired affecting about 110 land owners. About two ha of forest area will be submerged. To date seven houses and 49 ha of land have been acquired. Compensation has already been paid to land owners of 36 ha. MHDB has earmarked a sum of NRs 6.5 million (US$0.4 million) to meet compensation expenses. MHDB has also undertaken to offer employment to those displaced on a priority basis. It has been confirmed that tribal people are not being dislocated. During negotiations, HMG furnished a rehabilitation program for the dislocated persons. The project also provides for US$200,000 for preparing a report for implementation of a Marsyangdi catchment management plan. This plan would outline various steps to be taken, such as training of river banks and planting of trees and grass required to reduce the erosion and transport of sediment to the project site. The report would be prepared by consultants to be retained by HMG in accordance with IDA guidelines. An agreement was reached that the terms of reference, short list of consultants and procedure for selection would be

furnished to the Association so as to appoint the consultants by December 1984. Based on the consultant's report and with the approval of IDA, HMG will adopt and commence to implement the plan by December 31, 1985.

3.22 In addition to land required at the power station site, land will also be needed for extension of substations and for transmission line towers. An agreement was reached that the land acquisition process will be started as and when needed and that HMG will furnish to the Association, promptly after such acquisition, evidence satisfactory to the Association that such land and rights are available.

Local Distribution in the Kathmandu Valley

3.23 The present maximum demand in Kathmandu is 51 MW compared to 83 MW in the whole of Nepal. It is expected that Kathmandu will continue to be a major load centre after commissioning of the Marsyangdi project. Substantial improvements have been made in the Kathmandu distribution system during FY81 and FY82 and are likely to be made in FY84 with the help of grants provided by OECF of Japan (para 1.50). The details of these works are given below:

Works Already Executed (1981-82)		Works Planned in Next Program (1983-84)	
1. 11 kV lines	53.0 km	1. 11 kV lines	47.5 km
2. L.T. lines	119.0 km	2. L.T. lines	116.0 km
3. 11 kV line reinforcement	33.0 km	3. 11 kV reinforcement	3.0 km
4. Distribution transformer capacity	26.0 mvA	4. Distribution transformer capacity	28.0 mvA
5. Cables (11 kV & L.T.)	11.0 km	5. Cables(11 kV & L.T.)	25.0 km

It is foreseen that additional augmentation of the Kathmandu local distribution substations, not included in the OECF program of 1983-84, will be needed by 1989, when the proposed project is commissioned. This will consist of upgrading the existing 11 kV Balaju-Lainchaur line to 66 kV with a new 66 kV substation at Lainchaur. This has been included in the project.

Training Facility

3.24 Under technical assistance, the project provides for establishing such a facility along the lines recommended in a recent study carried out by the CIDA team. (A copy of the study is part of the project documentation file.) In determining the training needs, the study examined both the existing electric power system and its expected expansion over the next decade and the required staffing to operate and maintain it. The study shows, and senior NEC management agrees, that the most serious manpower problems lie in the technician category and that a training program for this category is especially needed. The technician category is that body of technical specialists whose training and deployment lie between that of the tradesman and the professional engineer, who directly supports engineers, can analyze operations and maintenance problems and carry out the work. According to the study, this category of technicians in the power sector numbers some 1,600 non-officer grades I-IV (supervisor-I, foreman-II, journeyman-III, helper-IV). Of the 1,600, about 1,100 are in operations and maintenance and the remainder in the design and construction divisions. While the plan is for

the proposed training program to focus on the technician category of staff, it would not be wholly restricted to this group. There also would be scope for training of financial and commercial staff as well as specialized and refresher courses for engineers.

3.25 The objective of the training component is to establish in the power sector a comprehensive, practical training facility as a center for formalized, continuous training programs that will serve to upgrade the staff and enable an overall system approach to be developed in dealing with Nepal's growing and increasingly complex power system.

3.26 The cost for establishing the training center and operating it for a period of three years is estimated at US$3.6 million, including a foreign exchange component of US$2.7 million (mid-1984 prices). The foreign cost, which would be financed under the project, would cover five specialists to be domiciled in Nepal for three years (US$1.9 million), two vehicles, including spare parts, (US$30,000) and training equipment (US$750,000). The local costs, to be financed by HMG, amount to US$0.9 million and would finance the building and housekeeping expenses for the three years. A project cost estimate is shown at Annex 17.

3.27 The plan of action together with a timetable for establishing the Center is:

(a) HMG to appoint a training coordinator by not later than two months from date of Credit effectiveness;

(b) HMG to prepare a short list of firms (about four), from which to call proposals, and to prepare terms of reference. The short list, the invitations for proposals and terms of reference to be submitted to IDA for approval by not later than four months from date of Credit effectiveness;

(c) invitation by HMG to submit proposals to be issued by not later than one month following the approval of Association of short list under (b) above;

(d) HMG to submit its recommendation for selection of consultants by not later than six months after issue of invitations under (c) above;

(e) the contract to be signed by not later than one month from date of approval of Association;

(f) the consultants to arrive in Nepal and commence their work by not later than two months after signing the contract. At this time the training center will commence operations in an existing building supplied by HMG. A regular building designed for the training center will be built and completed by not later than twelve months from the time of arrival of consultants; and

(g) HMG to appoint counterpart staff to the consultants team to be ready to join the team upon its arrival in Nepal. The counterpart staff will take over the training center's operations from the consultants team upon the latter's departure.

During negotiations agreement was reached that the plan of action for establishing the training center will be carried out in the time frame indicated in (a) through (g) above.

Risks

3.28 The risks involved in the execution of the project could be in respect of design, construction, project management, delays in supply of essential items such as fuel, cement, steel, excessive claims and cost overruns. Steps taken to prevent these risks include the appointment of a panel of experts to review the design and make periodic reviews during construction (para 3.19), appointment of a claims advisor (para 3.19), provision of appropriate physical contingencies (para 3.10), a well staffed executing agency (MHDB) which, with the close assistance of the consulting engineer, will manage the project and supervise the contractors (para 3.20). MHDB will also draw upon the experience gained in executing the Kulekhani Project. The most critical item in the project is the 7.1 km tunnel. Should exceptionally poor geology be encountered, the project could be delayed. The panel of experts, therefore, includes one geologist and one tunnelling specialist. Further steps include the erection of a 33 kV line to the project site to avoid dependency on diesel power generation, and construction of approach roads to the construction camp and offices. The contractors, suppliers and consultants will insure against physical risks to equipment during transport, handling and erection and against third party risks. The individual works during execution will also be insured against physical hazards. The insurance will cover design defects in the civil works as well as in the equipment. In view of these steps, HMG has decided that it would not appoint a special consultant to carry out a risk analysis of the project. This decision is acceptable.

Completion Report

3.29 HMG should undertake not later than six months after the closing date, or such later date as may be agreed for this purpose, to prepare and furnish to the Association a Project Completion Report of such scope and in such detail as the Association shall reasonably request, on the execution and initial operation of the project, its cost and the benefit derived from it, the performance by the Beneficiary and the Association of their respective obligations under the draft Development Credit Agreement and the accomplishment of the objectives of the Credit.

IV. FINANCES

4.01 The following discussion on the financial aspects is confined to the operations of NEC and would be applicable to the new Authority once it is officially established.

Tariffs

4.02 There has been a reluctance in Nepal to raise tariffs even in the face of increasing costs. Consequently, the present tariff level, averaging 81 paise/kWh (5.1 US cents), which was increased in May 1983 for the first time in three years, is still on the low side and has been a major factor in NEC's depressed earnings (para 4.14). This average tariff level compares to the estimated average long-run marginal cost of NRs 2.50 per kWh.

4.03 The tariff schedule consists of seven categories: domestic, commercial, industrial, irrigation, transport, street lighting and bulk supply. The tariff has a two-part structure consisting of a demand (kW) charge and an energy (kWh) charge for commercial and industrial consumers; there is an increasing block tariff for domestic consumers, and bulk electricity export to India is charged at 14 Indian paisa per kWh under a special agreement. (A summary of tariffs is at Annex 18.)

4.04 In order to achieve financial targets and objectives, tariff levels need to be raised and the schedules carefully restructured taking into account the marginal cost within consumer categories and the willingness and ability of consumers to pay. The basis for classifying consumers needs to be rationalized and, where possible, off-peak supply should be encouraged. Also, a distinction is required between wet and dry periods to reflect differences in cost of supply. It was in pursuance of these objectives that a tariff study was undertaken by HMG's Energy and Water Commission, assisted by consultants. The study's report presents an estimate of the marginal cost of providing electric power by season and time of day, and applies marginal cost to structuring tariffs for each customer class. In early 1983, NEC presented a tariff proposal along these lines to HMG; however, the tariff as finally approved addressed the level but not the differential for seasonal and time of day costs. Tariffs were increased on average by 58% in May 1983 and then three months later reduced by 2%, to 56% (para 4.07). In future tariff adjustments, HMG should be urged to reflect the cost differentials.

Earnings Covenant

4.05 The earnings covenant under Credit 600-NEP (Kulekhani I) stipulates that revenues of the Nepal Electricity Corporation (NEC) be sufficient to earn the following annual rates of return on average net fixed assets in operation: FY76-77 - 2.5%, FY78-82 - 4.0%, FY83 and thereafter - 6.0%. After the 6% target is reached, the position is to be jointly reviewed by HMG and IDA with a view to reaching 8% as early as possible thereafter. Except for FY80, NEC has not been meeting the earnings covenant (para 4.15).

4.06 In order for NEC to have reached a 6% rate of return in FY83 (FY83: July 16, 1982 - July 15, 1983), tariffs would need to have been increased by about 110%. In discussions between senior HMG and Bank officials, it was recognized that a single increase of this magnitude was not possible, and it was informally agreed that, as an alternative, tariffs could be raised in two tranches of 65% each, with the first increase to be implemented by December 16, 1982, to be followed by the second within nine months, i.e., by September 16, 1983. However, considering that it would likely prove too difficult for HMG to effect a second 65% increase within nine months, it is recommended that the interval be extended to eighteen months, at the latest.

4.07 Tariffs were eventually increased in May 1983 by 58%, and then reduced three months later to 56%. 1/ Based on an interval of 18 months, the second tranche of the increase would be introduced in November 1984 and would be 65%, the increase required to enable a 6% rate of return to begin to be achieved. Forecasts show that the 65% tariff increase would enable the rate of return to rise from 1.5% in FY83 to between 5.1% and 5.7% during FY84-86, and to 6% during FY87-89. 2/ A 65% increase, while substantial, is feasible with a rationally structured tariff, and is required to enable the electric utility operating the power sector to begin achieving financial viability.

4.08 The 56% tariff increase raised the average charge per kWh of 52 paise (3.3 US cents) to 81 paise (5.1 US cents); the 65% increase would raise it to NRs 1.34 (8.4 US cents at the present exchange rate). The reason for the substantial charge per kWh required to earn even a 6% rate of return 3/ is the higher than normal cost of building power infrastructure in Nepal. This stems from the remoteness of the country and its difficult terrain and geological conditions, poor communications, scattered load centers which are widely distributed, lengthy high voltage transmission lines relative to the size of loads and high cost of fossil fuel supplies for diesel generation.

4.09 During negotiations, agreement was reached that the second tranche of the tariff increase, amounting to 65%, would become effective by not later than November 30, 1984. Also, agreement was reached that (i) tariffs would continue to be maintained at a level to produce revenues sufficient to earn a rate of return on average net plant in service of not less than 5.0% in FY85, 5.4% in FY86 and 6% thereafter, and (ii) before April 16 in each fiscal year, the operating authority will, on the basis of forecasts prepared, satisfactory to IDA, review the adequacy of its rates to produce an annual rate of return as set forth above in respect of the current year and the following fiscal year, and furnish IDA the results of the review. If the review shows that the entity does not earn the required return, it will promptly take all action to do so, including adjusting the level and structure of its tariffs. In calculating the rate of return, the amount of income tax at the rate of 50% will be included as an operating expense. Should HMG in the future lower the rate of income tax, the required rate of return to be earned would be adjusted upward in the same proportion as though the 50% rate of income tax were in force. (See para 4.12 for a statement on that part of the earnings

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1/ Under the previous Government, a tariff increase of 58% became effective in May 1983; but, under the new Government, it was reduced to 56% in August 1983.

2/ FY means Borrower's fiscal year.

3/ It should be noted that while a 50% income tax is included as an operating expense, the tax is calculated on net profit after interest charges. Forecasts show that with the incurrence of debt, interest charges will become sizeable so that though there is a tax effect it is not as substantial as it might appear. Calculating the rate of return net of the tax would increase only by between 0.1% - 1.9% during the forecast period.

covenant related to revaluation of assets.) This proposed earnings covenant would supersede the existing agreement.

Revaluation of Assets

4.10 NEC does not revalue its assets nor is there a method presently established for doing so. For the time being, the effect of not valuing the assets at current prices would not be substantial, since expansion of the power sector to any degree has only recently commenced. For example, under the capital expansion programs, the value of gross fixed assets is shown to increase from NRs 914 million in FY83 to NRs 10,205 at the end of FY91, or eleven times, with 27% of the increase taking place in fiscal years 1984 and 1985, and 56% in FY89.

4.11 In considering revaluation, it should be borne in mind that to achieve a 6% rate of return on historically valued assets, tariffs already will need to be raised from the present average charge per kWh of 81 paisa (5.1 US cents) to NRs 1.34 (8.4 US cents). This is considered a reasonable step in a long-term strategy of increasing tariffs. In terms of a roughly revalued rate base, this would be equivalent to about 4.5% rate of return. One of the most important objectives of the covenant is to maximize earnings, and the present covenant provides for this.

4.12 While the principle of preserving values would require the earnings covenant to be based on revalued assets, it is too early to consider a revalued rate base until the new system of asset accounting and an agreed method for revaluation is established. The consultants, which are assisting HMG in designing the new accounting systems (para 2.08), will also be developing a method for asset revaluation.

4.13 Under the circumstances, a requirement to revalue assets was not included in the earnings covenant at this time. Instead, the revaluation concept will be introduced through the consultants' work and implemented at a later time. During negotiations, agreement was reached that assets would be revalued, using a method satisfactory to IDA, by July 16, 1986. Once the revaluation has been made, IDA will review it with HMG with the aim of agreeing on a rate of return based on revalued assets. Until such time as the rate of return on revalued assets would be introduced the proposed covenant would continue to be operative.

Past Operations

4.14 NEC income statements for FY79-83 are shown in Annex 19. The following table is a summary of past operating results:

Year ending July 15:	1978/79	1979/80	1980/81	1981/82	1982/83
GWh generated and purchased	182.0	195.0	201.2	228.5	333.9
GWh sold	119.3	137.2	133.5	148.2	224.1
Station and office use (GWh)	3.4	3.7	3.6	3.6	4.1
System losses	32%	28%	32%	34%	32%
	----------NRs Million----------				
Operating revenues	49.3	63.0	74.0	80.8	126.8
Operating expenses (incl. income tax	55.8	50.3	69.6	79.7	116.3
Net operating income after tax and before interest	(6.5)	12.7	4.4	1.1	10.5
Rate base	369.7	365.5	399.6	551.3	710.2
Rate of return	(1.8%)	3.5%	1.1%	0.2%	1.5%

4.15 NEC's past operating results have been depressed. As shown in the foregoing table, NEC sustained an operating loss in FY79 and earned returns of 3.5%, 1.1%, 0.2% and 1.5% in FYs '80, '81, '82 and '83 respectively. The improvement in FY80 was a result of HMG discontinuing the royalty surcharge 1/ and a 30% tariff increase, and satisfied the covenanted 4% rate of return when, in accordance with the covenant, revenues were annualized to reflect a tariff increase in that year. The generally depressed financial results have been due to low tariffs, high system losses and, before it was discontinued, the royalty surcharge.

4.16 Despite weak operating results, NEC's finances have been manageable because of its rather unique financial position of very little debt, a cash flow just sufficient to finance modest distribution expansion, and no call on earnings to finance generation and transmission plant. The background to this unusual situation for a public utility is that the few additions for generation and transmission plant have been provided through bilateral grants and, when the asset has been transferred to NEC, it has been recorded as equity. However this is now changing as credits/loans are being used to finance capital expansion. Beginning with FY81, NEC/the new Authority will increasingly incur debt in connection with assets transferred to it for operation (para 4.20).

4.17 NEC Balance Sheets for FY79-83 are shown in Annex 20. Following is a summary of NEC's capitalization as of July 15, 1983:

1/ A royalty surcharge of 7.5 paise for each kWh sold was levied. It was discontinued in FY80.

Equity	NRs Million	US$ Million Equivalent	%
Government investment	755.5	47.2	
Consumer contributions	10.5	.7	
Retained earnings	(3.4)	(0.2)	
Total Equity	762.6	47.7	95
Long-Term Debt	41.0	2.6	5
Total Capital	803.6	50.3	100

As mentioned, this very conservative capital structure, with debt amounting to only 5% of total capital, reflects a financing pattern where capital expansion has been financed with grants which were then passed on in the form of equity to NEC. The negative figure for retained earnings reflects the past depressed operating results.

Financing Plan

4.18 A forecast of sources and applications of funds for the period FY84-91 is shown in Annex 21. The assumptions used are outlined in Annex 22 and include upward tariff adjustments and execution of the construction program as planned. Following is a summary of the financing plan for the Beneficiary as a whole covering the period FY85-90, during which the proposed project would be implemented.

FINANCING PLAN

Period of Marsyangdi Project FY85-90

	NRs Million	US$ Million Equivalent	%
Application			
Capital assets transferred to NEC	7,271	454	91
Capital expenditures	290	18	4
Advances for construction	243	15	3
Working capital increase	157	10	2
Total requirements	7,961	497	100
Sources			
Internal cash generation	2,228	139	28
Less: Debt service	1,526	95	19
Net internal cash generation	702	44	9
Government equity contributions	3,172	198	40
Debt to be incurred, incl. the proposed IDA credit of US$107 million	4,087	255	51
Total sources	7,961	497	100

4.19 The amount of funds shown in the financing plan is large and illustrates the characteristic capital intensiveness of power infrastructure. During the six-year period under review, fund requirements are expected to total NRs 7,961 million (US$497 million), consisting of NRs 7,804 (US$487 million) for capital investment and NRs 157 million (US$10 million) for increase in working capital. The proposed project, estimated to cost NRs 5,173 million (US$323 million), including a foreign exchange component of US$248 million, represents 66% of the total capital investment during this six-year period.

4.20 Sources of funds include debt to be incurred by the Beneficiary in respect of assets to be transferred. This debt amounts to NRs 4,087 million (US$255 million), including the proposed IDA credit of US$107 million which would provide 43% of the project's foreign exchange component of US$248 million. The remaining US$148 million of debt is in respect of the debt portion of the capital cost of the proposed project and other projects being executed which upon completion will be transferred to the Beneficiary during the six-year period under review. Those works outside the proposed project, other than modest extensions to the distribution system by the Beneficiary, are being executed by Boards similar to the Marsyangdi Board or by donor organizations. All funds for these projects have been arranged.

4.21 The ownership of the Marsyangdi project upon its completion and commissioning would pass to the new Authority which would operate and maintain it. During negotiations, it was agreed that the ownership of the Marsyangdi plant shall be transferred to the new Authority within not more than six months of commissioning and that the Borrower shall inform the association within sixty days of the transfer. Such information shall include the date of transfer, the amount of assets transferred as equity and debt and in the latter case, the terms and conditions of such debt. The debt recorded would be less any amount that the new Authority would have contributed towards the cost of the project. It was further agreed that the part of the project financed with IDA funds would be transferred as debt with repayment over 30 years at 12% annual interest. 1/ A grace period is not involved since the Authority would assume ownership of the assets only after commissioning. The Government would bear the foreign exchange risk. It was also agreed that the Borrower shall cause NEC to increase its authorized share capital as and when needed to issue shares for assets transferred as equity.

4.22 The financing plan shows HMG providing funds to the Beneficiary as equity amounting to NRs 3,172 million over the six-year period. However, there is also a transfer of funds from the Beneficiary to HMG amounting to about NRs 1,550 million. This transfer consists of debt service payments to HMG at or near commercial terms on concessionary loans/credits extended to HMG, and payments for income tax and customs duties. The total of these payments is equivalent to about 20% of the total capital investment during the six-year period.

4.23 The Beneficiary is shown to finance 9% (12% before income tax) of capital requirements from internal cash generation, after debt service; government equity would provide 40% and borrowings 51%, bf which 42% would be the proposed IDA credit. The Beneficiary's modest contribution of 9% of capital investment reflects a situation where the present system is small (151 MW installed generating capacity and 127,000 consumers) in relation to a substantial capital program. In these circumstances and at the early stage of power development in Nepal, it is not expected that internal sources would finance more than a modest portion of capital investment.

Future Finances

4.24 Forecast income statements, balance sheets, and sources and applications of funds statements for FY84-91 are shown in Annexes 19, 20 and 21 respectively; notes and assumptions are in Annex 22. A summary of forecast operating results for the eight-year period is as follows:

1/ During the five-year period FY79-83, the average annual increase in the National Consumer Price Index in Nepal was 9.7%. Forecasts show an inflation rate of between 7% and 9%. The current interest rate for government loans for working capital range between 11% and 15%, and for investment purposes between 10% and 11%.

Year ending July 15:	1984	1985	1986	1987	1988	1989	1990	1991
Average revenue per kWh sold (NRs)	0.82	1.17	1.35	1.35	1.35	1.35	1.49	1.76
Revenue (NRs Million)	221	348	451	537	613	690	827	1058
Net Operating Income (after tax) (NRs million)	90	140	177	232	260	253	404	547
Times debt service covered by internal cash generation	1.2	1.5	1.9	1.6	1.8	1.8	1.0	1.4
Debt/equity ratio	47/53	36/64	40/60	47/53	46/54	45/55	52/48	52/48
Rate of return (historically valued assets)(%)	5.7	5.1	5.4	6.0	6.0	6.0	6.0	6.0

4.25 Revenue projections are based on increases in generation of electricity, tariff increases and a gradual reduction in system losses. Operating expenses are forecast based on system expansion and planned thermal generation. Depreciation is taken at a 2.7% composite rate. The eight-year forecast shows operating revenues and expenses increasing at an average annual rate of about 29% and 22%, respectively. The number of kWhs available for sale during this period is shown to increase by 131% and kWhs sold by 174%, reflecting a decrease in system losses. For the period through FY91, this improvement together with the tariff increase would enable the Beneficiary to begin earning a rate of return of 6%, cover its debt service and contribute 9% of the cost of the capital investment program. Forecasts show that in fiscal years 1990 and 1991 additional tariff increases of about 11% and 18% would be required in order to continue achieving a 6% rate of return.

4.26 Forecast balance sheets (Annex 20) show the Beneficiary's financial position during the eight-year period FY84-91. The balance sheets reflect the substantial growth expected in gross fixed assets, from NRs 914 million in FY83 to NRs 10,205 at the end of FY91. In financing this expansion, long-term debt is expected to increase from a negligible NRs 41 million in FY83 to NRs 4,986 million in FY91, resulting in a debt/equity ratio of 52/48 in FY91, normal for an electric utility. Equity would increase from NRs 763 million to NRs 4,645 million as a result of substantial Government equity contributions. Other than debt service coverage by internal cash generation reaching unity in FY90, debt service coverage is satisfactory throughout the forecast period, as is the ratio of current assets to current liabilities. Nevertheless, with the new financing pattern emerging with capital assets being increasingly financed with debt, the debt servicing position should be monitored. During negotiations agreement was reached regarding a limitation on the new Authority's incurring debt, based on the Bank's debt limitation covenant, with debt service coverage stipulated at 1.2 times.

V. JUSTIFICATION

5.01 A comparison of the load requirement of the integrated system with the available generating capacity reveals that unless a new generating station is added to the system by FY88/89, the forecast load demand would not be

met. Without any additional generation, the installed available capacity would be 142 MW compared to the maximum system demand of 159 MW; the energy requirement would be about 697 GWh compared to available hydro energy of about 614 GWh (Tables 1 and 2 of Annex 23). To meet these projected load demands, it is planned to construct the Marsyangdi Hydroelectric Power Project. As the first unit of Marsyangdi is not likely to be commissioned until March 1989, a capacity and energy shortage may be experienced in the winter of 1988 (para 1.44).

Least-Cost Solution

5.02 In 1982, the consulting engineer used a computer program (EXSIM) 1/ to determine the least-cost power expansion program out of four possible programs consisting of a mix of hydro projects (for which feasibility/ prefeasibility reports were available), 2/ coal-fired thermal and low-speed diesel. All programs were designed to meet a system demand of 495 MW and 1995 GWh by FY95. It was concluded that even up to a discount rate of 15%, it would be more economical to build Marsyangdi in comparison to alternative thermals.

5.03 Further economic comparison was carried out which established that the Marsyangdi Project is still the least-cost solution. Four alternative programs have been considered for the development of the power system to meet system demand of 391 MW and 1862 GWh up to FY2000.

Alternative I

(a) Eastern Interconnection consisting of 283 km of 132 kV transmission line from Hetauda to Biratnagar (to be operational by June 1986);

(b) Western Interconnection consisting of 270 km of 132 kV transmission line from Dumkibas to Nepalganj (to be operational by June 1987);

(c) Kulekhani II Power Station (hydro) consisting of 2 units of 16 MW each (to be commissioned by October 1986);

(d) Marsyangdi Power Station (hydro) consisting of 3 units of 23 MW each (to be commissioned between March-July 1989); and

(e) Sapt Gandaki Power Station (Hydro) consisting of 3 units of 75 MW each (to be commissioned during FY94, 95, 96).

1/ Interim report of the consulting engineer establishing the least-cost sequence for power generation expansion will be included in the project document file.

2/ Other projects for which studies are not available yet could not be considered. To enlarge the scope of selection for future power development program, additional studies are being carried out (para 1.23).

Alternative II 1/

Same as Alternative I except that the Marsyangdi Power Station is replaced by a coal-fired thermal station.

Alternative III 1/

Same as Alternative I except that the Marsyangdi Power Station is replaced by a low-speed diesel station.

Alternative IV 1/

Same as Alternative I except that the Marsyangdi Power Station is replaced by a gas turbine station using diesel oil.

5.04 In all alternatives, Sapt Gandaki is assumed to be the next hydro project because HMG has made detailed investigations of this project. The location of all thermal power stations has been assumed to be at Birganj, the terminus of the railway system from India. The Nepal Oil Corporation (NOC) has an agreement with the Indian Oil Corporation (IOC) for supplying fuel. All fuel is transported by NOC across the border by trucks. The total fuel consumption in Nepal in FY83 was about 147,600 tons and is estimated to grow to about 290,000 tons by FY93, a 7% per annum growth rate (para 1.10). If gas turbines are used, the requirement for of fuel would rise by an additional 117,000 tons in FY93 (peak period of thermal generation), or a 40% increase over the 290,000 tons. In order to handle this sharp increase, there would be two options. The first option would be to negotiate with IOC for an increase in supply and extend their existing road haulage facilities. However, this would not be reliable because of frequent breakdowns of trucks and likely interruptions due to land slides. The second option would be to use Indian Railways from Calcutta to Birganj via Baruni. This option would ensure better firm supplies of fuel if satisfactory transport arrangements are made. This option has been used in the economic analysis. The cost of transporting fuel has been estimated on the basis of existing tariff. (For details refer to Table 3 of Annex 23.)

5.05 In all alternatives, the thermal energy has been generated only when hydro energy is not available. The calculations are based on the assumption that 357 GWH produced by Marsyangdi annually would be used in the system. In case of drought, usable hydro energy would be reduced resulting in increased fuel cost required for extra thermal energy. However, these considerations have not been included in economic calculations because (a) it is difficult to quantify the shortage of energy in any particular dry year as hydrological data is short; and (b) the effect is not likely to be significant (para 3.02). The costs are based on mid-1984 prices and do not include price

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1/ It is not possible to replace the Marsyangdi project with any other hydro project because there has been no detailed engineering for any other hydro project. The only practical way of meeting the system load demand by 1988/89 is either to implement the Marsyangdi project or to replace it with one of the thermal alternatives referred to above.

escalation, nor local taxes and duties. Local costs have been converted to border costs. The planning period is up to FY2000. The comparison has been made between the present value of various alternative programs at discount rates of between 8% and 16%, and assuming the life of the proposed project to be 50 years.

5.06 The supporting energy balance calculations are shown in Table 4 of Annex 23. It will be seen from the cash flow and present value statements (Table 5) that the program which includes the Marsyangdi project, is the least-cost solution up to a discount rate of 11.9%, with the next best solution being Alternative IV (gas turbine). Nepal, being landlocked, HMG is strongly opposed to the idea of developing further power generation programs which depend upon fuel oil. It is felt that the continuous import of fuel oil would be a a drain on foreign exchange resources and also that in the light of past experience and tremendous transport constraints which exist the supply itself could be unreliable. This reasoning is sound, particularly in light of the abundant hydro resources in Nepal. The Marsyangdi project being the least-cost solution up to discount rate of 11.9% is therefore the correct choice.

5.07 The following sensitivity analysis was carried out in order to check the influence of a lower load growth, a variation of fuel costs and the cost of civil works of the Marsyangdi project:

Case 1: Investment of all alternatives has been postponed by one year on the assumption that load demand projected for FY89 will materialize only by FY90. This would mean that instead of overall annual growth rate of 14.7% in sales during FY83-FY89, it will be 12.5%;

Case 2: Instead of 3% annual increase in real prices of fuel from 1985 onwards, assumed in the calculations, a 4% increase has been considered for Alternatives III and IV;

Case 3: An annual increase in real prices of fuel has been assumed by 2% from FY85 to FY95. No increase has been considered beyond FY95.

Case 4: The cost of civil works of Marsyangdi project has been increased by 10%;

Case 5: The cost of civil works of Marsyangdi project has been decreased by 10%.

The present values of all alternatives and the switching values of discount rates up to which Alternative I is the least cost solution under various conditions are given in Table 5 of Annex 23. It will be seen that whereas postponement of the project has no effect (Case 1), an increase in the annual increase of 1% in real prices of fuel (4% as compared to 3%) makes the project the least-cost up to discount rate of 12.7% (Case 2). By assuming an annual increase of 2% upto FY95 and no increase thereafter, the project is the least cost upto discount rate of 10.4% (Case 3). Ten percent increase in civil works cost changes the discount rate to about 10.9% (Case 4).

5.08 The consulting engineer has used a computer program (EXSIM) to check if it would be economical to design Marsyangdi as 50 or 100 MW instead of 69 MW. For each different version, designs were optimized by the consultant and the costs were estimated. When these versions were used to replace 69 MW project in the expansion program referred to in para 5.02, it was concluded that 69 MW version is the most economical. This is a correct conclusion. Primarily because of low flows during winter, increase in installed capacity beyond 69 MW would not be justified. In addition, the pondage available for daily peak would also not permit a peak as high as 100 MW.

Cost/Benefit Analysis

5.09 The benefits of Marsyangdi project are:

(a) increased generation of primary and secondary energy making it possible to sell more electricity to consumers within Nepal or to India until the power market in Nepal is developed;

(b) conservation of imported fuel which would have been required to run the existing diesel stations to meet essential loads in the absence of Marsyangdi project; and

(c) strengthening of the grid transmission system of Nepal and local distribution system of Kathmandu.

The internal rate of return on the project is the discount rate which equalizes the economic costs and benefits. For the sale of energy to consumers within Nepal, there is consumers' surplus beyond the tariff. The benefits should, therefore, not only include the observed revenues paid by the consumers according to the prevailing tariff but also should include consumers' surplus. In the absence of electricity, some consumers would be willing to use alternative energy sources, even if the cost were higher than that for electricity. No sufficient bases are available for calculating benefits due to consumers' surplus; it is also not possible to calculate the benefits attributable to better transmission system reliability and to improved Kathmandu local distribution.

5.10 Benefits have therefore been calculated on the tariffs alone. Both the existing as well as the proposed tariff have been considered. All costs have been converted to border costs and are based on mid 1984 prices. Cost and benefit streams up to CY 2040 are shown in Annex 24. In Case 1 where the existing tariff is considered, the IRR is 3.9% and in Case 2 where the proposed tariff is considered, the IRR is 5.9%.

5.11 The true economic rate of return would be significantly higher if all benefits could be quantified, such as willingness to pay of all types of consumers, increased system reliability. Additional effect would be the conservation of foreign exchange due to reduced oil imports.

5.12 A sensitivity analysis has been made in order to check the impact of the following assumptions on the IRR:

(a) Benefits are increased by 10%;

(b) Benefits are decreased by 10%;

(c) Output of Marsyangdi (benefits) is deferred by one year; and

(d) Secondary energy is sold to India at the existing tariff of IRs 0.14/KWh.

The results are given in Annex 24. It will be seen that in all cases the sensitivity analysis has little effect on the internal rate of return.

5.13 The IRR of 5.9% is based on tariffs alone and shows that tariffs are low in relation to the cost of supplying electricity in Nepal. A start has been made to increase tariffs. An increase of 56% was made in May 1983 and another increase of 65% would be made under the project. Additional increases would be introduced in the future as part of the earnings covenant (para 4.25).

VI. AGREEMENTS REACHED AND RECOMMENDATION

6.01 The following matters were raised during negotiations on which satisfactory agreement was reached:

(a) IDA to receive reports of studies for future power projects in order to identify a future power development program (para 1.23);

(b) NEA establishing a plant maintenance program (para 1.45);

(c) A system loss reduction program to be implemented and a loss elimination specialist to be retained (para 1.49);

(d) Maintain MHDB with adequate staff, funds, powers and responsibilities to carry out the project (para 2.04);

(e) Except in special circumstances, the discontinuance of the formation of new development boards (para 2.05);

(f) The new Authority (NEA) commencing operations by April 30, 1985 (para 2.07);

(g) Submission of audited project accounts and full report for MHDB and audited financial statements and full report for the new Authority (para 2.10);

(h) HMG instituting effective methods/procedures for ensuring that government users pay their electricity bills on time and settling government arrears (para 2.12);

(i) Restriction on declaration of dividends (para 2.13);

(j) Development of an insurance program (para 2.14);

(k) Arranging funds for transmission lines (para 3.14);

(l) Maintain the existing panel of experts and appoint a claims advisor (para 3.19);

(m) A rehabilitation program for dislocated persons (para 3.21);

(n) Commencement of implementation of recommendations on the Marsyangdi catchment management plan (para 3.21);

(o) Land acquisition (para 3.22);

(p) Plan of action for establishing a training center (para 3.27)

(q) Financial performance covenant (para 4.09);

(r) Revaluation of assets (para 4.13);

(s) Transfer of the Marsyangdi plant to the new Authority, terms for repayment of the IDA funds to HMG and increases in share capital (para 4.21); and

(t) Limitation on incurrence of debt (para 4.26).

6.02 The following are conditions of effectiveness of the proposed credit:

(a) meeting of all conditions of effectiveness of (i) Kuwait Fund Loan Agreement, (ii) Saudi Fund Loan Agreement, and (iii) KfW Grant (paras 3.12 and 3.14); and

(b) securing of additional financing required to meet the total cost of Lot I of the civil works from sources outside Nepal (para 3.14).

6.03 With the above agreements reached, the proposed project forms an appropriate basis for an IDA Credit of US$107 million equivalent.

Annex 1

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

NEPAL ELECTRICITY CORPORATION (NEC)

Prospective Hydro Sites

Project	Basin	River	Region 1/	Type 2/	Catchment Area Sq.km	Average Annual Flow Cu.m/sec	Head (M)	Installed Capacity (MW)	Annual Energy (GWh)	Remarks
Chisapani	Karnali	Karnali	FW	S	42,890	1,335	175	4,600	15,225	Feasibility report by Nippon Koei in 1966 (UNDP). Review of the feasibility by Snowy Mountain in 1968 (UNDP). Revised feasibility report by Norconsult and Electrowitt in 1976/77(UNDP). Detailed report on integrated development of basin, field investigation, detailed design, system studies, revised cost estimates to be prepared under a technical assistance credit by the Bank to Nepal.
Lakhapata(KR-3)	Karnali	Karnali to Bheri	FW	S	20,970	587	377	2,141	11,339	Master Plan Study by Nippon Koei (N.K) in 1974 (Japan International Cooperation Agency (JICA).
Lakhapata(KR-3)	"	"	"	ROR	"	"	224	832	4,904	Additional studies by Water and Energy
Surkhet(Bheri)	"	Bheri	"	S	11,780	398	159	1,200	4,435	Commission in 1981/82
Seti	"	Seti	"	S	7,090	300	158	270	1,250	
Karnali Bend(KR-I)	"	Karnali	"	ROR	19,260	500	148	483	2,899	Studies by Water and Energy Commission in 1981/82.
Karnali Bend(KR-I)	"	"	"	S	19,260	500	301	1,600	8,433	KR-I and KR-3 schemes are mutually exclusive
Pancheswar	Mahakali	Mahakali (Sarda)	"	S	12,100	509	220	1,691	5,500	Feasibility study by Govt. of India in 1971. India is now doing detailed investigation.
Kali Gandaki (Run of River)	Gandaki	Kali Gandaki	C	ROR	7,100	310	95	60-90	385	Master Plan Study by N.K in 1974 (JICA). Feasibility study by Snowy Mountain in 1979(UNDP). This scheme will be submerged by Kali Gandaki Storage I Scheme.
Kali Gandaki I	"	"	C	S	9,150	410	314	1,600	6,700	Master Plan Study by N.K in 1974 (JICA). Gandaki basin study by Snowy Mountain in 1979 (UNDP).
Kali Gandaki II	"	"	C	S	11,330	500	143	300	1,240	
Sapt Gandaki	"	Sapt Gandaki	C	ROR	30,800	1,600	39	225	1,609	Master Plan Study by N.K in 1974 (JICA). Prefeasibility by Snowy Mountain in 1979 (UNDP). Feasibility by N.K. in 1982 (JICA).
Buri Gandaki	"	Buri Gandaki	C	S	5,370	218	175	320	1,353	Master Plan Study by N.K in 1974 (JICA). Gandaki basin study by Snowy Mountain in 1979 (UNDP). Reconnaissance studies by Water and Energy Commission in 1981/82.
Bagmati	Bagmati	Bagmati	C	S	2,720	177	91	295	674	Master Plan Study by N.K in 1974 (JICA). Feasibility Study in 1977 by GTZ.
Mulghat	Kosi	Tamur	E	S	5,640	324	49	68	425	Preliminary report by Yugoslavia in 1966. Feasibility study in 1982 by Electrowatt (UNDP & ADB)
Kankai	Kankai	Kankai	E	S	1,190	46	75	80	157	Investigation report by N.K & E.D in 1974. Report by GTZ in 1977. Feasibility report by Salzgitter Consult GMBH in 1978.
Sapt Kosi High Dam	Kosi	Sun Kosi	E	S	59,539	1,765	260	3,000	13,140	Feasibility study by Govt. of India in 1981. Kosi Basin Study proposed (JICA)
Sun Kosi High Dam	Kosi	Sun Kosi	E	S	16,200	639	120	360	832	Master Plan study by N.K in 1974 (JICA)
Tamba Kosi	Kosi	Kimiti Khola	E	ROR	384	27	723	66	185	Reconnaissance studies by Water & Energy Commission in 1981
Dudh Kosi II	Kosi	Dudh Kosi	E	ROR	1,900	113	308	170	327	Water and Energy Commission in 1981.
Dudh Kosi III	"	"	E	"	1,900	113	160	90	174	
West Rapti	Rapti	Rapti	FW	S	3,376	101	176	279	924	Reconnaissance studies by Water and Energy Commission in 1951. Feasibility proposed under Canadian aid.
Mugling	Gandaki	Trisuli Ganga	C	ROR	11,600	450	83	238	510	Master Plan study by N.K in 1974 (UNDP). Basin study Snowy Mountain in 1979 (UNDP).

1/ FW = Far Western
C = Central
E = Eastern

2/ S = Storage
ROR = Run of River

Sources:
1. Master Plan of Hydroelectric Power Development in Nepal by Nippon Koei - Sept. 1974.
2. Gandaki River Basin Power Study by Snowy Mountain Engineering Corporation - July 1979.
3. Water and Energy Commission Nepal (Project profiles)

Annex 2

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Small Hydro Projects

A. Completed

Name of Project	Region and District 1/	Installed Capacity(kW)	Year of Commissioning	Operated By	Energy Generated in 1980/81(MWh)
Dhankuta	E/Dhankuta	2x120	1972	NEC	491
Surkhet	M&F.W/Surkhet	3x115	1978	ED	336
Khairenitar	W/Kaski	2x140	1972	Agr.Deptt.	No metering
Gajouri	C/Dhading	1x25	1980	NEC	No metering
Baglung	W/Baglung	1x175	1982	SHDB	28 3/
Doti	F.W/Doti	2x120	1982	SHDB	37 3/
Phydim	E/Panchatar	2x130	1982	SHDB	43 3/
Dhading	C/Dhading	1x30	1982	SHDB	19 3/
Gorkha	E/Ilam	2x32	1982	SHDB	23.7 4/
Jumla	M&FW/Jumla	2x130	1982	SHDB	31.9 4/
Jomson	W/Mustang	2x130	1982	SHDB	34.6 4/
	Total	2,179			

B. Under Construction

Name of Project	Region and District 1/	Installed Capacity (kW)	Proposed Year of Commissioning	Financed By 2/	Total Estimated Cost (NRs million)
Namche	E/Solukhumbu	6x130	1986	Austrian Govt.	44.3
Chame		2x130	1986	HMG	3.3
Salleri/ Chialsa	E/Solokhumbu	2x100	1986	SATA/HMG	10.5
Tapeljung	E/Tapeljung	1x125	1986	UNCDF/HMG	5.34
Khandbari	E/Sankhuwasabha	2x125	1986	UNCDF/HMG	6.71
Okhaldhunga	E/Okhaldhunga	1x120	1986	UNCDF/HMG	5.94
Ramechap	E/Ramechap	1x75	1986	UNCDF/HMG	1.0
Bhojpur	E/Bhojpur	2x125	1986	UNCDF/HMG	8.8
Tehrathum	E/Tehrathum	2x100	1986	ADB/HMG	6.1
Dunche	C/Rasuwa	2x100	1986	"	7.63
Tatopani	W/Mustang	2x500	1986	"	36.90
Serpudah	F.W/Rukum	2x100	1986	"	9.62
Chaurjari	F.W/Rukum	2x100	1986	"	9.15
Bajura	F.W/Bajura	2x100	1986	"	6.37
Bajhang	F.W/Bajhang	2x100	1986	"	7.74
Helambu	C/Sindu Palchok	1x50	1985	"	2.25
Manang	W/Manang	4x40	1984	"	5.40
Dadeldhura	F.W/Dadeldhura	1x100	1984	"	3.5
Syangja	W/Syngja	2x40	1985	"	2.86
Darchula	F.W/Darchula	1x100	1984	"	3.54
Andhikhola	Western	2x2,500	1986	UMN/HMG	50.00
	Total	9,750			

C. Under Investigation

Name of Project	Region and District 1/	Possible Potential(kW)
Gai Ghat	E/Udaypur	180
Dunaie	W/Dolpa	130
Khalanga	M.W/Piuthan	33
Khalanga	M.W/Sallyan	150
Chainpur	F.W/Bajhang	200
Bandipur	W/Tanahu	163
Ridi Bazar	W/Gulmi	180
Jiri	C/Dolakha	120
Phalebar	W/Parbat	80
Chiangthapu	E/Pachthar	50
Sindhuliman	C/Sindhuli	120
Gorkha Bazar	W/Gorkha	90
Besi Sahar	C/Lamung	100
Detgown tar	W/Nawal Paresi	40
Chutra Besi	W/Argha Khanchi	50
Liwang	M.W/Rolpa	100
	Total	1,786

1/ E = Eastern, M & F.W = Mid and Far Western, C = Central, W = Western

2/ SATA: Swiss Association of Technical Assistance
UNCDF: United Nations Capital Development Funds
UMN: United Mission to Nepal

3/ Energy generated till October 1982

4/ Energy generated till August 1983

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Generation Capacity (Existing and Under Construction)

Location	Type	Ownership	Installed Capacity (MW) No X Rating	Firm Capacity (MW)	Year of Commissioning	Remarks
Central Region						
Existing						
Trisuli	Hydro	NEC	7x3.0 =21.0	18.0	1970	
Sunkosi	Hydro	NEC	3x3.35 =10.05	5.1	1973	
Panauti	Hydro	NEC	3x0.8 = 2.4	2.4	1964	
Sundarijal	Hydro	NEC	2x0.32 = 0.64	0.64	1934	
Pharping	Hydro	NEC	2x0.25 = 0.50	0.50	1911	
Mahendra	Diesel	NEC	4x0.424= 1.696	1.4	1956	
			4x2.5 =10.0	10.0	1981	
Hetauda	Diesel	NEC	3x1.43 = 4.47	4.0	1966	
Janakpur	Diesel	NEC	2x0.284= 0.832 1/	0.60	1961	
			1x0.264			
Bharatpur	Diesel	NEC	2x0.264= 0.528 1/	0.50	1961	
Patan	Diesel	NEC	1x1.49 = 1.49	1.2	1966	
Kulekhani I	Hydro	NEC 2/	2x30 =60.0	60.0	April 1982	
Devighat	Hydro	NEC 2/	3x4.7 =14.1	10.8	1983	
Total			127.706	115.14(H)		
			108.69 (H)	97.44(H)		
			19.016(D)	17.70(D)		
Under Construction						
Kulekhani II	Hydro	NEC 2/	2x16=32.0	32.0	Oct 1986	
Eastern Region						
Existing						
Ilam	Diesel	NEC	2x.100=0.200	0.160	1961,73	
Bhadrapur	Diesel	NEC	1x.346=0.346	0.240	1975	
Dhankuta	Hydro	NEC	2x.120=0.240	0.160	1973	
Dharan	Diesel	NEC	2x0.106=0.212	0.127	1965	
Biratnagar	Diesel	NEC	1x1.500=2.934	1.50	1977	Presently not in operation
			3.932	2.187		
			0.24(H)	0.16(H)		
			3.692(D)	2.027(D)		
Western Region						
Existing						
Gandak	Hydro	NEC	3x5.0 =15.0	10.8	1980	
Pokhara	Hydro	NEC	2x0.288=1.088	1.088	1969	
			2x0.256			
Pokhara	Diesel	NEC	3x0.346=1.038	0.982	1974/75	
Tansen	Diesel	NEC	2x0.112=0.244	0.160	1956	To be retired
Bhairawa	Diesel	NEC	2x0.264=0.528 1/	0.500	1961	
Taulihawa	Diesel	NEC	1x0.05 =0.05	0.050	1973	
Krishnangar	Diesel	NEC	1x0.112=0.112	0.112	1956	To be retired
Bahadurganj	Diesel	NEC	1x0.025=0.025	0.025	1956	To be retired
Butwal(Tinau)	Hydro	NEC	2x0.4 =1.23	1.23	1969	
		NEC	1x0.43	-	1974	
						Presently Not in Operation
	Diesel	NEC	0.225	-------		
Total			19.54	14.947		
			17.318(H)	13.118(H)		
			2.222(D)	1.829(D)		
Under Construction						
Seti	ED		= 1.0		1983/84	
Andhi Khola	ED		= 5.0		1986	
Mid and Far Western Region						
Existing						
Ghorahi	Diesel	ED	1x0.05=0.050	0.05	1982	
			1x0.05=0.050	0.05	1956	
Tulsipur	Diesel	ED	1x0.05			
			1x0.025=0.075	0.05	1956	
Surkhet	Hydro	ED	3x0.115=0.345	0.115	1978	
Surkhet	Diesel	ED	1x0.02 =0.020	0.020	1973	
Nepalgunj	Diesel	ED	2x0.264=0.5281/	0.500	1961	
Dhangadhi	Diesel	ED	1x0.025=0.025	0.025	1973	
Mahendranagar	Diesel	ED	1x0.025=0.025	0.025	1973	
Total			1.118	0.835		
			0.345(H)	0.115(H)		
			0.773(D)	0.720(D)		
Summary of Existing Capacity						
Nepal						
		Total	152.296	133.109		
		Hydro	127.593	110.833		
		Thermal (D)	24.703	22.276		
NEC		Total	151.178	132.274		
		Hydro	127.248	110.718		
		Thermal (D)	23.93	21.556		
Grid System		Total	147.246	130.087		
		Hydro	126.008	110.558		
		Thermal (D)	21.238	19.529		

1/ Transferred from Kathmandu

2/ Likely to be transferred to NEC

Annex 4

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Transmission Lines and Distribution Lines

A. Transmission Lines (66 and 132 kV)

Description	Length (km)	Conductor Size(ACSR)	Voltage (kV)	No. of Circuits	Type of Tower 1/	Expected Commissioning Date	Region
Existing							
Trisuli-Balaju	28.7	.10 sq in	66	2	DC		Central
Balaju-Siuchatar	7.0	.15 sq in	66	2	DC		"
Hetauda-Birganj	50.0	.15 sq in	66	2	DC		"
Patan-Sunkosi	57.21	120 sq mm	66	1	SC		"
Siuchatar-Kulekhani I	29.00	.15 sq in	66	2	DC		"
Kulekhani I-Hetauda	16.00	.15 sq in	66	2	DC		"
Hetauda-Bharatpur	70	.20 sq in	132	1	SC		"
Bharatpur-Dumkibas	52	.20 sq in	132	1	SC		Western
Dumbkibas-Gandak	32	.20 sq in	132	1	SC		"
Patan-Siuchatar	4	160 sq mm	66	1	SC		Central
Bharatpur-Pokhara	85	.15 sq in	132	1	SC		Central/Western
Devighat-Chabel	35	0.25 sq in	66	2	DC		Central
Under Construction							
Hetauda-Janakpur	137	0.25 sq in	132	1	DC	June 1986	Central
Janakpur-Biratnagar	146	0.25 sq in	132	1	DC	June 1986	Central/Eastern
Dumkibas-Butwal	45	0.25 sq in	132	1	DC	Oct. 1985	Western
Butwal-Shivpur	50	0.25 sq in	132	1	DC	June 1987	"
Shivpur-Lamahi	62.5	0.25 sq in	132	1	DC	June 1987	"
Lamahi-Nepalgunj	112.5	0.25 sq in	132	1	DC	June 1987	"
Marsyangdi-Bharatpur	40	0.25 sq in	132	1	SC	Jan 1989	Central
Marsyangdi-Balaju	90	0.25 sq in	132	1	SC	Jan 1989	"
Kulekhani II-Siuchatar	36	0.25 sq in	132	1	SC	Oct 1986	"
Kulekhani II-Hetauda	7	0.25 sq in	132	1	SC	Oct 1986	"
Balaju-Lainchaur	2	0.15 sq in	66	1	SC	Jan 1989	"
Planned							
Biratnagar(Dubi)-Anarmani	70	0.25 sq in	132	1	SC		Eastern
Nepalgunj-Dhangadi	175	0.25 sq in	132	1	SC		Farwestern
Dhangadi-Mahandranagar	55	0.25 sq in	132	1	SC		Farwestern
Hetauda-Bharatpur	70	0.25 sq in	132	1	SC		Central
Balaju-Chabel	8	160 sq mm	66	2	DC		Central

B. Distribution Lines (33 kV and below)

Regions	33 kV (km)	11 kV (km) DC	11 kV (km) SC 1/	3.3 and 2.3 kV (km)	LT Lines (km)
Existing					
Central	35	47.5	400	28	1500
Western	195	-	200	4	500
Eastern	188		76	-	286
Mid-Western	60		31	-	90
Far-Western	25		21	-	60
Under Construction					
Central	170		80	-	221.0
Western	20		35	-	150.0
Eastern	27		80	-	120.0
Mid-Western	80		35	-	100.0
Far-Western	-		250	-	100.0
Planned					
Central	154		380	-	900.0
Western	67		150	-	450.0
Eastern	66		125	-	225.0
Mid-Western	155		230	-	500.0
Far-Western	60		100	-	320.0

1/ DC = Double Circuit
SC = Single Circuit

Annex 5

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

NEPAL ELECRICITY CORPORATION (NEC)

A. Grid Substations (66 and 132 kV)

Name	Voltage (kV)	Transformer Capacity Per Unit (MVA)	No. of Units	Commissioning Date	Region
Existing					
Trishuli	6.6/66	3.750	2x3+1 1/	1966-70	Central
Balaju I	66/11	3.750	2x3+1 1/	1966-70	"
Balaju II	66/11	6.0	1	1981	"
Sunkoshi	6.3/72.6	6.3	2	1972	"
Patan I	66/11	6.3	2	1972	"
Gandaki	6.6/132	10.0	2	1979	Western
Bharatpur	132/11	10.0	1	1979	Central
Hetauda I	11/66	1.5	2	1966	"
Hetauda II	66/132	10.0	1	1979	"
Hetauda III	11/66	6.0	2	1981	"
Kulekhani I	11/66	35.0	2	1982	"
Siuchatar I	66/11	18.0	2	1982	"
Patan II	66/11	18.0	1	1982	"
Pokhara	132/11	6.0	1	1983	Western
Devighat	11/66	8.5	2	1983	Central
Chabel	66/11	8.5	2	1983	"
Under Construction					
Hetauda IV	66/132	10.0	2	1986	Central
Biratnagar	132/11	15.0	2	1986	Eastern
Janakpur	132/33/11	10.0	1	1986	Central
Marsyangdi	11/132	10.0	3x3+1 1/	1989	"
Balaju	132/66	15.0	1x3+1 1/	1989	"
Kulekhani II	11/132	39.6	1	1986	"
Siuchatar II	132/66	39.6	1	1986	"
Butwal	132/33	10.0	1	1985	Western
Dumkibas	132/33	5.0	1	1985	"
Shivpur	132/33	5.0	1	1987	"
Lamahi	132/33	5.0	1	1987	Mid-Western
Nepalgunj	132/33	10.0	1	1987	"
Lainchaur	66/11	10.0	2	1989	Central
Planned					
Anarmani	132/33/11	5.0	1	-	Eastern
Dhangadi	132/33/11	5.0	1	-	Far-Western
Mahandranagar	132/33/11	5.0	1	-	"

B. Distribution Substations (33 kV and below):

Existing	Transformer Capacity (kVA)
Central	98,250
Western	10,300
Eastern	20,085
Mid-Western	4,300
Far-Western	3,100
Under Construction	
Central	28,075
Western	2,500
Eastern	15,000
Mid-Wastern	1,500
Far-Western	1,000
Planned	
Central	60,000
Western	11,500
Eastern	5,500
Mid-Western	5,000
Far-Western	3,000

1/ Single Phase Units

NEPAL

MARSYANGDI HYDROELECTRIC PROJECT

Nepal Electricity Corporation (NEC)

Past Sales and Generation

(Energy Figures are in MWh and Demand Figures in MW)

Central Region 1/	1970/71		1975/76		1976/77		1977/78		1978/79		1979/80		1980/81		1981/82		1982/83	
Sales																		
Domestic	2/(40,550)	22,826	(60,565)	52,017	(62,528)	52,720	(67,086)	55,073	(71,028)	58,977	(76,959)	57,971	(80,959)	60,094	(86,504)	69,305	(93,049)	90,949
Industrial	(648)	5,749	(973)	18,212	(976)	22,463	(1,181)	25,749	(1,249)	25,352	(1,487)	31,807	(1,569)	27,441	(1,705)	31,583	(1,860)	40,810
Commercial 3/	(14)	4,567	(58)	8,951	(64)	10,133	(69)	12,792	(71)	17,987	(74)	25,058	(150)	26,166	(159)	23,819	171)	27,881
Others (including self consumption)		2,310		2,332		2,137		1,822		3,022		6,021		5,154	-	5,738	-	8,049
Sales in Nepal		35,452		81,512		87,453		95,436		105,338		120,857		118,855	-	130,445	-	167,689
Export to India				5,940		6,116		5,970		6,160		5,196		3,765	-	5,183	-	5,986
Supply to Western Region		-		-		-		-		-		-		-	-	3,610	-	13,850
Generation																		
Energy generated(Hydro)		53,565		123,840		133,231		146,631		163,094		168,896		169,835	-	203,596	-	273,218
Energy generated(Thermal)		84		1,009		2,176		3,501		3,644		16,511		11,483	-	7,635	-	2,046
Energy imported from India		-		-		-		-		-		-		-	-	-	-	-
Loss MWh (Percent) 4/	18,197	(33.9)	37,397	(30)	41,838	(30.9)	48,726	(32.4)	55,240	(33.1)	59,354	(33.2)	58,698	(32.5)	71,993	(34.1)	87,739	(31.84)
Maximum demand (Load Factor)5/	13.86	(44.2)	31.88	(44.7)	34.72	(44.5)	37.9	(45.2)	38.1	(49.9)	42.9	(49.1)	44.46	(46.6)	56.48	(42.7)	66	(47.6)
Western Region 6/																		
Sales																		
Domestic	(1,197)	410	(5,625)	3,465	(6,539)	4,311	(7,465)	5,017	(8,546)	5,515	(9,531)	5,636	(10,350)	6,154	(11,196)	6,520	(12,817)	10,057
Industrial	(20)	179	(154)	1,313	(194)	1,963	(240)	2,699	(302)	3,649	(352)	4,376	(400)	4,360	(434)	5,027	(508)	5,683
Commercial	(11)	13	(45)	222	(45)	272	(19)	276	(5)	33	(3)	186	(12)	720	(18)	721	(47)	1,786
Others (including self-consumption)		41		1,051		1,455		1,592		1,616		1,822		1,650	-	1,249	-	783
Sales in Nepal		643		6,051		8,001		9,584		10,808		12,020		12,884		13,517		18,309
Export to India		-		-		-		-		-		-	-	-	-	-	-	-
Generation																		
Energy generated(Hydro)		963		4,794		5,479		6,561		6,609		7,113		5,281	-	3,670		4,256
Energy generated(Thermal)		-		654		742		882		1,351		1,054		882	-	740		365
Energy imported from India		-		2,419		3,878		3,767		5,864		7,713		8,420	-	9,396		8,007
Supply from Central Region		-		-		-		-		-		-		-	-	3,610		13,850
Loss MWh (Percent)	320	(34.5)	1,816	(23.1)	2,098	(20.8)	1,626	(14.5)	3,016	(21.8)	3,860	(24.3)	1,699	(13.5)	3,899	(22.4)	8,239	(31.0)
Maximum Demand	0.360		2,295		2,820		3.07		3.47		3.96		3.43		3.5		3.1	
Eastern Region																		
Sales																		
Domestic	(2,120)	1,630	(8,272)	4,591	(10,252)	7,061	(11,526)	7,970	(12,839)	9,300	(13,937)	8,086	(14,515)	8,707	(15,095)	10,834	(17,436)	12,351
Industrial	(57)	2,804	(305)	11,510	(415)	13,129	(484)	12,752	(541)	16,926	(586)	14,569	(628)	15,880	(672)	20,811	(780)	22,840
Commercial	(5)	19		-		-		-		-		-		-	-	1	(28)	379
Others		362		583		532		778		879		820		942		810		400
Sales in Nepal		4,815		17,044		20,722		21,500		27,105		23,475		25,529		32,456		35,970
Export to India		-		-		-		-		-		-		-		-		-
Generation																		
Energy generated (Hydro)		-		180		309		117		369		398		491	-	614	-	687
Energy generated (Thermal)		4,801		302		378		1,759		1,902		1,374		1,526	-	1,898		2,116
Energy Import from India		617		19,800		21,201		22,957		28,574		24,653		28,633	-	37,634		43,144
Loss MWh (Percent)	603	(11.1)	3,238	(16)	1,161	(5.3)	3,133	(12.6)	3,736	(12.1)	4,298	(17.4)	5,121	(16.7)	7,690	(19.2)	9,977	(21.3)
Maximum demand	1.3		5.08		6.75		7.93		8.84		8.34		8.9		9.6	-	11.0	
Mid-Western and Far Western Regions																		
Sales																		
Domestic	-	-	(2,255)	1,354	(2,629)	1,676	(3,271)	3,288	(4,076)	3,429	(4,478)	3,130	(5,142)	3,615	(5,913)	4,007	(6,754)	5,540
Industrial	-	-	(55)	1,093	(71)	1,481	(90)	1,551	(120)	1,905	(148)	2,057	(175)	2,521	(210)	3,859	(222)	4,566
Commercial	-	-		-		-		-		-		-		-	-	92	-	-
Others	-	-		207		253		286		521		353		490	-	394	-	433
Sales in Nepal	-	-		2,654		3,410		5,135		5,855		5,540		6,626		8,352	-	10,529
Export to India	-	-		-		-		-		-		-		-		-		-
Generation																		
Energy generated(Hydro)	-	-		-		-		145		242		271		336		416		497
Energy generated(Thermal)	-	-		15		40		27		269		185		205		80		310
Import from India	-	-		3,153		4,062		6,002		6,188		6,606		7,697	1,673	9,529		12,193
Loss MWh (Percent)	-	-	514	(16.8)	692	(16.9)	1,039	(16.8)	9.96	(14.9)	1,522	(21.5)	1,612	(19.6)	3.3	(16.2)	2,471	(19.0)
Maximum demand	-	-	0.99		1.29		1.73		1.95		2.14		2.7			-		3.11
Nepal																		
Sales																		
Domestic	(43,867)	24,866	(76,717)	61,787	(81,948)	65,679	(89,348)	71,348	(96,489)	77,221	(104,905)	74,823	NA.	78,570	(118,708)	90,666	(130,056)	118,897
Industrial	(725)	8,732	(1,487)	32,128	(1,656)	39,036	(1,998)	42,751	(2,212)	47,827	(2,573)	52,089	(2,772)	50,202	(3,021)	61,280	(3,370)	73,899
Commercial	(30)	4,599	(103)	9,173	(109)	10,405	(88)	13,068	(76)	18,020	(77)	25,244	(162)	26,886	(177)	24,633	(246)	30,046
Others 7/		1,021		1,711		1,927		2,240		2,292		5,240		4,635		8,191	-	9,655
Self consumption		1,692		2,462		2,455		2,238		3,603		3,853		3,601		-		-
Sales in Nepal		40,910		107,261		119,591		131,655		148,963		161,249		163,899		184,770		232,497
Export to India		-		5,940		6,116		5,970		6,160		5,196		3,765		5,183		5,986
Generation																		
Energy generation(Hydro)		-		128,814		139,019		153,677		170,319		176,678		175,943		208,296		278,658
Energy generation(Thermal)		59,413		1,980		3,336		5,946		7,176		18,124		14,096		10,153		4,837
Import from India		617		23,572		29,141		32,726		40,626		38,972		44,750		56,759		63,414
Loss MWh (Percent)	19,120	(31.9)	42,965	(27.5)	45,789	(26.9)	54,724	(28.5)	62,998	28.9	67,329	(28.8)	67,130	(28.7)	85,255	(32.3)	108,426	(30.5)
Maximum demand(Load Factor)	15.5	(44.2)	40.2	(44.3)	45.6	(43.3)	50.6	(43.3)	52.4	(47.5)	56.9	(46.9)	58.92	(45.5)	72.88	(42.9)	83.2	(47.6)

1/ Janakpur, Gaur, Malangwa are excluded from Central Regions and included in Eastern Region to facilitate computation of future intereconnected grid.
2/ Figures in bracket against domestic, industrial and commercial sales show number of consumers.
3/ Commercial loads include water supply, irrigation and transport load demands.
4/ Loss Percent (1= $\frac{\text{Sales in Nepal and Export to India}}{\text{Internal Generation and Import}}$) x100

5/ Maximum demand includes the demand supplied by Indian system.
Load factor = $\frac{\text{Sales in Nepal and Export to India}}{\text{Maximum demand x 8,760}}$ x 100
6/ Butwal load is included in Western Region.
7/ Sales under 'Other' Category includes self-consumption for FYs82 and 83

Analysis of Data

A. Annual Average Growth Rate(%)	1975/76 to 1978/79 Central	Western	Eastern	Mid & Far Western	Nepal	1975/76 to 1982/83 Central	Western	Eastern	Mid & Far Western	Nepal	1970/71 to 1977/78 Central	Western	Eastern	Mid &Far Western	Nepal
Domestic Sales	4.3	16.8	26.5	36.3	7.7	8.3	16.2	15.1	22.3	9.8	13.41	43.01	25.45	55.83	16.2
Industrial Sales	11.7	40.6	13.7	20.3	14.2	12.2	23.3	10.3	22.7	12.6	23.89	47.35	24.16	19.12	25.4
Commercial Sales	26.2	-	-	-	25.2	13.0	17.0	-	-	18.5	15.85	54.73	-	-	16.1
Total Sales	8.9	21.3	16.7	30.1	11.6	10.7	20.0	13.5	21.8	11.7	15.20	47.10	23.83	39.10	18.2
Number of Domestic Consumers	5.5	15.0	15.8	21.8	7.9	6.3	12.5	11.2	21.8	7.9	8.34	29.89	27.36	20.44	10.7
B. Average Annual Increment of New Domestic Consumers	3,488	973	1,522	607	6,590	4,640	1,027	1,309	642	7,618	3,791	895	1,343	508	6,537
C. Average of Annual KWh Consumption Per Domestic Consumer	838	648	665	771	801	827	642	658	748	790					

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Captive Plants

Name	Region	Year of Installation	Installed Capacity (kW)	Firm Capacity (kW)	Type of Fuel	Units Generated 1979-80 (MWh)	Units Generated 1980-81 (MWh)	Units Generated 1981-82 (MWh)	Units Generated 1982-83 Estimated (MWh)
Biratnagar Jute Mill	Eastern	1941	1,400	1,100	Coal/Steam	2,290	1,328	898	-
Biratnagar Jute Mill	Eastern	1963	850	600	Diesel	1,596	970	880	630
Different small plants in Eastern Region	Eastern	1960-83	2,572	2,070	Diesel	929	1,051	1,176	1,320
Birgunj Sugar Mill	Central	1965-66	2,400	1,900	Steam(Sugar-cane fired)	2,749	2,262	2,334	2,280
Birgunj Sugar Mill	Central	1965-66	272	200	Diesel	11	18	20	24
Janakpur Cigarette Factory	Central	1965-66	1,058	800	Diesel	1,485	1,329	1,380	1,420
Different small industries & private installations including those in Kathmandu	Central	1960-83	3,980	3,080	Diesel	630	641	795	550
Godawari (Agriculture Department)	Central	1969	30	30	Hydro	-	Not in operation		-
Different small industries & private installations.	Western	1963-83	710	595	Diesel	315	349	388	330
Different small industries & private installations.	Western	1982-83	48	44	Hydro	-	-	-	48
Mahendra Sugar Mill	Western	1966	750	600	Steam	870	910	961	880
			20	15	Diesel	156	229	32	40
Different small industries & private installations	Middle & Far Western	1970-83	700	580	Diesel	600	750	830	890
			14,790	11,614		11,628	9,837	9,694	8,412

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Power Exchange with India

	Supply Voltage kV	Committed Power kW	Date of Initial Supply	Energy Exchanged (GWh) 1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83 (Estimated/Actual)
A. IMPORT 1/ 2/											
1. Farwestern & Midwestern Regions											
Mahendranagar	33	1000	July 73	0.360	0.499	0.837	1.116	1.105	1.214	1.420	1.582
Dhanghari	33	1000	Feb 74	0.354	0.473	0.580	0.738	0.722	1.192	1.402	2.765
Nepalgunj	33	2000	Feb 73	2.315	2.947	4.340	4.064	4.469	5.129	4.920	7.556
Koilabas	33	1000	Feb 74	0.124	0.143	0.245	8.270	0.310	0.162	0.158	0.290
2. Western Region											
Krishannagar	33	1000	Nov 72	0.647	1.158	1.126	1.298	1.588	1.724	1.897	2.483
Bhairahawa	33	2000	March 73	1.73	2.613	2.538	4.431	5.945	6.445	7.218	5.271
Tribeni	-	-	-	0.042	0.107	0.103	0.135	0.200	0.251	0.281	0.323
3. Central Region											
Gaur	11	300	April 74	0.292	0.300	0.243	0.320	0.320	0.127	0.108	0.114
Malangawa	11	200	April 74	0.156	0.280	0.229	0.208	0.406	0.161	0.563	0.234
Janakpur-Jaleswor	33	1000	April 74	1.263	1.963	1.791	2.136	0.973	0.387	1.044	0.933
4. Eastern Region											
Siraha	11	200	Feb 75	0.313	0.451	0.529	0.550	0.595	0.630	0.813	0.783
Bhadhrpur	11	1000	March 75	0.418	0.925	1.202	1.429	0.855	0.996	1.288	1.967
Biratnagar area/ EEC System	33	6800	1954	17.368	17.282	18.963	23.931	21.504	26.332	34.018	39.227
B. EXPORT 2/											
Central System											
Raxul/Birganj	11	5000	March 73	5.940	6.116	5.970	6.160	5.196	3.765	5.183	5.986
TOTAL IMPORT				25.372	29.141	32.726	40.626	38.972	44.733	55.130	63.528
TOTAL EXPORT				5.940	6.116	5.970	6.160	5.196	3.765	5.183	5.986

1/ Farwestern, Midwestern and Western Regions import from U.P. State Electricity Board, Central and Eastern Regions import from Bihar State Electricity Board.

2/ All metering and billing is done on GWh basis alone without any demand charge.

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Load Forecast - Assumptions

Industrial Load

1. The load demand of 20 prospective industries 1/ which are likely to be established by FY92 was estimated year-wise by assuming appropriate load factor for each type of industry (Table 2). For the remaining industries, allowance has been made by assuming a certain annual growth rate for each region as shown below:

	Central	Western	Eastern	Far& Mid Western
FY84-92	5	10	10	10
FY87	-	-	3.8 GWh	-

Note: All figures (except 3.8 GWh) indicate an annual % growth rate.

The growth rate in other regions would be more than in the Central Region because of HMG's plans to establish new industries in other regions. In FY87, when the Eastern Region is connected to the grid, captive load (3.8 GWh) is likely to be added to the grid system.

Domestic Load

2. It is estimated that in FY84 the number of new domestic consumers and consumption per consumer would be as per the following table:

	Central	Western	Eastern	Far&Mid Western
New Consumers (Number)	4,000	1,000	1,200	500
Consumption per Consumer (kWh)	800	650	675	650

During FYs 84 to 91, the annual growth rate in the number of consumers would be 6% in the Central Region and 7% in other regions. It is also estimated that there would be an annual increase of 2% in the consumption of previous consumers in the Central Region and 1% in other regions.

1/ A list of 48 industries was handed over to the mission by ED and NEC. After detailed discussion, it was agreed that 20 industries were at such a stage that their demand could be considered as definite.

Commercial Load

3. It is estimated that two large hotels (Kathmandu and Sherpa) which are under construction in Kathmandu would be completed in 1984. Their consumption requirement is expected to be 5.3 and 6.0 GWh. For commercial loads other than the above big hotels, a growth rate of 10% has been assumed for the period FY83-92.

4. Transport. The present transport load consists of the Kathmandu-Hetauda ropeway and the Kathmandu city electric tramway. It is intended to upgrade the ropeway and extend the tramway bus to the airport. The load required for these extensions has been estimated and included in the forecast.

5. Street Lighting. A small growth of 5% per annum is assumed in all regions.

6. Bulk Supply to India. As mentioned in para 1.35, Nepal and India have entered in a mutual agreement to exchange power. For purpose of load forecast it is assumed that Nepal would export to India the power which is already committed. This would be 5 MW (22 GWh per year).

7. Self Consumption. Self consumption consists of power used by NEC in its works, substations and for auxiliaries of generating stations. It is assumed to be 2% of sales.

Annex 9
Table 1

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation

Load Forecast

Year	Region	Domestic (GWh)	Industrial (GWh)	Commercial (GWh)	Irrigation & Water Supply (GWh)	Transport (GWh)	Street Light& Others (GWh)	Total Sales (GWh)	Self-Consumption (GWh)	Export to India (GWh)	Losses %	Total Requirement (GWh)	Requirement: Nepal (GWh)	Requirement: NEC (GWh)	Requirement: Integrated System (GWh)	Requirement: Integrated System (MD)	Year
82/83	Central	90.9	40.8	21.0	5.4	1.5	4.5	164.1	3.5	6.0	33.5	261.4	346.8	333.8	287.9	69.1	82/83
	Western	10.1	5.7	0.6	1.2	-	0.5	18.1	0.3	-	30.5	26.5	-	-	-	-	-
	Eastern	12.4	22.8	0.4	-	-	0.1	35.7	0.5		21.1	45.9					
	Mid-West &Far West	5.5	4.6	-	-	-	0.2	10.3	0.2	-	19.0	13.0					
83/84	Central	95.9	45.7	34.4	16.8	1.5	4.7	199.0	4.0	22.0	30.0	321.4	415.6	401.7	351.9	82.8	83/84
	Western	11.0	6.3	0.7	2.5	-	0.5	21.0	0.4	-	30.0	30.5	-	-	-	-	-
	Eastern	13.3	25.1	0.4	-	-	0.1	38.9	1.0	-	20.0	49.8	-	-	-	-	-
	Mid-West &Far West	5.9	5.1	-	-	-	0.2	11.2	0.2	-	18.0	13.9	-	-	-	-	-
84/85	Central	101.2	53.8	37.8	18.3	1.5	5.0	217.6	4.3	22.0	28.0	338.7	446.8	431.9	378.7	89.1	84/85
	Western	11.9	10.1	0.8	5.1	-	0.5	28.4	0.6	-	28.0	40.2					
	Eastern	14.3	27.6	0.5	-	-	0.1	42.5	1.0	-	18.0	53.0					
	Mid-West &Far West	6.4	5.7	-	-	-	0.2	12.3	0.2	-	16.0	14.9					
85/86	Central	106.8	65.6	41.6	23.6	1.6	5.2	244.4	4.9	22.0	25.0	361.7	487.8	471.4	415.0	94.7	85/86
	Western	12.9	14.0	0.9	7.9	-	0.6	36.3	0.7		25.0	53.3					
	Eastern	15.3	30.4	0.5	-	-	0.1	46.3	1.1		16.0	56.4					
	Mid-West &Far West	6.9	6.4	-	-	-	0.2	13.5	0.3		16.0	16.4					
86/87	Central	112.8	92.3	45.8	24.8	1.7	5.5	282.9	5.6	22.0	24.0	408.6	562.0	544.4	544.4	124.3	86/87
	Western	14.0	18.3	1.0	9.3	-	0.6	43.2	0.9		24.0	58.0					
	Eastern	16.4	37.5	0.6	10.0	-	0.1	64.6	1.5		15.0	77.8					
	Mid-West& Far West	7.4	7.1	-	-	-	0.2	14.7	0.3		15.0	17.6					
87/88	Central	119.1	112.6	50.3	26.0	1.8	5.7	315.5	6.3	22.0	23.0	446.5	629.6	610.4	629.6	143.7	87/88
	Western	15.1	20.1	1.1	10.8	-	0.6	47.7	0.9		23.0	63.1					
	Eastern	17.8	41.6	0.6	23.6	-	0.2	83.3	1.9		15.0	100.8					
	Mid-West& Far West	7.9	7.8	-	-	-	0.3	16.0	0.3		15.0	19.2					
88/89	Central	125.8	133.9	55.4	27.3	1.9	6.0	350.3	7.0	22.0	22.0	486.2	696.5	675.7	696.5	159.0	88/89
	Western	16.3	22.1	1.2	11.9	-	0.7	52.2	1.0		12.0	68.2					
	Eastern	19.1	46.1	0.7	34.8	-	0.2	100.9	2.2		15.0	121.3					
	Mid-West& Far West	8.5	8.6	-	-	-	0.3	17.4	0.3		15.0	20.8					
89/90	Central	132.8	143.2	61.0	28.7	2.0	6.3	374.0	7.5	22.0	21.0	510.7	744.8	722.1	744.8	170.0	89/90
	Western	17.5	24.3	1.3	13.1		0.7	56.9	1.1		20.0	72.5					
	Eastern	20.5	50.7	0.8	43.4		0.2	115.6	2.5		15.0	138.9					
	Mid-West& Far West	9.1	9.5	-	-		0.3	18.9	0.4		15.1	22.7					
90/91	Central	140.3	153.0	67.0	30.1	2.1	6.6	399.1	8.0	22.0	20.0	536.4	795.1	770.2	795.1	181.5	90/91
	Western	18.8	26.7	1.4	15.0	-	0.7	62.6	1.2		18.0	77.8					
	Eastern	22.0	55.8	0.9	52.5	-	0.2	131.4	2.8		14.0	156.0					
	Mid-West& Far West	9.7	10.5	-	0.5	-	0.3	21.0	0.4		14.0	24.9					
91/92	Central	147.9	160.7	73.7	31.0	2.2	7.0	422.5	8.4	22.0	20.0	566.1	868.4	840.0	868.4	198.2 3/	91/92
	Western	20.2	29.4	1.6	17.1		0.8	69.1	1.4		18.0	85.9					
	Eastern	23.6	78.4	1.0	55.1		0.2	158.3	3.4		14.0	188.0					
	Mid-West& Far West	10.4	11.5	-	1.7		0.3	23.9	0.5		14.0	28.4					
92/93															955.2	209.7	92/93
93/94															1050.7	230.7	93/94
94/95															1155.8	253.7	94/95
95/96															1271.4	279.1	95/96
96/97															1398.6	307.0	96/97
97/98															1538.4	337.7	97/98
98/99															1692.3	371.5	98/99
99/00															1861.5	408.6	99/00

Annual Average Growth Rates (%) of Sales Between FY83 to FY92

	Central	Western	Eastern	M&F Western	Total
Domestic	5.6	8.0	7.4	7.3	6.1
Industrial	16.5	20.0	14.7	10.7	15.9
Commercial	15.0	11.5	10.7	-	14.8
Irrigation	21 4	34.3	40.7	-	36.0
Total	11.1	16.0	18.0	9.8	12.8

Maximum Demands at Important Load Centers (FY82)

Kathmandu	45 MW
Biratnagar	6 MW
Birgung	3 MW
Hetauda	3 MW
Bhairwa	3 MW
Pokhara	2 MW
Janakpur	1.5 MW
Butwal	1 MW
Tarsen	1 MW

Percentage Share

	FY83	FY92
Domestic sales	52.0	30.0
Industrial sales	32.0	41.0
Commercial sales	10.0	11.0
Irrigation sales	3.0	16.0
Other sales	3.0	2.0
Total	100.0	100.0

1/ Most of the Western Region is now interconnected with the Central Region through 132kV Bharatpur-Pokhara, 33kV Gandak-Butwal lines. Complete integration of Western Region will take place in FY87. But for calculating M.D. of integrated system it is assumed that Western Region is already integrated.

2/ Annual load factor is assumed 48.5% through FY85, 50% through FY92 and 52% beyond FY93.

3/ Annual growth rate of energy from FY92 onwards is 10%.

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Load Forecast - New Industrial Loads

	Name	Location (Region)1/		Source of Funds	M D kW	Increment of Energy Requirement (Sales) 83/84	84/85	85/86	86/87	87/88 (MWh)	88/89	89/90	90/91	91/92
1.	Nepal Vegetable Ghee Factory	Hetauda	(C)	NIDC/Private	1,000	1,100	-	-	-	-	-			
2.	Himalya Brewery	Kathmandu	(C)	NIDC/Private	200	263	-	-	-	-	-			
3.	Dry Cell Battery Plant	Kathmandu	(C)	NIDC/Union Carbide	320	840	-	-	-	-	-	-	-	-
4.	Hetauda Cement Plant (i) Plant	Hetauda	(C)	ADB/HMG	8,500	-	-	-	13,154	13,154	13,154	-	-	-
	(ii) Quarry	Bhainse	(C)	ADB/HMG	1,000	-	-	-	1,241	1,241	1,241	-	-	-
5.	Magnesite Plant													
	i) Dead Burnt Mgn.	Lamosangu	(C)	IFC	2,000	-	-	2,628	2,628	-	-	-	-	-
	ii) Refractory brick	Birgunj	(C)	IDBI(India)	1,000	-	-	-	-	1,314	1,314	-	-	-
	iii) Extraction Plant	Khairidhunja	(C)	HMG	400	-	-	1,050	1,050	-	-	-	-	-
6.	Paper Factory	Gaidakot	(C)	China/HMG	2,000	-	3,504	3,504	3,504	-	-	-	-	-
7.	Lead & Zinc Mining Project	Rusawa	(C)	India/HMG/IFC	2,000	-	-	-	-	-	-	2,628	2,628	-
8.	Pilot Foundry Project	Pattan	(C)	UNIDO	1,000	-	-	1,314	1,314	-	-	-	-	-
9.	Hulas Steel Industry (pipes & galvanizing, etc.)	Simra	(C)	NIDC/Private	800	526	1,578	-	-	-	-	-	-	-
10.	Balaju Textile Mill	Balaju	(C)	NIDC/HMG	90	105	105	-	-	-	-	-	-	-
11.	Brick Factory	Kathmandu	(C)	NIDC/Private	188	-	275	275	275	-	-	-	-	-
12.	Sound Equipment	Kathmandu	(C)	Private	120	-	105	105	105	-	-	-	-	-
13.	Beer Factory	Pattan	(C)	NIDC/Private	160	-	200	200	200	-	-	-	-	-
14.	Paper Mill	Rupandehi	(W)	NIDC/Private	2,000	-	2,750	2,450	2,450	-	-	-	-	-
15.	Brown Sugar Mill	Parasi	(W)	NIDC/Private	160	-	116	116	116	-	-	-	-	-
		Nawal Parasi	(W)	NIDC/Private	160	-	116	116	116	-	-	-	-	-
16.	Aluminium Conductor	Rupandehi	(W)	NIDC/Private	160	-	186	186	186	-	-	-	-	-
17.	Resin & Turpentine	Nepalgunj	(F.W)	Russia/HMG	170	-	100	100	100	-	-	-	-	-
18.	Fruit Processing	Biratnagar	(E)	NIDC/Private	80	-	-	-	58	58	58	-	-	-
19.	Brown Sugar	Dhanushe	(E)	NIDC/Private	160	-	-	-	116	116	116	-	-	-
		Sunsari	(E)	NIDC/Private	160	-	-	-	116	116	116	-	-	-
20.	Cement Factory	Udaypur	(E)	India/HMG	12,000	-	-	-	-	-	-	-	-	17000

1/ E = Eastern, W = Western, C = Central, FW = Far-Western

Annex 9
Table 3

NEPAL

MARSYANGDI HYDROELECTRIC PROJECT

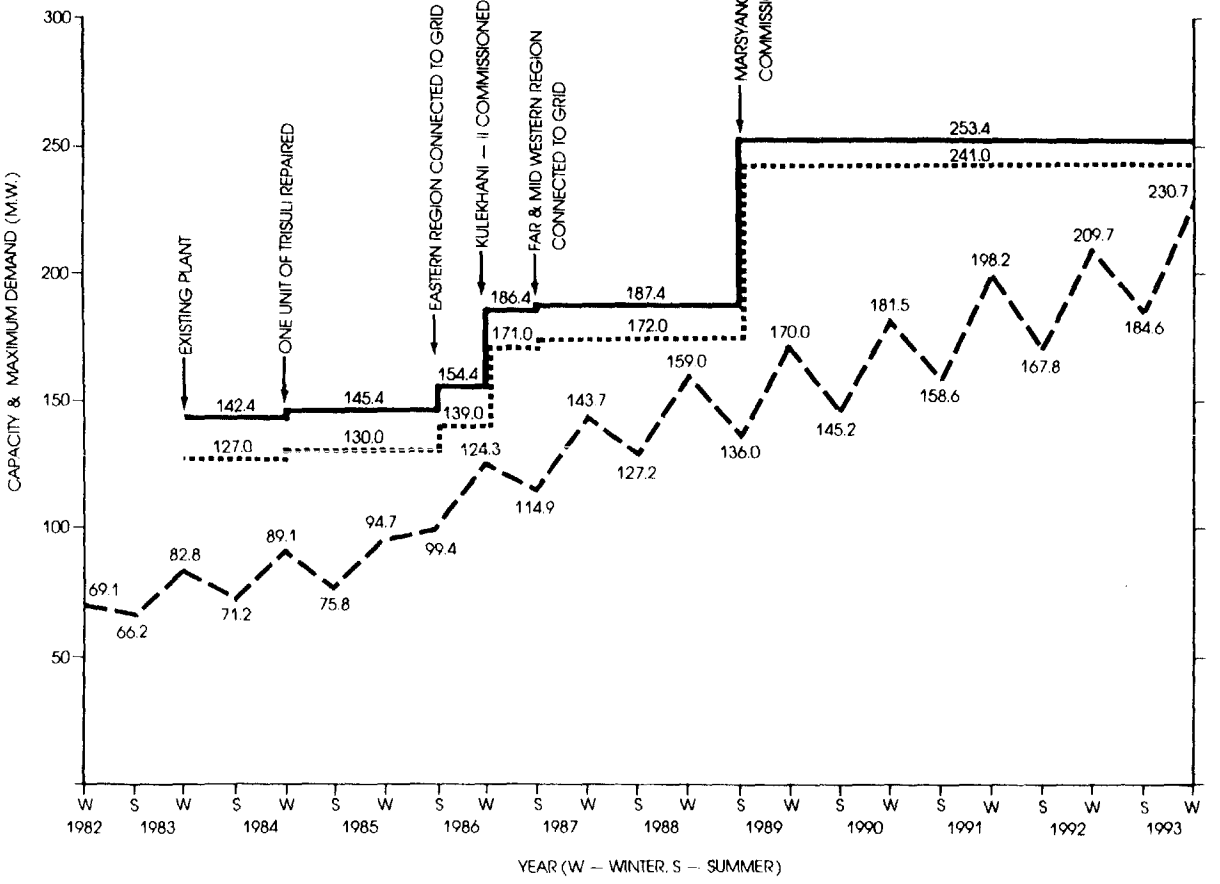
Nepal Electricity Corporation (NEC)

Load Forecast - New Irrigation Loads

Name of Project	Region 1/	Max Demand MW	Annual Load Factor %	Increment of Energy Requirement (Sales (MWh) 81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	Financing Arrangements
1. Narayani Lift Irrigation	C	6,280	32	-	3,600	10,443	-	3,753	-	-	-	-	-	-	ADB/HMG
2. Lumbini I, II & III Phase (ground water)	W	3,200	30	-	1,168	1,168	2,336	2,336	-	-	-	-	-	-	IDA/HMG
3. Birgunj Ground Water	C	1,200	25	-	-	650	650	650	-	-	-	-	-		IDA/HMG
4. Rajbirag Lift Irrigation	E	4,170	34	-	-	-	-	-	3,097	6,225	3,097	-	-		Govt. of India
5. Janakpur Agriculture (ground water)	E	6,000	34	-	-	-	-	-	3,540	3,540	3,540	3,540	3,540		Govt. of Japan/HMG
6. Sagarmatta Project (ground water)	E	5,610	34	-	-	-	-	-	3,340	3,340	3,340	3,340	3,340		ADB/HMG
7. Marchur Lift Irrigation	W	790	34	-	-	-	-	-	600	600	-	-	600	600	UNCDF/HMG
8. Kailali Ground Water	FW	2,720	25	-	-	-	-	-	-	-	-	-	500	1,200	HMG

1/ C = Central
W = Western
E = Eastern
FW= Far Western

NEPAL
MARSYANGDI HYDRO ELECTRIC POWER PROJECT
Maximum Demand and Installed Capacity of Grid System



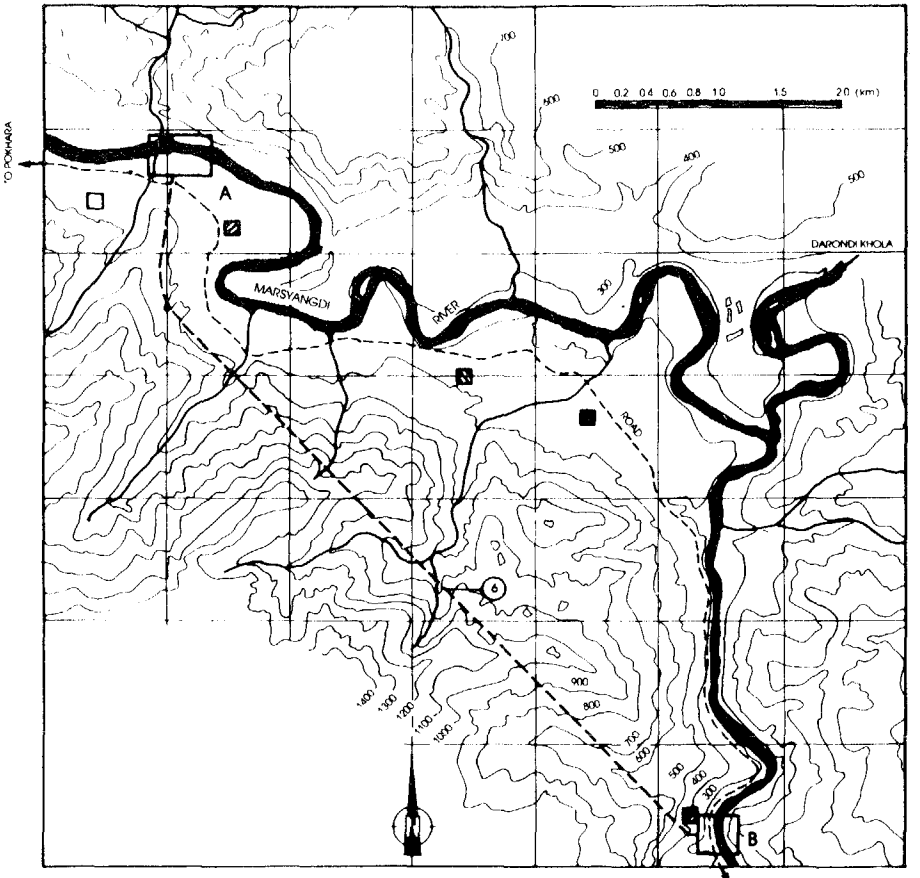
PLANT	TYPE	CAPACITY M.W. SUMMER	CAPACITY M.W. WINTER	STATUS OF COMMISSIONING
EXISTING				
Kulekhani – I	H	60.0	60.0	
Trisuli	H	18.0	15.0	
Sunkosi	H	10.0	5.1	
Gandak	H	15.0	10.8	
Devighat	H	14.1	10.8	
Small Hydros	H	5.8	5.8	
DIESELS	D	19.5	19.5	
Sub-Total		142.4	127.0	
Trisuli (One Unit)	H	3.0	3.0	Dec 1984
Cum Sub-Total		145.4	130.0	
EXTENSION				
Eastern Region				
(I) Diesels	D	2.2	2.2	June 1986
(II) Kosi	H	6.8	6.8	June 1986
F&M Western Region	D	1.0	1.0	June 1987
Kulekhani – II	H	32.0	32.0	Oct 1986
Marsyangdi	H	66.0	69.0	July 1989
Grand Total		253.4	241.0	

Legend:
H – Hydro
D – Diesel

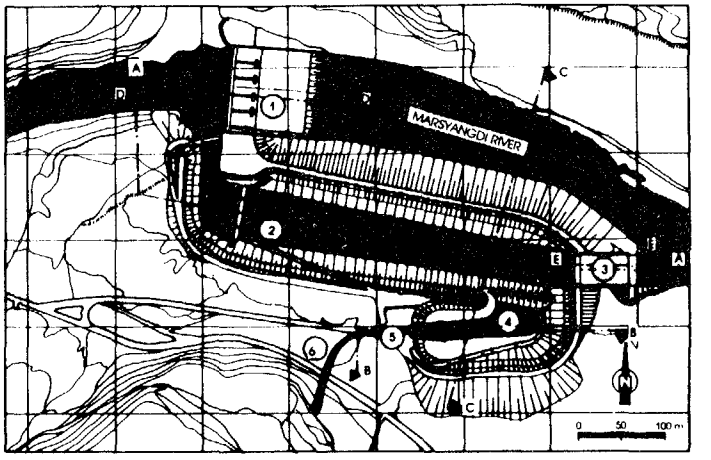
PLANT CAPACITY IN SUMMER
PLANT CAPACITY IN WINTER
MAXIMUM DEMAND

World Bank – 24622

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT



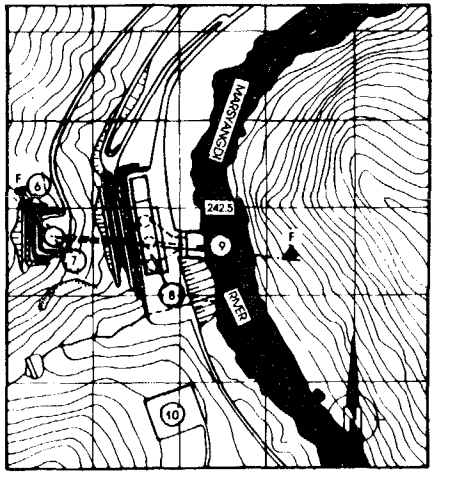
GENERAL LAYOUT



A: LAYOUT WEIR AND SETTLING BASIN

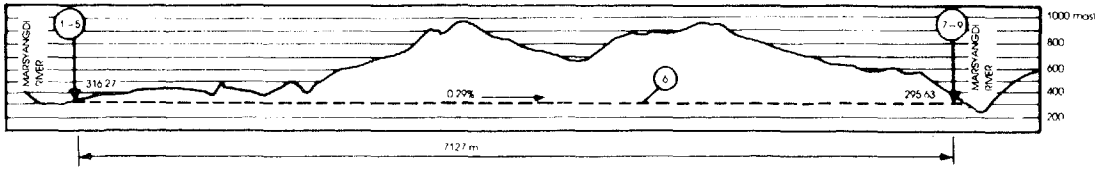
KEY
1 Weir
2 Settling Basin
3 Flushing Structure
4 Transition Pondage
5 Intake Structure
6 Headrace Tunnel
7 Surge Tank
8 Power Station
9 Outlet Structure
10 Switch Yard
Construction Camps
MHDB Camp, Offices
Contractor's Camp
Dumping Site

0 100 200 (m)



B: LAYOUT POWER HOUSE AREA

LONGITUDINAL SECTION THROUGH HEADRACE TUNNEL



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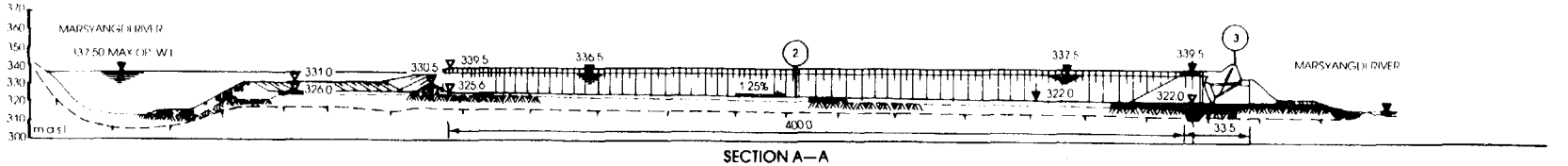
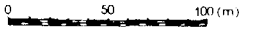
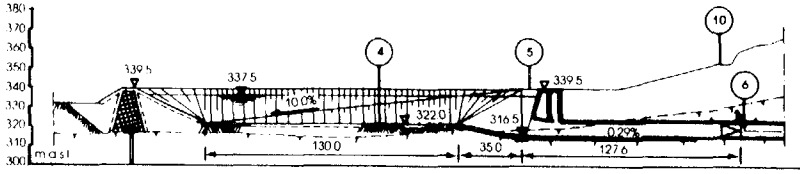
MARSYANGDI HYDROELECTRIC POWER PROJECT

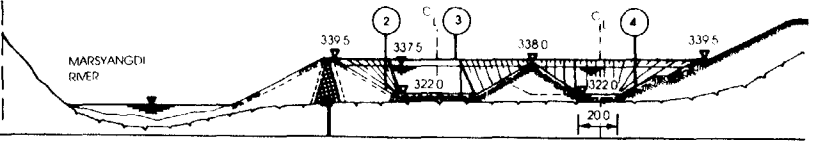


SECTION A—A





SECTION B—B



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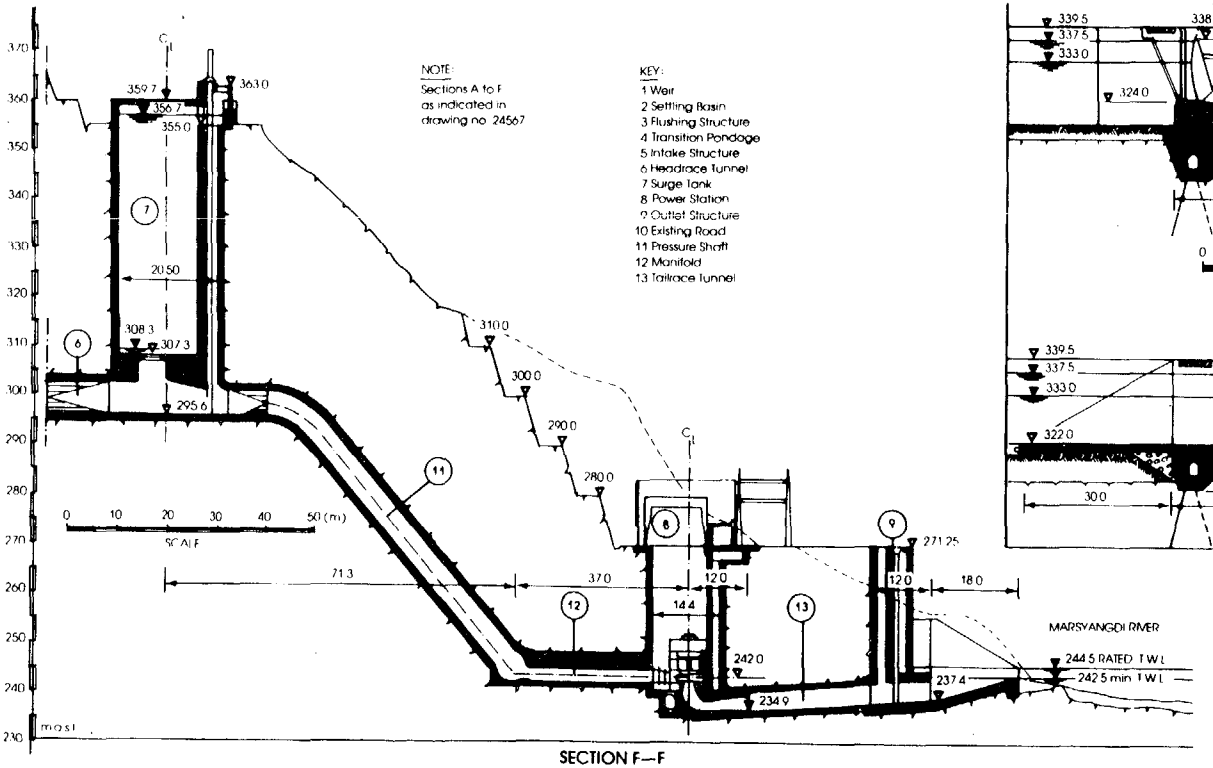

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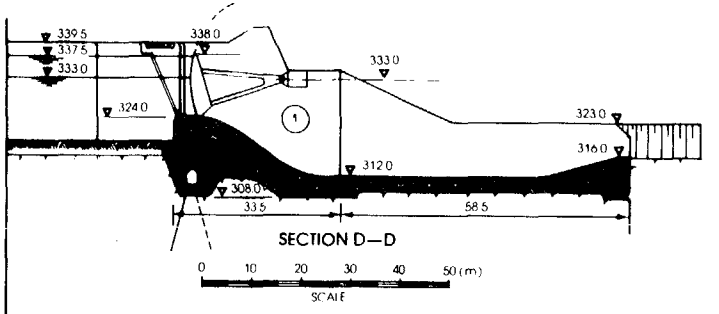

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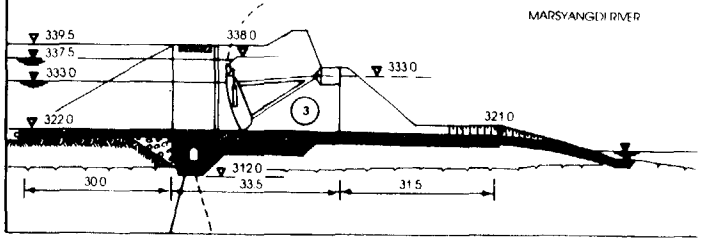

SECTION E—E

World Bank - 24568

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Project Details

General

1. The project aims at developing the potential of Marsyangdi River on a 13 km stretch where a gross head of about 90 meter is available. A diversion weir with power intake on the right side, a desilting basin, a head race tunnel, a surge tank and a power station with 3 units of 23 MW each each will be built for power generation. For important basic data of the project refer to Table 1 at the end of the Annex.

Diversion Weir

2. A 98 m wide gated diversion weir, founded on rock, will be constructed about 13 km upstream of the power station site to divert water for power generation. The weir will comprise 5 bays, with each bay having a radial gate. Energy dissipation downstream of the weir is obtained by a 58.5 m long hydraulic jump type horizontal stilling basin.

3. The average bed level of the river of the weir site is 315.0 m a s l. The normal operating reservoir level during wet summer season is 333 m a s l. Because of high transport of sediment, it is expected that a sediment delta with crest level at or about 330.0 m a s l will form in the reservoir. The weir crest level in the three left bays is designed at 324.0 m a s l and that in the two eight bays is a meter lower at 323.0 m a s l. The purpose of different crest settings is to develop a lower bed level opposite the power intake by selective operation of the weir bays during medium to high flows. Relevant model studies carried out at Karlsruhe University are part of Project documents file.

4. The maximum operating level during dry winter season (November through May) is 337.5 m a s l. At this elevation, the reservoir has a surface area of 62 ha. The reservoir can be drawn down to 333.0 m a s l to provide a compensation pondage of 1.5 million cubic meter (cu.m) under the reservoir-silted condition. The daily regulation of level between 337.5 and 333.0 m a s l will enable the project to meet the system peak demand of 69 MW during winter. The pondage capacity is approximately equivalent to 9 hours when the plant is operated continuously at 69 MW.

Settling Basin

5. A settling basin with an effective length of 400 m, width of 75 m and depth of 10 to 12 m is provided to remove sediment particles of .05 mm and larger sizes. The storage volume of basin is 70,000 cu.m for 3 meter depth of deposit. Sediment removal capacities and flushing periods for the basin are described in Annex 13.

Flushing Structure

6. The flow in the basin is regulated by a flushing structure which has a crest level of 322.0 m a s l. This structure which is partly founded on rock and partly on alluvium, comprises 2 bays, each bay fitted with 15.8 m high radial gates with flaps.

Power Intake

7. At the righthand end of the settling basin just upsteam of the flushing structure, the turbine flow is led into a relatively small transition pond and then to intake structure.

8. The entrance section of intake is 11.5 m high, 11 m wide and is provided with a trash rack. The section reduces to bulk head section of 6 m high and 5 m wide.

Headrace Tunnel

9. The tunnel, which is 7,100 m long and has 6.4 m diameter and which will be concrete lined, will be excavated by New Austrain Tunneling Method which has proven to be the fastest and most economical method for the geology similar to that encountered at site. Shotcrete will be used to control loosening of the rock after excavation of cavity. In fault zones, rockbolts and post-tensioned rock anchors will be used. In cases, where self-supporting time for the rock mass does not allow shotcrete or rockbolts and anchors to be placed, arch steel supports will be used. The tunnel will be grouted along the entire length and adequate drainage will be provided to relieve external water pressure.

Surge Tank

10. The surge tank has been designed to accomodate extreme operating conditions such as sudden full load rejection or sudden full load increase. Computed oscillations in the transition pond are negligible. For emergency shut off and for inspection of pressure shaft and butterfly valve without emptying the head race tunnel, an emergency shut off gate is provided on the downstream side of the surge tank.

Powerstation

11. Three generating units will be installed in individual 14.4 m diameter, 34 m deep, concrete lined shafts. At the turbine floor level, the shafts will be interconnected by a gallery. A gantry crane will service the generators, turbines and valves. Individual passenger elevators and staircases will be provided in the three shafts.

Diversion Works

12. The construction area for the diversion weir will be enclosed by cofferdams with crest elevation 334.5 m a s l at upstream end and 326.0 m a s l at downstream end. River flows will be passed through the settling basin excavated as a 500 m long, 75 m wide diversion channel. The channel can pass the construction period design flood of 3,354 cu.m/sec with a water surface elevation of 333.10 m upstream of the upper cofferdam.

Turbines

13. Francis type turbines have been selected for the power station. The turbines will have vertical shafts and will be coupled to generators with an intermediate shaft. The turbines will be equipped with one guide bearing located close to the runner. The turbine runner and guide vanes will be of nickle chrome cast steel to resist cavitation and erosion. Each turbine will be fitted with a hydraulic type governor and a butterfly valve.

Electrical Equipment

Generators and Other Equipment

14. There will be 3 synchronous generators each rated at 11 kV, 30 MVA and power factor of 0.85 lag. There will be an upper thrust bearing, common to generator and turbine. Each generator will be connected to a bank of single phase transformers through 11 kV dry bus bar. There will be 11 kV switchgear close to each generator. Two stepdown transformers of 1000 kVA each will be provided for station use. The main transformers will consist of 3 banks of 11/132 kV, 30 MVA each. The banks will be formed by single phase units, one single phase unit will be spare.

Marsyangdi Switchyard

15. The 132 kV side of power transformers will be connected to Marsyangdi Switchyard through an overhead span of line. 132 kV breakers will be of 20 kA breaking capacity. There will be a single u-shaped bus bar with bypass facility for breakers on Bharatpur and Kathmandu lines.

Transmission Lines and Local Distribution

16. The new transmission lines have been proposed after detailed system studies. The present highest system voltage in Nepal is 132 kV and the proposed transmission voltage will also be 132 kV. There will be 2 single circuit lines (i) from Marsyangdi to Balaju (90 km) and (ii) from Marsyangdi to Bharatpur (40 km). The towers will be of galvanized steel self-supporting lattice type. In addition, existing 11kV line between Balaju-Lainchaur in Kathmandu will be upgraded to 66 kV with a 66 kV substation at Lainchaur with a provision for 2 transformers of 66/11 kV, 10 MVA each.

132 kV Balaju Substation

17. 132 kV line from Marsyangdi will be terminated at a new 132 kV substation which will be located close to the existing 66 kV substation. There will be a bank of 132/66 kV, 45 MVA transformer. There will be a single 132 kV bus bar with provision to convert it to double bus bar later on. 132 kV and 66 kV breakers will be 20 kA and 12.5 kA breaking capacity respectively.

132 kV Bharatpur Substation

18. Under the proposed project one 132 kV bay will be added to 132 kV Bharatpur substation to terminate Marsyangdi-Bharatpur line.

IMPORTANT BASIC DATA

Hydrology

a. Catchment area	3850 km2
b. Mean annual flw	6596 Mm3 (209 m3/sec)
c. Maximum recorded flood	3354 m3/sec
d. 1000-year flood	5870 m3/sec
e. Design flood	9100 m3/sec
f. Probable maximum flood	12300 m3/sec
g. Minimum recorded flow	33 m3/sec
h. 95% probability low flow	35.6/sec

Diversion Structure (Gated)

a. Operating water level(summer)	333.0 meters above sea level (m a s l)
b. Operating water level range(winter)	337.0 to 333.0 m a s l
c. Crest elevation - weir	324.0 m a s l
- under sluice	323.0 m a s l
d. No. of bays - weir	3
- under sluice	2
e. Width of each bay	16 meters
f. Top levels of pier	339.5 meters
g. Average bed level	315.0 m a s l
h. Invert level of stilling basin	312.0 m a s l

Pondage

a. Surface area at elevation of 337.5 m.a.s.l.	62.0 ha
b. Volume between elevation 333.0 and 337.5 m.a.s.l. (after sedimentation)	1.5 million cubic meter

Flushing Structure (Gated)

a. No. of bays	2
b. Gate width	16 meter
c. Pier level	339.5 m a s l
d. Sill level	322.0 m a s l

Headrace Tunnel (Lined)

a. Length	7058 meter
b. Diameter	6.4 meter
c. Thickness of Lining	0.50 - 0.60 meter
d. Longitudinal slope	0.29%

Surge Shaft	
a. Inner diameter	20.5 meter
b. Height	50 meter
Pressure Shaft	
a. Length	75 meter
b. Diameter	5 meter
c. Thickness of lining	1-2 cm
Tailrace Tunnel	
a. Section	Rectangular with circular vault as crown
b. Dimension	4.5 m high x 4.5 m wide
c. Length	30, 35, 40 m
d. Overflow sill at end of outlet	242.5 m a s l
e. River bed level downstream of outlet	242.0 m a s l
f. Max tail water level at PMF	270.5 m a s l
Construction Period Flood Disposal	
a. Peak flow	3354 m3/s
b. Cofferdam crest level (upstream)	334.5 m a s l
Cofferdam crest level (downstream)	326.0 m a s l
c. Discharge channel - length	500 meter
- bed width	75 meter
- side slope	2:1
Design Flood Disposal	
a. Flood level	337.3 m a s l
b. Weir bays	4505 m3/s
c. Undersluice bays	3389 m3/s
d. Flushing structure	1206 m3/s
e. Flood level with one weir bay closed	338.8 m a s l
Probable Maximum Flood Disposal	
a. Flood level	339.0 m a s l
b. Weir bays	5812 m3/s
c. Undersluice bays	4218 m3/s
d. Flushing structure	2270 m3/s

Diversion Structure Gates

a. Type	Radial
b. No. of gates	5
c. Width of gates	16.0 meter
d. Height of gates- weir	13.8 meter
- undersluice	14.8 meter
e. Width of flap gates (2 nos)	14.0 meter
f. Height of flap gates(2 nos)	2.0 meter
g. Operation	Oil hydraulic servomotor
h. Stop logs	1 set
i. Top elevation of closed gates	337.8 meters

Flushing Structure Gates

a. Type	Radial
b. No. of gates	2
c. Width	16.0 meter
d. Height of gates	15.8 meter
e. Width of flap gates	13.5 meter
f. Height of flap gates	2.8 meter
g. Operation	Oil hydraulic servomotor
h. Stop logs	Common to diversion structure

Intake Bulkhead Gate

a. Type	Roller gate
b. Size	6.0 m high x 5.0 m wide
c. Operation	With mobile crane

Emergency Gate

a. Type	Roller gate
b. Size	5.0 m high x 4.6 m wide
c. Operation	Oil hydraulic servomotor

Tailrace Bulkhead Gate

a. Type	Roller gate
b. Size	4.5 m high x 4.5 m wide
c. Operation	Electric gantry crane

Lifting Cranes

a. Operation	Electric
b. Powerhouse crane	90 tons main hoist
	10 ton auxiliary hoist
c. Draft tube crane	16 ton

Turbines

a. Number		Three
b. Type		Francis
c. Rated Output		23 MW
d. Guaranteed Max. Output		26 MW
e. Rated speed		300 r.p.m.
f. Rated discharge		3x33m3/s
g. Winter gross head:	maximum	95.0 m (337.5 m-242.5 m)
	minimum	90.5 m (333.0 m-242.5 m)
h. Winter net head:	maximum	85.2 m
	minimum	82.3 m
i. Summer gross head		90.5 m (333.0-242.5)
Summer net head -	(1000 m3/s)	76.4 m
-	(200 m3/s)	79.1 m
j. Winter output -	maximum	70.7 MW
-	minimum	69.6 MW
k. Summer output -	(1000 m3/s)	65.4 MW
-	(200 m3/s)	67.7 MW

In winter maxmum turbine discharge is assumed as 97 m3/s and in summer, it is assumed as 99 m3/s because available net head in winter is more than in summer.

Butterfly Valve

a. Inlet/outlet dia.	2.5/2.2 m
b. Elevation of centre line	242 m a s l
c. Maximum operation pressure	132 m w c
d. Closing and opening time	30 sec

Generators

a. Number	3
b. Rated output	30 MVA
c. Rated voltage	11.0 kV$\pm$ 7.5%
d. Rated frequency	50 cycles
e. Rated speed	300 r.p.m.

Transformers	
a. Step Up Transformers Marsyangdi)	
b. Number	Ten units for 3 banks (including one spare unit)
c. Type	ONAN
d. Rating	11/76.2kV single phase, each unit 10MVA with off load tap changer having ± 2x2.5% taps on HV side.
e. Connection	Delta/Star
Step Down Transformers (Balaju)	
a. Number	Four units for 1 bank (including one spare unit)
b. Type	ONAN
c. Rating	76.2/38.1kV single phase, each unit 15 MVA with on load tap changer ± 8x1.25% taps on HV side.
d. Connection	Star/Star
Transmission Line	
a. Rated voltage	132 kV single circuit
b. Type of towers	lattice steel, self-supporting
c. Conductor	ACSR 300 mm2
d. Earth Wire	Single 68.1 mm2
e. Normal span	350 m

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Hydrology and Sedimentation

A. Hydrology

General

1. The drainage area of Marsyangdi River lies within Gandaki Basin, between latitudes 27-50′ and 28-40′ North and longitudes 84-10′ and 84-40 East. The catchment area at the dam site is 3,850 sq.km. It is kidney shaped and is about 140 km long and 40 km wide and is divided into two physiographic regions. The upper catchment, 1,980 sq.km, comprises a large mountain valley in the inner Himalayan zone with a valley floor level of 3,000 m a s l. The lower catchment, 1,870 sq.km., with valley floor elevations of 300–3,000 m a s l is separated from the upper catchment by a deep narrow gorge through which Marsyangdi breaks out of the Great Himalayan Range. The gradient of the main river is steep and varies between 0.36 and 2.0 percent. The side walls of valley are also steep and range from nearly vertical cliffs to 20 percent slope. Near the weir site the river slope has been measured to be about 0.4%.

Climate

2. Due to large range of altitude and topography, the climate variation within the catchment is considerable. The upper catchment has a much lower average annual rainfall - 1,500 mm compared to 3,300 mm in the lower catchment. The lower catchment is under the general influence of the Sub-Continental climate pattern and has two distinct seasons: the wet summer monsoon season and the dry winter season. About 80 percent of the annual precipitation occurs during the wet season.

3. Climatological data in Marsyangdi catchment are scarce. However, about 15 years of temperature data are available at Gorkha (28-00′N, 84-37′E) which lies just outside the south-eastern boundary of the lower catchment, at an elevation of 1,135 m. The mean maximum temperature during the year varies in a range from 17.7 C (January) to 29.5 C (May) and the mean minimum temperature varies from 7.6 C (January) to 20.2 C (July). The relative humidity varies from 49% (April) to 88% (July and August).

4. Although no evaporation records are available for Marsyangdi Catchment for the Gandaki Basin, in general, the mean annual evaporation varies with elevation and is about 1,900 mm at 100 m and 900 mm at 2,000 m.

Rainfall

5. There are seven non-recording rain gauges in the Marsyangdi Catchment. Of these, the five gauges in the lower catchment were established between 1956 and 1957 and the other two in the upper catchment area between 1974 and 1975.

Runoff

6. There are two stream gauging stations in the catchment area. Goplin Ghat station on Marsyangdi River is located 250 m upstream of the proposed weir site. It was established in 1973 and has a stable rating curve. The other gauge on Chepe Khola, a tributory joining Marsyangdi River about 15 km upstream of the weir site, was established in 1964. The runoff data of Goplin Ghat station has been used, in conjunction with the rainfall data in the lower catchment, to determine the flood and low flow estimates for the project.

7. The low flows at Goplin Ghat show a relatively small variation from year to year and the ratio of maximum to minimum flow rate is large compared to many other streams in the basin. This is attributed to relatively larger and consistent snow-melt component of Marsyangdi flow. Monthly flows (cu.m/sec), mean and on 95% probability basis are given below:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
43.25	37.80	35.55	39.63	56.21	87.7	331.50	427.0	229.70	132.95	81.46	54.90	1/
50.6	43.2	40.4	56.7	97.3	222.40	555.9	609.8	439.80	194.1	104.0	66.6	2/

Flood Flow

8. The proposed project does not involve significant storage and the downstream habitations are at high level terraces, so that the failure of weir during flood will not endanger human life. The design flood for the project has, therefore, been selected as Assumption A flood, following U.S. Bureau of Reclamation Criteria. For this purpose, a 6-hour duration unit graph was developed. It is based on isolated and nearly uniform precipitation events in the lower catchment and it uses a constant infiltration rate of 7 mm/hour. Runoff hydrograph with 100-year and probable maximum precipitation storms has been calculated and arranged to obtain the project design flood which has a peak flow rate of 9,100 cubic meter/sec. The probable maximum flood derived by convoluting the probable maximum precipitation with the above unitgraph, has a peak flow rate of 12,300 cubic meter/sec. A construction period design flood of 3,354 cubic

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1/ On 95% probablity basis.
2/ On mean monthly flow basis.

meter/sec has been adopted. This is equal to the maximum discharge measured at Goplin Ghat site so far.

9. In view of the short duration of annual flood series, available sufficient reliance cannot be placed in the frequency analysis. Regional flood frequency analysis, based on Gandaki Basin Study has therefore been used to estimate the magnitude of flood of different return periods as follows:

Return Period (Years)	Flood Peak (Cubic meter/sec)
2	1,729
10	2,896
100	4,490
1,000	5,870

Flood Handling

10. The diversion weir is designed to pass 7,500 cu.m/sec peak discharge, at a reservoir level of 337.3 m a s l with all of the 5 bays running. Flood flows between 7,500 m/sec and the design flood of 9,100 m/sec will be passed through the settling basin. In the event of one weir bay going out of commission, the discharge capacity of the weir is 6,500 cu.m/sec with a reservoir elevation of 338.8 m a s l. The balance of design flood, 2,600 cu.m/sec will then be passed through the settling basin. The project is also flood proofed for the probable maximum flood discharge of 12,300 cu.m/sec flowing through the weir bays and the balance through the settling basin.

Low Flows

11. Low flow estimates for different months have been made by frequency analysis of runoff data at Goplin Ghat. These estimates show that the minimum daily flow occurs in the month of March. The minimum 1-day duration low flow for a return period of 10 years is estimated to be 33.6 cu.m/sec.

12. A copy of study on Hydrology prepared by the Consulting Engineer is a part of Project documents file.

B. Sedimentation

12. Sedimentation data in Nepal are scarce and Marsyangdi River is no exception. Suspended sediment load measurements have been periodically made at Goplin Ghat site since May 1978. The measurements cover about 3 high flow periods.

13. The mean annual suspended sediment load at Goplin Ghat site has been estimated by using suspended sediment rating curve and 1974-80 flow

records. The estimated amount is 26.7 million tons per year which corresponds to 2.6 mm per year of erosion in the watershed. The unmeasured load at the gauging site is estimated to be an additional 15 percent. Petrographic analyses of sediment samples show that Quartz, Feldspar and Mica constitute 60, 30 and 10 percent of the suspended load. Based on limited grain size analysis, the suspended load comprises the following size fractions:

Fraction	Percentage by Weight in Measured Suspended Load
> 0.25 mm	20.9
0.25 - 0.125 mm	26.1
0.125- 0.05 mm	26.45
0.02 - 0.05 mm	25.25
> 0.02 mm	1.3

14. Monthwise distribution of suspended sediment load has been patterned after Trisuli River data. According to this distribution more than 74 percent of the annual sediment load is carried during July and August and about 94 percent during the monsoon period - June through September.

Flushing of Basin

15. The settling basin is designed to remove sediment particles of size larger than 0.05 mm (para 5 of Annex 12). It will be necessary to periodically flush the sediments accumulated in the desilting basin. This will be done during night time so as not to lose the capacity during peak time. The following table shows the month-wise requirement of flushing time:

Required Flushing Time for the Basin

Months	QT	QF	SL	TT	POP
Jan	50	-	8.7	-	-
Feb	43	-	8.8	-	-
March	40	-	13.1	-	-
April	56	60	34.1	20	29.3
May	97	100	112.5	37	29.4
June	99	300	390.4	40	28.3
July	99	450	786.4	59	28.5
Aug	99	450	540.4	41	29.3
Sept	99	450	248.8	19	29.2
Oct	99	240	186.8	23	30.0
Nov	99	120	25.9	7	29.7
Dec	67	70	17.3	8	30.7

QT = Turbine discharge in cub.m/sec
QF = Flushing discharge in cub.me/sec
SL = Settled material in thousand tons/month
TT = Total flushing time in hours/month
POP = Possible plant operation time in day/month

16. A copy of study on Sedimentation prepared by the Consulting Engineer and subsequent model studies at Karlsruhe University are part of Project documents file.

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Geology and Seismicity

A. Geology

Project Area

1. The lower 20 km of the Marsyangdi Valley, in which the project is located, is partly alluviated and partly entrenched in a gorge. The bedding strikes generally east-west, with dips ranging from gentle to steep and locally overturned. A large fold crosses the Marsyangdi Valley near the power station. A fault, Shilung Fault, strikes generally east-west in the project area, and sheared rock is exposed along this fault zone in the river bed and left bank cliffs within 1.5 km of downstream of the weir site.

2. Instability along the steep river banks is common in both alluvial terraces and the bedrock, with slides extending as high as 180 m above the river level. Most slides appear to be sheet like, affecting loosened and weathered superficial layers.

Weir Site

3. Eleven drill holes totalling 272 m length were made in 1978 and 1980-81 explorations. All drill holes are located on the bank terraces except one, located in the right river channel. In addition, three test pits were excavated on the left bank terrace and 28 seismic traverses were made, all on the right bank. Geological mapping of the site including the reservoir was done. In 1982-83, 3 additional holes were drilled as the weir was shifted upstream by about 260 meters.

4. Alluvium is exposed in river and creek banks, terrace faces, road batters and test pits. The alluvium consists of both clean and silty micaceous sand, gravel and boulders. The rock types in boulder-gravel are predominantly phyllite and quartzite. The rock type exposed in outcrops and recovered in cores consists of white and grey metaquartzite, conglomerate, quartzose phyllite and softer fissile phyllite. In four drill holes, 10 to 200 mm wide seams of sheared rock and clay were encountered. From other drill log description it appears that bed rock is generally sheared and fractured but not weathered. There is no evidence to suggest recent movement of fault. During construction, conventional methods, such as over-excavation, dental concreting and consolidation grouting etc. will

be used wherever required. Ground water level measurement, water pressure tests and permeability tests were made in boreholes. A large creek on the right bank normally goes underground on reaching the alluvial terraces.

Headrace Tunnel

5. The tunnel intake will be located in a deep open cut. From intake to 1.85 km, the tunnel passes beneath alluvial terraces with a cover of 15 m to 135 m. From 1.85 km to 6.8 km it passes beneath mountains and spurs with the cover increasing to 645 m at 3.15 km, and then decreasing to 260 m at 6.8 km. From 6.8 km to 7.1 km, the tunnel is located beneath the steeply descending wall of the Marsyangdi gorge with the cover of 85 m at the surge shaft. Geological mapping of the area along the tunnel line was done.

6. Six vertical drill holes totalling about 360 m were made along the tunnel alignment, surge shaft and intake. Above the tunnel, the bedrock is largely covered by deposits of soil, slopewash, alluvium and talus.

Rocktype generally encountered in the drill holes comprised phyllites and quartzites. The quratzites range from white very hard metaquartzite to grey silty dolomitic varieties. Phyllites range from hard, quartzose and relatively massive rock to soft and fissile, micaceous, chloritic and talcose rocks. Cores of both phyllite and quartzite are mostly closely fractured and much of the core was recovered in fragments and pieces less than 100 mm long. At least two drill holes appeared to encounter a fault along one of the lineaments associated with Shilung Fault Zone. The tunnel length is 7.1 km, it would not be economical to spend more time and money on additional investigation. The element of uncertainty would not be reduced by few additional drillings. Accordingly higher physical contingencies have been provided for tunnel than for other civil works.

7. Method of construction of the tunnel and the steps used to control the loosening of rock after excavation are described in Annex 12.

Power Station

8.. The power station is located underground in the right wall of the gorge. Near the site, the river channel is 40 m to 70 m wide.

9.. Extensive rock exposure in the area is mainly of quartzite. The quartzite is hard, white to pale gray, medium grained, extensively granulated, microfractured and recrystallized metaquartzite. Some beds of 20 mm to 100 mm sheared phylittes occur. Core recovery in quartzite ranged from 47 percent to 91 percent. Outcrops of quartzites are mostly fresh to slightly weathered. Two main faults were found in the power station area. Zones of microfracturing and sheared to crushed rock were found. Numerous

small springs occur along the toe of the highway cut through the power station site. Three drill holes totalling 71 meters were drilled in the power station and tail race area.

B. Seismicity

10. Nepal is an area of high seismic risk with extreme events exceeding Magnitude Richter 8. List of events compiled for this project shows that the project site lies in the zone of concentration of epicenters, which cluster around Pokhara and Gorkha. The tectonic process is believed to be the thrusting of Indian Subcontinent under the Eurasian land mass. Using the attenuation function and adjustment for rock foundation and considering the low susceptibility of the project to serious seismic damage, a design dynamic acceleration of 0.2g horizontally and 0.15 g vertically has been adopted. For design purposes, both the accelerations are taken into consideration simultaneously.

11. A copy of report of Geology and Seismicity prepared by the Consulting Engineer is a part of Project documents file.

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Nepal Electricity Corporation (NEC)

Project Cost Estimate

Description	Foreign	Local	Total	Foreign	Local	Total
	---Thousand N. Rupees---			-----Thousand US$-----		
A. Preliminary works including land acquisition	40,300	47,000	87,300	2,500	2,900	5,400
B. Administration Cost by HMG	8,000	43,400	51,400	500	2,700	3,200
Sub-total	48,300	90,400	138,700	3,000	5,600	8,600
C. Civil Works (Lot I)						
Site Installation Lot I	101,600	18,000	119,600	6,300	1,200	7,500
Diversion works during construction including settling basin	109,100	48,800	157,900	6,800	3,100	9,900
Diversion weir, flushing structure & intake structure	510,400	148,600	659,000	31,900	9,300	41,200
Sub-total	721,100	215,400	936,500	45,000	13,600	58,600
Civil Works (Lot II)						
Site Installation Lot II	308,600	54,800	363,400	19,300	3,400	22,700
Head race tunnel, surge tank	700,900	265,500	966,400	43,800	16,600	60,400
Pressure shaft, tail race tunnels, power station, switchyard	159,700	74,700	234,400	10,000	4,600	14,600
Permanent roads and outdoor works	9,400	5,900	15,300	600	400	1,000
Sub-total	1,178,600	400,900	1,579,500	73,700	25,000	98,700
D. Equipment						
Hydraulic steel structure						
Gates	166,500	21,500	188,000	10,400	1,300	11,700
Penstock and manifold	47,100	6,100	53,200	3,000	400	3,400
Cranes and elevators	18,900	2,500	21,400	1,200	200	1,400
Sub-total	232,500	30,100	262,600	14,600	1,900	16,500
Mechanical Equipment						
Turbines	87,600	16,500	104,100	5,500	1,000	6,500
Butterfly valves	21,100	4,900	26,000	1,300	300	1,600
Auxiliary system	11,900	2,600	14,500	800	200	1,000
Sub-total	120,600	24,000	144,600	7,600	1,500	9,100
Electrical Equipment						
Generators	119,400	21,900	141,300	7,500	1,400	8,900
Transformers	35,300	4,800	40,100	2,200	300	2,500
Switchgear etc.	131,000	25,700	156,700	8,200	1,600	9,800
Auxiliary system	11,600	2,800	14,400	700	200	900
Sub-total	297,300	55,200	352,500	18,600	3,500	22,100
E. Transmission Lines	88,000	44,800	132,800	5,500	2,800	8,300
F. Substations and local distribution system	135,200	36,700	171,900	8,400	2,200	10,600
G. Consulting Engineer for Construction Supervision	120,400	-	120,400	7,500	-	7,500
H. Technical Assistance						
(i) Panel of experts and claims advisor	17,200	-	17,200	1,100	-	1,100
(ii) Supervision of system loss reduction program	1,700	-	1,700	100	-	100
(iii) Catchment management plan	3,400	-	3,400	200	-	200
(iv) Training for power sector	43,000	-	43,000	2,700	-	2,700
Sub-total	65,400		65,400	4,100	-	4,100
Base cost(mid-84 prices)	3,007,300	897,500	3,904,800	188,000	56,100	244,100
Physical contingencies	413,400	124,800	538,200	25,800	7,800	33,600
Price contingencies	553,800	176,300	730,100	34,600	11,000	45,600
Total project cost	3,974,500	1,198,600	5,173,100	248,400	74,900	323,300

Note: Local taxes and duties amounting to NRs 253.1 million equivalent to US$15.81 million are included in the local costs.

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT
PROJECT COST SUMMARY

	(NRs. Million)			(US$ Million)				
	Local	Foreign	Total	Local	Foreign	Total	% Foreign Exchange	% Total Base Costs
A. CIVIL WORKS								
SITE INSTALLATION I	18.0	101.6	119.6	1.1	6.3	7.5	84.9	3.1
SITE INSTALLATION II	54.8	308.6	363.4	3.4	19.3	22.7	84.9	9.3
DIVERSION WORKS	48.8	109.1	158.0	3.1	6.8	9.9	69.1	4.0
DIVERSION WEIR	148.6	510.4	659.0	9.3	31.9	41.2	77.5	16.9
HEAD RACE TUNNEL ETC	265.5	700.9	966.3	16.6	43.8	60.4	72.5	24.7
PRESSURE SHAFT ETC	74.7	159.7	234.4	4.7	10.0	14.6	68.1	6.0
PERMANENT ROADS	5.9	9.4	15.3	0.4	0.6	1.0	61.7	0.4
Sub-Total CIVIL WORKS	616.2	1,899.7	2,515.9	38.5	118.7	157.2	75.5	64.4
B. POWER HOUSE	281.2	1,107.6	1,388.9	17.6	69.2	86.8	79.8	35.6
Total BASELINE COSTS	897.5	3,007.3	3,904.8	56.1	188.0	244.0	77.0	100.0
Physical Contingencies	124.8	413.4	538.2	7.8	25.8	33.6	76.8	13.8
Price Contingencies	176.3	553.8	730.1	11.0	34.6	45.6	75.8	18.7
Total PROJECT COSTS	1,198.6	3,974.5	5,173.1	74.9	248.4	323.3	76.8	132.5

Annex 15
Table 2

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT
Summary Account by Time

	Base Costs (NRs. Million)						Foreign Exchange		Base Costs + Price Cont. on Base Costs	Total Incl. Cont.
	84/85	85/86	86/87	87/88	88/89	Total	%	Amount	(US$ Million)	(US$ Million)
I. INVESTMENT COSTS										
A. PRELIMINARY WORKS	43.7	26.2	17.5	-	-	87.3	46.1	40.3	5.9	5.9
B. ADMINISTRATION COSTS	10.3	10.3	10.3	10.3	10.3	51.4	15.5	8.0	3.8	3.8
C. CIVIL WORKS	348.2	706.5	706.5	503.2	251.6	2,515.9	75.5	1,899.7	183.7	214.8
D. EQUIPMENT										
1. HYDRAULIC EQUIPMENT										
GATES ETC	56.4	37.6	37.6	37.6	18.8	187.9	88.6	166.4	13.5	14.9
PENSTOCK AND MANIFOLD	16.0	10.6	10.6	10.6	5.3	53.2	88.6	47.1	3.8	4.2
CRANES AND ELEVATORS	6.4	4.3	4.3	4.3	2.1	21.4	88.6	18.9	1.5	1.7
Sub-Total HYDRAULIC EQUIPMENT	78.8	52.5	52.5	52.5	26.3	262.5	88.6	232.5	18.9	20.7
2. MECHANICAL EQUIPMENT										
TURBINES	31.2	20.8	20.8	20.8	10.4	104.1	84.2	87.6	7.5	8.2
BUTTERFLY VALVES	7.8	5.2	5.2	5.2	2.6	26.0	80.9	21.1	1.9	2.1
AUXILIARY SYSTEM	4.4	2.9	2.9	2.9	1.5	14.5	82.1	11.9	1.0	1.1
Sub-Total MECHANICAL EQUIPMENT	43.4	28.9	28.9	28.9	14.5	144.7	83.4	120.6	10.4	11.4
3. ELECTRICAL EQUIPMENT										
GENERATORS	42.4	28.3	28.3	28.3	14.1	141.3	84.5	119.4	10.2	11.2
TRANSFORMERS	12.0	8.0	8.0	8.0	4.0	40.1	88.2	35.3	2.9	3.2
SWITCHGEAR ETC	47.0	31.3	31.3	31.3	15.7	156.7	83.6	131.0	11.3	12.4
VENTILATION ETC	4.3	2.9	2.9	2.9	1.4	14.4	80.9	11.6	1.0	1.1
Sub-Total ELECTRICAL EQUIPMENT	105.7	70.5	70.5	70.5	35.2	352.4	84.4	297.3	25.3	27.9
Sub-Total EQUIPMENT	227.9	151.9	151.9	151.9	76.0	759.7	85.6	650.4	54.6	60.0
E. TRANSMISSION LINES AND LOCAL DISTRIBUTION										
TRANSMISSION LINES AND LOCAL DISTRIBUTION 1/	-	46.6	46.6	46.6	15.5	155.3	67.6	105.0	11.6	12.8
Sub-Total TRANSMISSION LINES AND LOCAL DISTRIBUTION	-	46.6	46.6	46.6	15.5	155.3	67.6	105.0	11.6	12.8
F. SUBSTATIONS										
SUBSTATIONS	44.8	29.9	29.9	29.9	14.9	149.4	79.1	118.2	10.7	11.8
Sub-Total SUBSTATIONS	44.8	29.9	29.9	29.9	14.9	149.4	79.1	118.2	10.7	11.8
G. CONSULTING ENGINEER	24.1	24.1	24.1	24.1	24.1	120.4	100.0	120.4	8.9	9.3
H. TECHNICAL ASSISTANCE										
PANEL OF EXPERTS AND CLAIMS SPECIALIST	3.4	3.4	3.4	3.4	3.4	17.2	100.0	17.2	1.3	1.3
SUPERVISION OF SYSTEM LOSS REDUCTION PROGRAM	0.3	0.3	0.3	0.3	0.3	1.7	100.0	1.7	0.1	0.1
CATCHMENT MANAGEMENT PLAN	0.7	0.7	0.7	0.7	0.7	3.4	100.0	3.4	0.3	0.3
TRAINING FOR POWER SECTOR	8.6	8.6	8.6	8.6	8.6	43.0	100.0	43.0	3.2	3.2
Sub-Total TECHNICAL ASSISTANCE	13.1	13.1	13.1	13.1	13.1	65.3	100.0	65.3	4.8	4.8
Total INVESTMENT COSTS	712.0	1,008.5	999.8	779.0	405.5	3,904.8	77.0	3,007.3	284.1	323.3
Physical Contingencies	85.5	144.5	144.5	109.2	54.4	538.2	76.8	413.4	-	-
Price Contingencies	29.3	125.7	204.6	221.4	149.1	730.1	75.8	553.8	-	-
Total PROJECT COSTS	826.8	1,278.8	1,348.9	1,109.6	609.0	5,173.1	76.8	3,974.5	284.1	323.3
Taxes	40.4	63.0	66.6	54.7	28.4	253.1	0.0	0.0	-	15.8
Foreign Exchange	652.7	968.0	1,023.7	857.1	473.0	3,974.5	0.0	0.0	-	248.4

1/ Local distribution component costing US$1.3 million (F.E. $1.0 million, L $ 0.2 million and taxes 0.1 million) is to be financed by KFW and has therefore been combined with substations in Annex 15.

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT
Table 101, POWER HOUSE
Detailed Cost Table

	Base Costs (NRs. Million)						Totals Including Contingencies (NRs. Million)						Breakdown of Totals Incl. (US$ '000)		
	84/85	85/86	86/87	87/88	88/89	Total	84/85	85/86	86/87	87/88	88/89	Total	For. Exch.	Local (Excl. Taxes)	Duties & Taxes
I. INVESTMENT COSTS															
A. PRELIMINARY WORKS	43,673	26,204	17,469	-	-	87,345	45,336	29,153	20,673	-	-	95,161	2,731,619	2,993,530	222,440
B. ADMINISTRATION COSTS	10,271	10,271	10,271	10,271	10,271	51,353	10,675	11,463	12,202	12,934	13,710	60,983	586,737	3,224,732	-
C. EQUIPMENT															
1. HYDRAULIC EQUIPMENT															
GATES ETC	56,379	37,586	37,586	37,586	18,793	187,928	64,264	45,789	48,654	51,574	27,334	237,615	13,144,052	866,341	840,564
PENSTOCK AND MANIFOLD	15,964	10,643	10,643	10,643	5,321	53,215	18,197	12,966	13,777	14,604	7,740	67,284	3,721,924	245,317	238,018
CRANES AND ELEVATORS	6,415	4,277	4,277	4,277	2,138	21,384	7,313	5,210	5,536	5,869	3,110	27,038	1,495,664	98,581	95,648
Sub-Total HYDRAULIC EQUIPMENT	78,758	52,505	52,505	52,505	26,253	262,527	89,774	63,966	67,968	72,046	38,184	331,938	18,361,640	1,210,239	1,174,230
2. MECHANICAL EQUIPMENT															
TURBINES	31,231	20,820	20,820	20,820	10,410	104,102	35,605	25,376	26,967	28,585	15,150	131,684	6,919,407	844,999	465,831
BUTTERFLY VALVES	7,814	5,209	5,209	5,209	2,605	26,047	8,910	6,352	6,750	7,155	3,792	32,960	1,663,786	279,598	116,595
AUXILIARY SYSTEM	4,362	2,908	2,908	2,908	1,454	14,541	4,974	3,545	3,768	3,994	2,117	18,397	942,701	142,036	65,080
Sub-Total MECHANICAL EQUIPMENT	43,407	28,938	28,938	28,938	14,469	144,690	49,489	35,273	37,485	39,734	21,059	183,041	9,525,894	1,266,632	647,506
3. ELECTRICAL EQUIPMENT															
GENERATORS	42,378	28,252	28,252	28,252	14,126	141,260	48,313	34,433	36,591	38,787	20,557	178,681	9,427,466	1,108,016	632,084
TRANSFORMERS	12,020	8,013	8,013	8,013	4,007	40,066	13,701	9,763	10,373	10,996	5,828	50,661	2,790,655	196,433	179,213
SWITCHGEAR ETC	47,018	31,345	31,345	31,345	15,673	156,726	53,605	38,207	40,602	43,038	22,810	198,262	10,344,908	1,345,141	701,353
VENTILATION	4,319	2,879	2,879	2,879	1,440	14,395	4,924	3,510	3,731	3,954	2,096	18,216	919,514	154,523	64,438
Sub-Total ELECTRICAL EQUIPMENT	105,734	70,489	70,489	70,489	35,245	352,447	120,544	85,913	91,297	96,775	51,291	445,820	23,482,542	2,804,114	1,577,088
Sub-Total EQUIPMENT	227,899	151,933	151,933	151,933	75,966	759,665	259,807	185,151	196,750	208,555	110,534	960,798	51,370,077	5,280,985	3,398,823
D. TRANSMISSION LINES AND LOCAL DISTRIBUTION 1/															
TRANSMISSION LINES	-	46,601	46,601	46,601	15,534	155,337	-	56,897	60,488	64,117	22,655	204,157	8,600,642	3,436,969	722,206
Sub-Total TRANSMISSION LINES AND LOCAL DISTRIBUTION	-	46,601	46,601	46,601	15,534	155,337	-	56,897	60,488	64,117	22,655	204,157	8,600,642	3,436,969	722,206
E. SUBSTATIONS	44,822	29,881	29,881	29,881	14,941	149,407	51,111	36,440	38,728	41,052	21,758	189,089	9,333,788	1,815,377	668,903
F. CONSULTING ENGINEER	24,080	24,080	24,080	24,080	24,080	120,400	26,194	27,985	29,732	31,516	33,407	148,835	9,302,192	-	-
G. TECHNICAL ASSISTANCE															
PANEL OF EXPERTS	3,440	3,440	3,440	3,440	3,440	17,200	3,564	3,808	4,045	4,288	4,545	20,250	1,265,604	-	-
SUPERVISION OF SYSTEM LOSS REDUCTION PROGRAM	0,342	0,342	0,342	0,342	0,342	1,712	0,355	0,379	0,403	0,427	0,452	2,016	125,972	-	-
CATCHMENT MANAGEMENT PLAN	0,688	0,688	0,688	0,688	0,688	3,440	0,713	0,762	0,809	0,858	0,909	4,050	253,121	-	-
TRAINING FOR POWER SECTOR	8,598	8,598	8,598	8,598	8,598	42,992	8,908	9,517	10,111	10,718	11,361	50,615	3,163,422	-	-
Sub-Total TECHNICAL ASSISTANCE	13,069	13,069	13,069	13,069	13,069	65,344	13,539	14,465	15,368	16,290	17,267	76,930	4,808,119	-	-
Total INVESTMENT COSTS	363,813	302,038	293,304	275,835	153,860	1,388,851	406,662	361,554	373,942	374,465	219,331	1,735,954	86,733,174	16,751,592	5,012,372

1/ Local distribution component costing $1.6 million (F.E. $1.3, L $ 0.2 and taxes 0.1 million) is to be financed by KFW and has therefore been combined with substations in Annex 15.

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT
Table 102. CIVIL WORKS
Detailed Cost Table

	Base Costs (NRs. Million)						Totals Including Contingencies (NRs. Million)						Breakdown of Totals Incl. Cont (US$ '000)				Parameters		
	84/85	85/86	86/87	87/88	88/89	Total	84/85	85/86	86/87	87/88	88/89	Total	For. Exch.	Local (Excl. Taxes)	Duties & Taxes	Total	Phy. Cont. Rate	For. Exch.	Gross Tax Rate
I. INVESTMENT COSTS																			
A. SITE INSTALLATION I	35.876	23.917	23.917	23.917	11.959	119.587	42.760	30.475	32.386	34.329	18.194	158.144	8,385.047	1,001.811	497.166	9,884.025	0.15	0.84	0.05
B. SITE INSTALLATION II	109.015	72.676	72.676	72.676	36.338	363.382	129.933	92.604	98.409	104.313	55.286	480.545	25,479.180	3,044.149	1,510.712	30,034.041	0.15	0.84	0.05
C. DIVERSION WORKS	15.796	47.389	47.389	31.593	15.796	157.964	18.840	60.483	64.298	45.437	24.082	213.140	9,177.160	3,474.003	670.057	13,321.220	0.15	0.67	0.05
D. DIVERSION WEIR	65.899	197.698	197.698	131.798	65.899	658.992	78.568	252.102	267.952	189.353	100.357	888.332	42,915.444	9,812.570	2,792.693	55,520.727	0.15	0.76	0.05
E. HEAD RACE TUNNEL ETC	96.635	289.904	289.904	193.270	96.635	966.348	120.246	385.954	410.267	289.922	153.659	1,340.049	61,496.167	19,231.213	4,275.653	85,003.032	0.2	0.71	0.05
F. PRESSURE SHAFT ETC	23.440	70.319	70.319	46.879	23.440	234.396	27.956	89.757	95.421	67.431	35.738	316.304	13,428.637	5,346.001	994.382	19,769.020	0.15	0.66	0.05
G. PERMANENT ROADS	1.527	4.581	4.581	3.054	1.527	15.270	1.822	5.851	6.221	4.396	2.330	20.621	791.669	432.318	64.827	1,288.814	0.15	0.6	0.05
Total INVESTMENT COSTS	348.188	706.485	706.485	503.188	251.594	2,515.939	420.125	917.227	974.954	735.182	389.646	3,437.134	161,673.325	42,342.065	10,805.490	214,820.880			

Annex 15
Table 5

NEPAL
MARSYANGDI HYDROELECTRIC POWER PROJECT
Summary Account by Project Component
(NRs. Million)

	CIVIL WORKS									Physical Contingencies	
	SITE INSTALLATION I	SITE INSTALLATION II	DIVERSION WORKS	DIVERSION WEIR	HEAD RACE TUNNEL ETC	PRESSURE SHAFT ETC	PERMANENT ROADS	POWER HOUSE	Total	%	Amount
INVESTMENT COSTS											
A. PRELIMINARY WORKS	-	-	-	-	-	-	-	87.3	87.3	0.0	0.0
B. ADMINISTRATION COSTS	-	-	-	-	-	-	-	51.4	51.4	0.0	0.0
C. CIVIL WORKS	119.6	363.4	158.0	659.0	966.3	234.4	15.3	-	2,515.9	16.9	425.7
D. EQUIPMENT											
1. HYDRAULIC EQUIPMENT											
GATES ETC	-	-	-	-	-	-	-	187.9	187.9	10.0	18.8
PENSTOCK AND MANIFOLD	-	-	-	-	-	-	-	53.2	53.2	10.0	5.3
CRANES AND ELEVATORS	-	-	-	-	-	-	-	21.4	21.4	10.0	2.1
Sub-Total HYDRAULIC EQUIPMENT	-	-	-	-	-	-	-	262.5	262.5	10.0	26.3
2. MECHANICAL EQUIPMENT											
TURBINES	-	-	-	-	-	-	-	104.1	104.1	10.0	10.4
BUTTERFLY VALVES	-	-	-	-	-	-	-	26.0	26.0	10.0	2.6
AUXILIARY SYSTEM	-	-	-	-	-	-	-	14.5	14.5	10.0	1.5
Sub-Total MECHANICAL EQUIPMENT	-	-	-	-	-	-	-	144.7	144.7	10.0	14.5
3. ELECTRICAL EQUIPMENT											
GENERATORS	-	-	-	-	-	-	-	141.3	141.3	10.0	14.1
TRANSFORMERS	-	-	-	-	-	-	-	40.1	40.1	10.0	4.0
SWITCHGEAR ETC	-	-	-	-	-	-	-	156.7	156.7	10.0	15.7
VENTILATION ETC	-	-	-	-	-	-	-	14.4	14.4	10.0	1.4
Sub-Total ELECTRICAL EQUIPMENT	-	-	-	-	-	-	-	352.4	352.4	10.0	35.2
Sub-Total EQUIPMENT	-	-	-	-	-	-	-	759.7	759.7	10.0	76.0
E. TRANSMISSION LINES AND LOCAL DISTRIBUTION											
TRANSMISSION LINES AND LOCAL DISTRIBUTION	-	-	-	-	-	-	-	155.3	155.3	10.0	15.5
Sub-Total TRANSMISSION LINES AND LOCAL DISTRIBUTION	-	-	-	-	-	-	-	155.3	155.3	10.0	15.5
F. SUBSTATIONS											
SUBSTATIONS	-	-	-	-	-	-	-	149.4	149.4	10.0	14.9
Sub-Total SUBSTATIONS	-	-	-	-	-	-	-	149.4	149.4	10.0	14.9
G. CONSULTING ENGINEER	-	-	-	-	-	-	-	120.4	120.4	5.0	6.0
H. TECHNICAL ASSISTANCE											
PANEL OF EXPERTS AND CLAIMS SPECIALIST	-	-	-	-	-	-	-	17.2	17.2	0.0	0.0
SUPERVISION OF SYSTEM LOSS REDUCTION PROGRAM	-	-	-	-	-	-	-	1.7	1.7	0.0	0.0
CATCHMENT MANAGEMENT PLAN	-	-	-	-	-	-	-	3.4	3.4	0.0	0.0
TRAINING FOR POWER SECTOR	-	-	-	-	-	-	-	43.0	43.0	0.0	0.0
Sub-Total TECHNICAL ASSISTANCE	-	-	-	-	-	-	-	65.3	65.3	0.0	0.0
Total INVESTMENT COSTS	119.6	363.4	158.0	659.0	966.3	234.4	15.3	1,388.9	3,904.8	13.8	538.2
Physical Contingencies	17.9	54.5	23.7	98.8	193.3	35.2	2.3	112.5	538.2	0.0	0.0
Price Contingencies	20.6	62.7	31.5	130.5	200.4	46.7	3.1	234.6	730.1	12.3	89.6
Total PROJECT COSTS	158.1	480.5	213.1	888.3	1,360.0	316.3	20.6	1,736.0	5,173.1	12.1	627.8
Taxes	8.0	24.2	10.7	44.7	68.4	15.9	1.0	80.2	253.1	12.6	32.0
Foreign Exchange	134.2	407.7	146.8	686.6	983.9	214.9	12.7	1,387.7	3,974.5	12.1	480.9

Jun 15, 1984 15:08

NEPAL

MARSYANGDI HYDROELECTRIC POWER PROJECT

Implementation Schedule

Legend
Full Time Work
Part Time Work
Target Date of Activity No. 12

DESCRIPTION OF WORKS	MONTHS TO COMPLETE
CONTRACT SIGNING	
Civil Works	
Hydraulic Steel Structures	
Mechanical Equipment	
Electrical Equipment	
Switchyard, Transmission Line & Substations	
MOBILIZATION, SITE INSTALLATION	4.0
DIVERSION, RESERVOIR, SETTLING BASIN, TRANSITION, POND	
Excavation, Settling Basin/Diversion	4.0
Excavation, Transition Pondage	2.0
Embankment, Settling Basin	6.5
Construction Sealing in Embankment Settling Basin	6.0
Placing Rip Rap, Settling Basin/Diversion	3.5
Placing Rip Rap, Transition Pondage	4.0
Placing Rip Rap on River Banks	2.5
Cofferdam Construction Around the Weir	1.5
WEIR, FLUSHING STRUCTURE & INTAKE	
Excavat on Weir	1.5
Excavation, Flushing Structure	1.0
Excavation, Intake Structure	1.0
Concrete, Weir	11.0
Concrete, Flushing Structure	4.0
Concrete, Intake Structure/Open Cut Tunnel Section	7.0
Curtain Grouting, Weir	2.5
Curtain Grouting, Flushing Structure	1.5
Placing Rip Rap, Weir	3.5
Placing Rip Rap, Flushing Structure	2.0
Radial Gates, Weir	6.0
Radial Gates, Flushing Structure	2.0
Trashrack & Bulkhead Intake	3.5
Cofferdam Removal	1.0
HEADRACE TUNNEL & SURGE TANK	
Adit for Tunnel & Surge Tank	2.0
Open Cut Excavation, Surge Tank	2.5
Open Cut Excavation, Tunnel Heading Upstream	1.5
Underground Excavation, Tunnel	37.0
Underground Excavation, Surge Tank	6.0
Concrete Lining, Tunnel	37.0
Concrete Lining, Surge Tank	6.5
Emergency Gate, Surge Tank	2.0
PRESSURE SHAFT & MANIFOLD	
Underground Excavation Manifold	5.0
Underground Excavation Pressure Shaft	3.5
Steel Lining, Pressure Shaft	10.5
Steel Lining, Manifold	9.5
Backfill Concrete, Pressure Shaft	10.5
Backfill Concrete, Manifold	8.5
POWERHOUSE SHAFT, TAILRACE TUNNEL, OUTLET STRUCTURE	
Open Cut Excavation, Powerhouse	4.0
Open Cut Excavation, Outlet Structure	1.5
Underground Excavation, Shafts & Galleries	9.0
Underground Excavation, Tailrace Tunnels	2.0
Concrete Lining, Shafts	8.0
Concrete Lining, Tailrace Tunnels	5.0
Concrete Structural, Powerhouse	8.5
Concrete Structural, Outlet Structure	5.0
Draft Tubes	4.5
Spiral Cases	6.0
Superstructural Concrete, Powerhouse	4.5
Turbines & Valves	19.0
Generators & Auxiliary Equipment	18.5
Bulkhead, Outlet Structure	2.0
POWERHOUSE SUPERSTRUCTURE & CONTROL BUILDING	
Open Cut Excavation Control Building	3.0
Foundations, Transformerbank, Gallery	5.0
Steel Structure Powerhouse (Machine Hall)	4.0
Superstructural Concrete, Control Building	4.0
Powerhouse Crane	1.5
Transformers 11/132 kv	4.0
Electrical Equipment	13.0
Passenger Elevators	3.0
Air Conditioning & Ventilation	11.0
Architectural Finish, Control Building	12.0
PERMANENT ROADS & OUTDOOR WORKS	9.5
SWITCHYARD, TRANSMISSION LINES, SUBSTATIONS	
Switchyard Civil Works	4.0
Switchyard Electrical Equipment	5.0
Transmission Lines including Civil Works	12.0
Extension of Substations, Civil Works	6.0
Extension of Substations, Electrical Equipment	7.0

1985 | 1986 | 1987 | 1988 | 1989

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52

RIVER DIVERSION

TEST RUN UNITS

The contract for civil works is assumed to be awarded in March 1985.
The schedule will be revised depending upon the actual award of contract.

World Bank—9458D

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Training Facility - Cost Estimate

Foreign Cost (US$)

Description	Unit	Rate Per Unit	Total
1. Project Personnel			
i) Team Leader	40 mm	12,000 1/	480,000
ii) Specialist/Electrical	36 mm	10,000	360,000
iii) Specialist/Mechanical	36 mm	10,000	360,000
iv) Speciaist/Transmission Lines	36 mm	10,000	360,000
v) Specialist/Operation	36 mm	10,000	360,000
		Sub-total	1,920,000
2. Vehicles			
Vehicles	2	15,000 2/	30,000
3. Training Equipment			
i) Simulators, Test Benches,	Lump sum		150,000
ii) Testing Instruments (For Switchgear, Relays, Transformers, Generators, Cables, Meters & Communication Equipment)	"		300,000
iii) Workshop, Laboratory	"		250,000
iv) Audio-Visual Aids	"		50,000
		Total	2,700,000

Local Cost (US$)

Building With Furnishing			
1. To accomodate class room, workshops, workshops, laboratories, store room, administrative wing, etc.			700,000
2. Housekeeping Expenses			
To include utilities, office supplies, printing, maintenance of vehicles, local travelling, salaries of local staff	36 months	5,500	200,000
		Total	900,000

1/ The rate is per man-month (mm) and includes overhead, foreign travel, subsistence, reimbursibles.

2/ The rate includes spares required to maintain vehicles.

NEPAL

NEPAL ELECTRICITY CORPORATION

Tariffs

CONSUMER CATEGORY	DEMAND CHARGE	UNIT RATE
I. DOMESTIC CONSUMERS		
A. (a) 1-25 units	-	44 paisa
(b) 26-100 units	-	66 paisa
(c) 101-300 units	-	80 paisa
(d) above 300 units	-	90 paisa
B. Minimum Charge		
(a) 2.5 Amps 15 Amps	NRs 11.00 per month and 25 free units	(excess units priced as above)
(b) 16 Amps - 30 Amps	NRs 27.50 per month and 50 free units	" " " "
(c) 31 Amps - 60 Amps	NRs 60.50 per month and 100 free units	" " " "
(d) 61 Amps - 100 Amps	NRs 100.50 per month and 150 free units	" "
(e) above 100 Amps	NRs 220.50 per month and 300 free units	" "
II. COMMERCIAL CONSUMERS		
A. Hotels	NRs 50 per kW of maximum demand per month	70 paisa
B. Other commercial consumers	NRs 40 per kW of maximum demand per month	65 paisa
C. Government Offices, Foreign Mission	NRs 41 per month and 50 free units	85 paisa

Tariffs

CONSUMER CATEGORY	DEMAND CHARGE	UNIT RATE
III. INDUSTRIAL CONSUMERS		
A. Small (up to 50 kW)	NRs 18 per kW of installed capacity per month	56 paisa
B. Medium (up to 500 kW)	NRs 45 per kW of maximum demand per month	52 paisa
C. Large (above 500 kW)	NRs 50 per kW of maximum demand per month	50 paisa
IV. STREET LIGHTING		
A. Metered B. Unmetered	33 paise per watt per month	
V. IRRIGATION		
A. 400 volt	NRs 35 per kW of maximum demand per month	42 paisa
B. 11 kV	NRs 35 per kW of maximum demand per month	35 paisa
VI. TEMPORARY SUPPLY		
A. Metered		NRs 1.60 per unit per month
B. Unmetered	72 paisa per watt per month	
VII. TRANSPORT		
	NRs 40 per kW of maximum demand per month	40 paisa
VIII. SUPPLY TO INDIA		14 Indian paisa

NEPAL

Annex 19

NEPAL ELECTRICITY CORPORATION (NEC)

INCOME STATEMENT

ACTUALS 1978/79-1982/83; FORECAST 1983/84-1990/91

Fiscal Year ending July 15:	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
KWH GENERATED (MILLION) - HYRO	166.7	169.5	175.2	208.0	278.2	346.7	376.9	416.4	489.4	580.4	580.7	722.1	770.2
KWH GENERATED (MILLION) - DIESEL	6.1	7.0	13.6	9.4	4.5	5.0	5.0	5.0	5.0	5.0	45.0		
TOTAL KWH GENERATED	172.8	176.5	188.8	217.4	282.7	351.7	381.9	421.4	494.4	585.4	625.7	722.1	770.2
ENERGY PURCHASED-GANDAK		10.0	3.3										
ENERGY PURCHASED-INDIA	9.2	8.5	9.1	11.1	51.2	50.0	50.0	50.0	50.0	25.0	50.0		
TOTAL ENERGY AVAILABLE	182.0	195.0	201.2	228.5	333.9	401.7	431.9	471.4	544.4	610.4	675.7	722.1	770.2
KWH SOLD (MILLION) - NEPAL	113.1	131.3	129.7	143.0	217.9	258.9	288.5	327.0	390.7	447.0	503.4	546.5	593.1
KWH SOLD (MILLION) - INDIA	6.2	5.9	3.8	5.2	6.2	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
TOTAL KWH SOLD	119.3	137.2	133.5	148.2	224.1	280.9	310.5	349.0	412.7	469.0	525.4	568.5	615.1
NEC CONSUMPTION	3.4	3.7	3.6	3.6	4.1	4.6	5.9	6.7	8.0	9.1	10.2	11.1	12.0
SYSTEM LOSSES (%)	32.3	27.8	31.9	33.6	31.6	28.9	26.7	24.5	22.7	21.7	20.7	19.7	18.6
AVERAGE REVENUE PER KWH SOLD (PAISA)	39.3	43.8	52.4	52.2	55.2	81.5	117.0	134.5	134.5	134.5	134.5	149.0	176.2
OPERATING REVENUES							NRs Million						
SALES - NEPAL (EXISTING TARIFF)	44.5	57.5	68.0	74.6	120.3	211.0	235.1	266.5	318.4	364.3	410.3	445.4	483.4
SALES - INDIA	1.3	1.2	0.7	1.0	1.2	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
OTHER OPERATING REVENUES	3.5	4.3	5.3	5.2	5.3	5.8	6.1	6.4	6.7	7.4	8.1	8.5	9.0
TOTAL	49.3	63.0	74.0	80.8	126.8	221.2	245.6	277.3	329.5	376.1	422.8	458.3	496.8
TARIFF INCREASE							102.4	173.3	207.1	236.9	266.8	368.9	561.7
TOTAL OPERATING REVENUES	49.3	63.0	74.0	80.8	126.8	221.2	348.0	450.6	536.6	613.0	689.6	827.2	1058.4
OPERATING EXPENSES													
SALARIES, WAGES & ALLOWANCES	12.6	14.6	16.2	22.5	29.8	33.0	38.7	42.9	45.7	53.2	61.7	67.4	73.4
OPERATION & ADMINISTRATION	8.6	10.3	13.0	18.1	19.2	32.4	51.2	57.3	72.5	73.2	74.0	152.3	153.1
FUEL	4.5	6.0	22.6	14.8	9.0	9.0	9.0	9.0	9.0	9.0	80.6		
DEPRECIATION	12.5	12.9	14.7	21.5	24.6	47.3	81.1	97.7	116.8	131.1	132.5	203.7	274.9
ROYALTY AND SURCHARGE	15.9												
PURCHASE OF ENERGY	1.7	2.1	1.7	2.8	26.8	10.0	10.0	10.0	10.0	5.0	10.0		
TOTAL OPERATING EXPENSES	55.8	45.9	68.2	79.7	109.4	131.7	190.0	216.8	253.9	271.5	358.7	423.4	501.3
OPER. INCOME (BEF. TAX AND INTEREST)	-6.5	17.1	5.8	1.1	17.4	89.5	158.1	233.8	282.7	341.5	330.9	403.8	557.1
INTEREST			2.0	4.3	3.6	100.5	122.6	120.5	180.8	177.7	174.7	541.0	535.9
OPERATING INCOME BEF TAX	-6.5	17.1	3.8	-3.2	13.8	-11.0	35.5	113.3	101.9	163.8	156.2	-137.2	21.2
INCOME TAX		4.4	1.4		6.9		17.7	56.7	50.9	81.9	78.1		10.6
NET INCOME	-6.5	12.7	2.4	-3.2	6.9	-11.0	17.7	56.7	50.9	81.9	78.1	-137.2	10.6
RATE BASE	369.7	365.5	399.6	551.3	710.2	1574.1	2760.1	3283.8	3885.4	4292.4	4210.6	6679.1	9076.4
RATE OF RETURN ON AVE. NET FIXED ASSETS IN OPERATION(%)	-1.8	3.5	1.1	0.2	1.5	5.7	5.1	5.4	6.0	6.0	6.0	6.0	6.0

NEPAL

NEPAL ELECTRICITY CORPORATION (NEC)

BALANCE SHEET

ACTUALS 1978/79-1982/83; FORECAST 1983/84-1990/91

(NRs Million)

As of July 15:	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
ASSETS													
FIXED ASSETS													
GROSS FIXED ASSETS	449.4	459.0	545.1	793.8	913.8	2593.6	3414.2	3819.8	4831.8	4881.8	4931.8	10154.9	10204.9
LESS ACCUMULATED DEPRECIATION	82.2	95.1	109.8	131.3	155.9	203.2	284.4	382.0	498.8	629.9	762.4	966.1	1241.0
TOTAL NET FIXED ASSETS	367.2	363.9	435.3	662.5	757.9	2390.4	3129.8	3437.8	4333.0	4251.9	4169.4	9188.8	8963.9
CURRENT ASSETS													
CASH	10.0	17.8	10.9	13.8	28.0	21.9	25.3	27.2	31.5	37.8	48.2	53.1	59.2
INVENTORIES	10.7	12.7	19.7	21.2	22.5	35.4	41.1	42.9	47.5	47.7	53.6	70.7	70.9
ACCOUNTS RECEIVABLE	14.3	19.4	23.1	30.1	32.5	36.9	58.1	75.3	89.6	102.4	115.2	138.1	176.8
ADVANCES RECOVERABLE	13.5	20.9	25.4	33.6	31.5	17.7	20.5	21.5	23.7	23.8	26.8	35.3	35.5
TOTAL CURRENT ASSETS	48.5	70.8	79.1	98.7	114.5	112.0	145.0	166.8	192.3	211.7	243.8	297.3	342.3
INVESTMENTS	4.5	4.3	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
ADVANCES FOR CONSTRUCTION										140.0	243.0	243.0	388.0
TOTAL ASSETS	420.2	439.0	519.4	766.2	877.4	2507.4	3279.9	3609.6	4530.3	4608.5	4661.2	9734.1	9699.3
CAPITAL AND LIABILITIES													
EQUITY													
HMG CAPITAL	398.1	398.1	421.5	655.5	755.5	1317.2	2042.4	2051.6	2225.9	2225.9	2225.9	4489.9	4489.9
CONSUMERS CONTRIBUTIONS	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
RETAINED EARNINGS	-24.4	-11.7	-9.3	-12.5	-3.4	-14.4	3.3	60.0	110.9	192.8	270.9	133.7	144.3
TOTAL EQUITY	384.2	396.9	422.7	653.5	762.6	1313.3	2056.2	2122.1	2347.3	2429.2	2507.3	4634.1	4644.7
LONG-TERM DEBT			47.2	44.2	41.0	1167.1	1173.9	1396.0	2093.0	2057.6	2019.4	5045.4	4986.3
CURRENT LIABILITIES													
ACCOUNTS PAYABLE	4.8	5.5	7.2	20.9	18.5	13.5	17.4	19.1	21.9	22.5	36.2	35.2	36.2
MISCELLANEOUS DEPOSITS	2.5	3.5	7.7	9.0	10.0	11.0	12.1	13.3	14.6	16.1	17.7	19.5	21.4
ROYALTY AND SURCHARGE	28.1	28.1	28.1	28.1	28.1								
PURCHASE OF ENERGY	0.4	0.6	3.3	6.0	8.0	2.5	2.5	2.5	2.5	1.3	2.5		
PROVISION FOR TAX		4.4	3.2	4.5	9.2		17.7	56.7	50.9	81.9	78.1		10.6
TOTAL CURRENT LIABILITIES	35.8	42.1	49.5	68.5	73.8	27.0	49.8	91.5	90.0	121.7	134.5	54.6	68.3
TOTAL CAPITAL AND LIABILITIES	420.0	439.0	519.4	766.2	877.4	2507.4	3279.9	3609.6	4530.3	4608.5	4661.2	9734.1	9699.3
DEBT/EQUITY RATIO			10/90	6/94	5/95	47/53	36/64	40/60	47/53	46/54	45/55	52/48	52/48

NEPAL

NEPAL ELECTRICITY CORPORATION (NEC)

SOURCES AND APPLICATIONS OF FUNDS 1983/84-1990/91

(NRs Million)

Fiscal Year ending July 15:	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
SOURCES OF FUNDS								
OPERATING INCOME BEF INTEREST	89.5	140.3	177.2	231.7	259.6	252.8	403.8	546.5
DEPRECIATION	47.3	81.1	97.7	116.8	131.1	132.5	203.7	274.9
TOTAL INTERNAL CASH GENERATION	136.8	221.4	274.8	348.5	390.7	385.3	607.5	821.4
GOVERNMENT EQUITY CONTRIBUTION	561.7	725.2	9.2	174.3			2264.0	
LONG TERM LOANS (CAP INVESTMENT)	1143.9	30.0	247.1	729.6			3080.0	
TOTAL SOURCES OF FUNDS	1842.4	976.6	531.1	1252.4	390.7	385.3	5951.5	821.4
APPLICATIONS OF FUNDS								
CAPITAL INVESTMENT								
NEC CAPITAL WORKS (OWN FUNDS)	30.0	40.0	50.0	50.0	50.0	50.0	50.0	50.0
EEC GENERATION & DISTRIBUTION PLANT								
HETAUDA DIESEL PLANT								
BAHARATPUR-POKHARA TRANSMISSION LINE	36.6							
BIRATNAGAR DIST. REINFORCEMENT		40.2						
DEVIGHAT POWER PLANT		720.4						
KULEKHANI I	1512.9							
ANDHIKHOLA POWER PLANT			51.7					
KULEKHANI II				903.5				
MARSYANGDI HYDROELECTRIC PLANT							5173.1	
DEVIGHAT-KHATMANDU TRANSMISSION LINE		20.0						
DUMKEBAS-BUTWAL TRANSMISSION LINE				58.5				
HETAUDA BIRATNAGAR TRANSMISSION LINE			303.9					
VALLEY DISTRIBUTION NETWORK	100.3							
TOTAL CAPITAL INVESTMENT	1679.8	820.6	405.6	1012.0	50.0	50.0	5223.1	50.0
ADVANCES FOR CONSTRUCTION					140.0	103.0		145.0
DEBT SERVICE								
INTEREST	100.5	122.6	120.5	180.8	177.7	174.7	541.0	535.9
AMORTIZATION	17.8	23.2	25.0	32.6	35.4	38.2	54.0	59.1
TOTAL DEBT SERVICE	118.3	145.8	145.5	213.4	213.1	212.9	595.0	595.0
CASH INCREASE (DECREASE)	-6.1	3.4	1.9	4.3	6.2	10.4	4.9	6.0
OTHER THAN CASH INCREASE (DECREASE)	50.4	6.9	-21.9	22.7	-18.6	8.9	128.4	25.3
NET INCREASE (DECREASE)	44.3	10.2	-20.0	27.0	-12.4	19.4	133.4	31.4
TOTAL APPLICATIONS OF FUNDS	1842.4	976.6	531.1	1252.4	390.7	385.3	5951.5	821.4
TIMES DEBT SERVICE COVERED BY INTERNAL CASH GENERATION	1.2	1.5	1.9	1.6	1.8	1.8	1.0	1.4

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NEPAL ELECTRIC POWER CORPORATION

MARSYANGDI HYDROELECTRIC PROJECT

Notes and Assumptions for Financial Forecasts

INCOME STATEMENTS

Sale of Electricity

Sale of electricity forecasts are based on projected system expansion and takes into account a reduction in system losses. Sales are forecast to increase at an average annual rate of about 15% through FY91.

System Losses

Under a system loss reduction program being instituted with outside assistance, system losses are expected to be gradually reduced to 19% of total generation by FY91.

Average Revenue per kWh Sold

The average revenue per kWh sold reflects a tariff increase of 65% effective November 30, 1984 and increases of 11% and 18% effective the beginning of FYs90 and 91, respectively.

Other Operating revenues

Other operating revenues are mainly miscellaneous services rendered to consumers, such as transfer/replacement of meters, application fees, reconnection of service etc. Annual increases are based on the increase in number of consumers.

Salaries, Wages and Allowances

Forecasts are based on the number of staff and include an 8% annual inflation allowance.

Operation and Administration

Forecasts of operation and administration expenses are related to the system's growth and are based on a percentage of gross plant in service varying between 1.25% - 2.0%.

Fuel

The cost of fuel has been forecast on the basis of existing fuel prices in Nepal and the utilization of thermal plant.

Depreciation

A composite rate of depreciation of 2.7% is presently being used by NEC, and has been used for the forecasts.

BALANCE SHEETS

Cash

Cash balances are projected on the basis of two-three months cash operating expenses.

Inventories

Inventories are forecast taking into account maintenance supplies, fuel reserves and stores in connection with the system expansion.

Accounts Receivable

Accounts receivables are forecast on the basis of two months' annual billings.

Advances Recoverable

Advances recoverable are mainly in respect of advances for the supply of material and equipment. Forecasts assume the advances to be 50% of inventory.

Investment

Investment represents the purchase of bonds issued by the Central Bank.

Advances for Construction

Advances for construction are funds advanced to help finance capital investment.

Accounts Payable

Accounts payable are forecast on the basis of two months' operating expense net of depreciation.

Miscellaneous Deposits

Miscellaneous deposits include suppliers' and contractors' deposits and deposits on account of theft cases. Forecasts assume an annual 10% increase.

Provision for Tax

Provision for tax is the income tax incurred in the current year and paid in the following year.

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Economic Comparison - Capacity Balance

(All Figures are in MW)

Fiscal Year	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Existing Hydro 1/	110.5																
Existing Diesel	19.5		2.2														
Eastern System (Diesel)			6.8														
Eastern System (Kosi)																	
Western System					1.0												
Kulekhani II																	
Marsyangdi				32.0		69.0					75.0	75.0			75.0		
Sapt Gandaki																	
Total	130.0	130.0	139.0	171.0	172.0	241.0	241.0	241.0	241.0	241.0	316.0	391.0	391.0	391.0	466.0	466.0	466.0
Reserve 2/	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Net Available	100.0	100.0	100.0	141.0	142.0	211.0	211.0	211.0	211.0	211.0	241.0	316.0	316.0	316.0	391.0	391.0	391.0
MD 3/	82.8	89.1	94.7	124.3	143.7	159.0	170.0	181.5	198.2	209.7	230.7	253.7	279.1	307.0	337.7	371.5	408.6

1/ This is the effective available plant capacity available during dry period in winter.

2/ Reserve capacity does not include scheduled maintenance which is planned to be done mostly during summer when demand is low and effective available plant capacity is more than winter.

3/ For demand through 1991/92, refer Annex 9, Table 1. Energy requirement from 91/92 through FY99/2000 has been assumed to increase at 10% annually.

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Economic Comparison - Energy Balance (GWh)

	Total Requirement	Availability from Existing/under Construction Plant		Contribution of Marsyangdi	Contribution of Sapt. Gandaki	Contribution by Gas Turbines if Marsyangdi is replaced by Gas Turbine
		Hydro	Diesel			
9	696.5	614.1				
0	744.8	614.1	-	130.7	-	130.7
1	795.1	614.1	-	181.0	-	181.0
2	868.4	614.1	-	254.3	-	254.3
3	955.2	614.1	-	341.1	-	341.1
4	.45 (1050.7)=472.8	280.1	-	192.7	-	192.7
e 93 to Nov.93)						
4						
93 to May 94)	.55(1050.7)=577.8	334.0	-	163.7	80.1	-
5	1155.8	614.1	-	357.3	184.4	-
6	1271.4	614.1	-	357.3	300.0	-
7	1398.6	614.1	-	357.3	427.2	-
8	1538.4	614.1		357.3	536.3	30.7
9	1692.3	614.1	14.4	357.3	648.1	58.4
0	1861.5	614.1	47.2	357.3	692.7	150.2

Monthwise Comparison for FY 99/00

	---Energy Balance With Marsyangdi---------					Energy Balance Without Marsyangdi but with Gas Turbines				
h	Requirement	From Existing/ under Construction (Hydro)	From Marsyangdi	From Sapt Gandaki	From Diesel	Energy Requirement	From Existing/ under Construction (Hydro)	From Sapt Gandaki	Gas Turbines	Additional Thermal From Gas Turbines 1/
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
e Y99	$\frac{1861.5 \times .45}{6}$									
	= 139.6	48.84	31.6	59.2	-	139.6	48.84	82.9	7.9	7.9
y Y99	= 139.6	47.09	32.6	59.9	-	139.6	47.09	84.3	8.2	8.2
Y99	= 139.6	43.70	32.6	63.3	-	139.6	43.70	87.7	8.2	8.2
t Y99	= 139.6	43.48	31.6	64.5	-	139.6	43.48	88.2	7.9	7.9
Y99	= 139.6	46.53	32.6	60.5	-	139.6	46.53	84.9	8.2	8.2
Y99	= 139.6	50.47	31.6	57.5	-	139.6	50.47	81.23	7.9	7.9
Y2000	$\frac{1861.5 \times .55}{6}$	61.19	32.6	76.8	-	170.6	61.19	100.8	8.6	8.6
	= 170.6									
a Y2000	= 170.6	63.38	27.2	80.0	-	170.6	63.38	94.4	12.8	12.8
b Y2000	= 170.6	56.47	21.1	68.7	24.3	170.6	56.47	68.7	45.4	21.1
r Y2000	= 170.6	56.03	21.9	71.7	21.0	170.6	56.03	71.7	42.9	21.9
r Y2000	= 170.6	47.74	29.3	91.7	1.9	170.6	47.74	91.7	31.2	29.3
y Y2000	= 170.6	49.24	32.6	88.8	-	170.6	49.24	113.2	8.2	8.2
	1861.5	614.1	357.3	842.6	47.2	1861.5	614.1	1049.73	197.4	150.2

1/ From May to November, gas turbines are assumed to run for 4 hours to meet system peak of 66MW and in December to meet peak of 69 MW. From January to April, additional thermal energy has been considered after deducting the diesel energy (Column 6).

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MARSYAGDI HYDROELECTRIC POWER PROJECT

Economic Comparison - Assumptions

Alternative I

Marsyangdi 3x23 MW

1. (a) Total cost of Marsyangdi with price contingency:

Total US$323.3 million
Foreign US$248.4 million
Local US$ 59.1 million
Taxes US$ 15.8 million

(b) Project cost without price contingecy, taxes, technical assistance and administration expenses of HMG but including physical contingencies and Consulting Engineer:

	Total	Foreign	Local
	(US$ million)		
Civil works	173.0	138.8	34.2
Other works at power station	54.0	47.2	6.8
Transmission,distribution and substations	19.5	15.3	4.2
Consulting Engineer	7.9	7.9	-
Total	254.4	209.2	45.2

2. Disbursement pattern of Marsyangdi Project Cost: As Per Annex 15.

3. SCF = 0.9 for local material and transport
= 0.6 for local labor
All local works are assumed to consist of 50% of labor & 50% material.

4. Economic cost is based on mid-1984 prices and is as per para 1(b) above.

5. Opertation and maintenance cost is 1% of cost of hydro power station. Foreign portion of O&M is 60%.

6. Operation and maintenance cost for transmisston lines and substations is 3%. Foreign portion is 40%.

7. Economic life of Marsyangdi Power Project = 50 years.

8. Planning period is upto FY 2000.

Alternative II

Coal Thermal 3x25 MW

1. Cost of coal thermal = $2,200 per kW, 15% is assumed as local cost.

2. SCF is as per Alternative I.

3. Disbursement pattern:

FY	1985	86	87	88	89
Powerstation	40%	20%	20%	15%	5%
Transmission& substations	40%	20%	20%	15%	5%

4. Location of power station is assumed at Birganj. Three 132kV lines are assumed, i.e. from Birganj to Hetauda (50 km), from Birganj to Bharatpur (70 km) and from Birganj to Janakpur (100 km) @ US$80,000 per k.m. and US$ 1.5 million is assumed for Kathmandu local distribution. US$10.0 million is assumed for four substations.

5. Coal-heat content = 6600 kcal/kg
Thermal efficiency= 33%
Cost of coal ex Calcutta: $50/ton
Cost of transport from Calcutta to Birganj is $13.0 per ton. Additional 680 rail wagons (250 broad gauge (B.G.) and 430 small gauge (S.G.) have been assumed @ US$30,000 and 25,000 respectively for 15 days turn around. US$10.0 million has been assumed for improvement of siding and crane facilities at various places. 90% cost is assumed as foriegn and 10% local. The capacity of broad gauge wagon is assumed as 25 tons and that of small gauge 15 tons. The disbursement schedule of wagons & cranes etc. is:

1986	1987	1988
40%	40%	20%

6. 1 GWh = $\frac{860 \times 10}{0.33 \times 6600 \times 10000}$ = 395 tons

7. Thermal energy required to substitute Marsyangdi hydro energy (GWh)

FY	90	91	92	93	94	95to97	98	99	2000to2040
GWh	130	181	254	341	193	0	31	58	150

8. Operation and maintenance cost is 3% of power station cost. Foreign portion of O&M is 60%. O&M for transmission is as per Alternative I.

9. Economic life = 20 years.

10. Planning period is upto FY2000.

Alternative III

Low speed Diesel 3x24 MW

1. Cost of low speed diesel U$1,500 per kW, 15% is assumed as local cost.

2. SCF is as per Alternative I

3. Disbursement pattern:

FY	85	86	87	88	89
Power station	40%	20%	20%	15%	5%
Transmission & substations	25%	30%	30%	10%	5%

4. Location of power station and 132kV lines is assumed as per Alternative II.

5. Fuel oil heat content = 10,000 kcal/kg
Thermal efficiency 40%
Cost of oil at Calcutta = US$184/ton(1983)
No increase in real prices is considered upto 1985. Thereafter real increase at 3% p.a. has been assumed.
Transport cost from Calcutta to Birganj is assumed US$58 per ton.

Additional 370 rail wagons (140 broad gauge and 230 small gauge) have been assumed for 15 days turn around. US$10.0 million has been assumed for improvement of siding and crane facilities at various places. 90% cost is assumed as foreign and 10% as local. The capacity of broad gauge wagon is assumed 25 ton and that of small gauge wagon is 15 ton. The disbursement schedule of wagons and cranes is:

1986	87	88
40%	40%	20%

6. 1 GWh = $\frac{860 \times 10}{0.4 \times 10{,}000 \times 1{,}000}$ = 215 tons

7. Thermal energy required is as per Alternative II.

8. O&M cost is 3% of power station. Foreign portion of O&M is 60% O&M of transmission is as per Alternative I.

9. Economic life = 17 years.

10. Planning period is upto FY2000.

Alternative IV

Gas Turbine 3x24 MW

1. Cost of gas turbine $500 per kW, 15% is assumed as local cost.

2. SCF is as per Alternative I.

3. Disbursement pattern:

FY	85	86	87	88	89
Power station	40%	20%	20%	15%	5%
Transmission& substations	40%	20%	20%	15%	5%

4. Location of power station and 132kV lines is assumed as per Alternative II.

5. Diesel oil heat content = 10,000 kcal/kg
Thermal efficiency 25%
Cost of oil at Calcutta port = $270 per ton (1983). No increase in real prices upto 1985. Thereafter real increase at 3% p.a. has been assumed. Transport cost from Calcutta to Birganj = US$58 per ton.

Additional 600 rail wagon (225 broad gauge and 375 small gauge) have been assumed for 15 days turn around. US$10.0 million has been assumed for improvement of siding and crane facilities at various places. 90% cost is assumed as foreign and 10% as local. The capacity of broad gauge wagon is assumed as 25 ton and that of small gauge wagon is 15 ton. The disbursement schedule of wagons & cranes etc. is:

1986	87	88
40%	40%	20%

6. 1 GWh = $\frac{860 \times 10}{0.25 \times 10{,}000 \times 1{,}000}$ = 344 tons

7. O&M is 3% of gas power station. Foreign portion of O&M is 60%. O&M of transmission lines is as per Alternative I.

8. Economic life is 15 years.

9. Planning period is upto FY2000.

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Economic Comparison - Annual Average Energy Availability from Hydros

All Figures are in GWh

	Jan	Feb	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Existing Hydros	26.72	21.32	24.69	25.45	31.04	26.60	31.09	33.10	31.82	30.83	26.27	25.92	334.85
Kulekhani I	22.40	21.62	19.05	13.01	10.27	12.57	7.14	2.55	3.35	7.44	13.85	21.45	154.70
Kulekhani II	11.76	11.03	9.79	6.78	5.43	7.17	6.36	5.55	3.81	5.76	7.85	11.32	94.60
Kosi	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	30.00
Marsyangdi 69MW 1/	27.2	21.1	21.9	29.3	47.5	46.0	47.5	47.5	46.0	47.5	46.0	35.1	462.5
Sapt Gandaki 225MW 2/	94.4	68.7	71.7	91.7	167.4	162.0	167.4	167.4	162.0	167.4	162.0	127.5	1609.0

1/ Maximum consumable energy in wet months of May, July, August, Oct = 32.6 GWh. It is based on 70% plant factor with a capacity of 66 MW. Another 5% energy is assumed to be lost due to closure of the plant for flushing. On the same basis, consumable energy in the months of June, September and November = 31.6 GWh.

2/ Based on Nippon Koei feasibility report January 1983, net head 40.0 meters during dry period and combined plant efficiency of 86%.

Annex 23
Table 5

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Economic Comparison - Cash Flow Statement & Present Values
(US$ million)

	ALTERNATIVE 1					ALTERNATIVE II						ALTERNATIVE III					ALTERNATIVE IV					
	P/STN	TRANS	W & S	O & M	C.W.	TOTAL	P/STN	TRANS	W & S	O & M	FUEL	TOTAL	P/STN	TRANS	W & S	O & M	FUEL	TOTAL	P/STN	TRANS	W & S	O & M	FUEL	TOTAL
COST85	18.1	2.7	0	0	22.7	43.5	63.5	10.8	0	0	0	74.3	41.6	10.8	0	0	0	52.4	13.8	10.8	0	0	0	24.6
COST86	12.5	4.6		0	46.0	63.1	31.8	5.4	11.04	0	0	48.24	20.8	5.4	8.5	0	0	34.7	6.9	5.4	10.2	0	0	22.5
COST87	12.0	4.6		0	46.0	62.6	31.8	5.4	11.04	0	0	48.24	20.8	5.4	8.5	0	0	34.7	6.9	5.4	10.2	0	0	22.5
COST88	11.1	4.6		0	32.8	48.5	23.8	4.1	5.52	0	0	33.42	15.6	4.1	4.1	0	0	23.8	5.2	4.1	5.1	0	0	14.4
COST89	6.3	1.8		0	16.4	24.5	7.9	1.4	0	0	0	9.3	5.2	1.4		0	0	6.6	1.7	1.4	0	0	0	3.1
COST90				2.51	0	2.51	0	0	0	5.2	3.24	8.44				3.6	7.6	11.2	0	0	0	1.71	16.6	18.31
COST91				2.51	0	2.51	0	0	0	5.2	4.5	9.7				3.6	10.8	14.4	0	0	0	1.71	23.7	25.41
COST92				2.51	0	2.51	0	0	0	5.2	6.32	11.52				3.6	15.5	19.1	0	0	0	1.71	34.1	35.81
COST93				2.51	0	2.51	0	0	0	5.2	8.48	13.68				3.6	21.3	24.9	0	0	0	1.71	46.9	48.61
COST94				2.51	0	2.51	0	0	0	5.2	4.8	10				3.6	12.4	16	0	0	0	1.71	27.2	28.91
COST95				2.51	0	2.51	0	0	0	5.2	0	5.2				3.6	0	3.6	0	0	0	1.71	0	1.71
COST96				2.51	0	2.51	0	0	0	5.2	0	5.2				3.6	0	3.6	0	0	0	1.71	0	1.71
COST97				2.51	0	2.51	0	0	0	5.2	0	5.2				3.6	0	3.6	0	0	0	1.71	0	1.71
COST98				2.51	0	2.51	0	0	0	5.2	.77	5.97				3.6	2.2	5.8	0	0	0	1.71	4.8	6.51
COST99				2.51	0	2.51	0	0	0	5.2	1.44	6.44				3.6	4.2	7.8	0	0	0	1.71	9.3	11.01
C.2000				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	11.1	14.7	13.8	0	0	1.71	24.7	40.21
C.2001				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	11.4	15	6.9	0	0	1.71	25.3	33.91
C.2002				2.51	0	2.51	0	0	0	5.2	3.73	8.93	41.6			3.6	11.7	56.9	6.9	0	0	1.71	26	34.61
C.2003				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	12	36.4	5.2	0	0	1.71	26.7	33.61
C.2004				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	12.3	36.7	1.7	0	0	1.71	27.4	30.81
C.2005				2.51	0	2.51	63.5	0	0	5.2	3.73	72.43	15.6			3.6	12.6	31.8	0	0	0	1.71	28.1	29.81
C.2006				2.51	0	2.51	31.8	0	0	5.2	3.73	40.73	5.2			3.6	12.9	21.7	0	0	0	1.71	28.9	30.61
C.2007				2.51	0	2.51	31.8	0	0	5.2	3.73	40.73				3.6	13.2	16.8	0	0	0	1.71	29.7	31.41
C.2008				2.51	0	2.51	23.8	0	0	5.2	3.73	32.73				3.6	13.6	17.2	0	0	0	1.71	30.4	32.11
C.2009				2.51	0	2.51	7.9	0	0	5.2	3.73	16.83				3.6	13.9	17.5	0	0	0	1.71	31.3	33.01
C.2010				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	14.3	17.9	0	0	0	1.71	32.1	33.81
C.2011				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	14.7	18.3	0	0	0	1.71	33	34.71
C.2012				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	15.1	18.7	0	0	0	1.71	33.8	35.51
C.2013				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	15.4	19	0	0	0	1.71	34.8	36.51
C.2014				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	15.9	19.5	0	0	0	1.71	35.8	37.51
C.2015				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	16.3	19.9	13.8	0	0	1.71	36.7	52.21
C.2016				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	16.7	20.3	6.9	0	0	1.71	37.7	46.31
C.2017				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	17.2	20.8	6.9	0	0	1.71	38.8	47.41
C.2018				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	17.6	21.2	5.2	0	0	1.71	39.8	46.71
C.2019				2.51	0	2.51	0	0	0	5.2	3.73	8.93	41.6			3.6	18.1	63.3	1.7	0	0	1.71	40.9	44.31
C.2020				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	18.5	42.9	0	0	0	1.71	42	43.71
C.2021				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	19.1	38.3	0	0	0	1.71	43.3	45.01
C.2022				2.51	0	2.51	0	0	0	5.2	3.73	8.93	15.6			3.6	19.6	28.4	0	0	0	1.71	44.6	46.31
C.2023				2.51	0	2.51	0	0	0	5.2	3.73	8.93	5.2			3.6	20.2	23.8	0	0	0	1.71	45.8	47.51
C.2024				2.51	0	2.51	0	0	0	5.2	3.73	8.93				3.6	1.3	4.9	0	0	0	1.71	47	48.71
C.2025				2.51	0	2.51	63.5	0	0	5.2	3.73	72.43				3.6	21.2	24.8	0	0	0	1.71	48.3	50.01
C.2026				2.51	0	2.51	31.8	0	0	5.2	3.73	40.73				3.6	21.8	25.4	0	0	0	1.71	49.7	51.41
C.2027				2.51	0	2.51	31.8	0	0	5.2	3.73	40.73				3.6	22.4	26	0	0	0	1.71	51.1	52.81
C.2028				2.51	0	2.51	23.8	0	0	5.2	3.73	32.73				3.6	23	26.6	0	0	0	1.71	52.6	54.31
C.2029				2.51	0	2.51	7.9	0	0	5.2	3.73	16.83				3.6	23.7	27.3	0	0	0	1.71	54.1	55.81
C.2030				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	24.3	27.9	13.8	0	0	1.71	55.6	71.11
C.2031				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	25	28.6	6.9	0	0	1.71	57.2	65.81
C.2032				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	25.7	29.3	6.9	0	0	1.71	58.8	67.41
C.2033				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	26.4	30	5.2	0	0	1.71	60.4	67.31
C.2034				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	27.1	30.7	1.7	0	0	1.71	62.2	65.61
C.2035				2.51	0	2.51	0	0	0	5.2	3.73	8.93	0			3.6	27.9	31.5	0	0	0	1.71	64	65.71
C.2036				2.51	0	2.51	0	0	0	5.2	3.73	8.93	41.6			3.6	28.7	73.9	0	0	0	1.71	65.8	67.51
C.2037				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	29.5	53.9	0	0	0	1.71	67.6	69.31
C.2038				2.51	0	2.51	0	0	0	5.2	3.73	8.93	20.8			3.6	30.3	54.7	0	0	0	1.71	69.6	71.31
C.2039				2.51	0	2.51	0	0	0	5.2	3.73	8.93	15.6			3.6	31.2	50.4	0	0	0	1.71	71.6	73.31
C.2040				2.51	0	2.51	0	0	0	5.2	3.73	8.93	5.2			3.6	32	40.8	0	0	0	1.71	73.6	75.31

Present Value

	Base Case				Case 1				Case 2				Case 3				Case 4				Case 5			
	Alt.I	Alt.II	Alt.III	Alt.IV	Alt.I	Alt.II	Alt.III	Alt.IV	Alt.I	Alt.II	Alt.III	Alt.IV	Alt.I	Alt.II	Alt.III	Alt.IV	Alt.I	Alt.II	Alt.III	Alt.IV	Alt.I	Alt.II	Alt.III	Alt.IV
8%	217.3	287.0	287.67	311.56	201.68	265.75	261.73	288.48	Same values as		302.17	346.34	Same value as		265.08	258.14	234.4	Same values as Base Case			208.8	Same Values As Base Case		
9%	209.5	265.66	253.85	269.22	192.74	243.73	232.89	246.99	Base Case		268.52	294.94	Base Case		241.69	230.34	225.9				200.16			
10%	202.5	248.16	230.97	236.30	184.64	225.60	209.97	214.82			242.20	255.64			222.59	207.54	218.2				193.10			
11%	196.1	233.38	212.45	210.23	177.25	210.44	191.70	189.40			221.20	225.00			206.75	188.75	211.22				186.72			
12%	190.2	221.26	197.21	189.23	170.45	197.55	176.08	168.95			204.14	200.68			193.38	173.04	204.8				180.88			
13%	184.8	210.69	184.47	172.04	164.13	186.46	163.25	152.24			190.05	181.04			181.98	159.71	148.86				175.5			
14%	179.7	201.53	173.67	157.75	158.25	176.78	152.35	138.8			178.23	164.93			172.12	148.30	193.33				170.52			
15%	174.9	193.48	164.40	145.72	152.74	168.24	142.96	126.71			168.17	151.52			163.51	138.43	188.14				165.86			
16%	170.4	186.34	156.35	135.47	147.55	160.63	134.78	116.78			159.51	140.21			155.92	129.78	183.27				161.49			

Base Case: Alt. I is of least cost upto discount rate of 11.93% as compared to next best Alternative IV.
Case 1: Alt. I is of least cost upto discount rate of 11.89% as compared to next best Alternative IV.
Case 2: Alt. I is of least cost upto discount rate of 12.68% as compared to next best Alternative IV.
Case 3: Alt. I is of least cost upto discount rate of 10.35% as compared to next best Alternative IV
Case 4: Alt. I is of least cost upto discount rate of 10.94% as compared to next best Alternative IV.
Case 5: Alt. I is of least cost upto discount rate of 12.71% as compared to next best Alternative IV.

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Internal Rate of Return

Fiscal Year	1985	86	87	88	89	90	91	92	93	94	1995-2040
Capital Costs(US Million Dollars)											
Project cost including transmission and distribution works	43.5.	63.1	62.6	48.5	24.5	-	-	-	-	-	-
O&M of project works	-	-	-	-	-	2.51	2.51	2.51	2.51	2.51	2.51
Total Project Cost	43.5	63.1	62.6	48.5	24.5	2.51	2.51	2.51	2.51	2.51	2.51
Sales (GWh)											
Total incremental sales GWh(after deducting 20% loss upto FY92 and 18% thereafter)	-	-	-	-	-	104.5	144.8	208.5	279.7	292.2	293.0
Generation (GWh)						130.7	181.0	254.3	341.1	356.4	357.3
Tariff											
Existing tariff 0.815 NRs or US$0.0526											
Proposed tariff 1.1777NRs or US$0.0736 1/											
Benefits (US Million Dollars)											
Case 1											
Existing tariff						5.5	7.6	11.0	14.7	15.4	15.4
Case 2											
Proposed tariff						7.7	10.7	15.3	20.5	21.5	21.6

Internal Rate of Return(%)

	Case 1	Case 2
Base Cse	3.89	5.9
Benefits 10%(+)	4.45	6.44
Benefits 10%(-)	3.28	5.28
Benefits shifted by One year	3.67	5.57
Sale of secondary energy to India	4.4	6.4 2/

1/ Proposed tariff in 1991 would be 1.762 NRs (Annex 19). At 1984 prices, it would be equivalent to 1.1777 NRs or US$0.0736.

2/ For sale of secondary energy to India, energy surplus to 462 GWh (Table 4 of Annex 23) which cannot be consumed within Nepal has been assumed to be sold to India at existing tariff of 0.14 Indian Rupees (IRs) or US$0.01273 per KWh (para 4.03)

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MARSYANGDI HYDROELECTRIC POWER PROJECT

Data and Documents Available in the Project File

A. Lahmeyer International reports regarding Phase A of the Project:

Vol 1 - Topo survey & transportation route investigation
Vol 2 - Hydrological investigation and study
Vol 3 - Geological survey
Vol 4 - Sedimentation study
Vol 5 - Construction material survey
Vol 6 - Environmental & ecological survey
Summary report on Phase A findings and results

B. Lahmeyer International reports regarding investigation and detailed engineering design:

Vol 1 - Geological and construction material assessment
Vol 2 - Hydraulic design of civil structures
Vol 3 - Design criteria and stability analysis for civil structures
Vol 4 - Design criteria and design of permanent equiment
Vol 5 - Construction schedule and cost estimate
Vol 6 - Near final design drawing
Transmission, substations & distribution extension

C. Lahmeyer International interim report establishing least cost sequence for power generation expansion.

D. Lahmeyer International reports on hydraulic model tests:

i) Interim report no. 1
ii) Interim report no. 2
iii) Interim report no. 3
iv) Interim report no. 4

E. HMG report "Proposal for the establishment of an Electric Power Sector operations and maintenance training center".

F. NEC annual reports.

G. Reports of Panel of experts and L. I. comments

H. Marsyangdi Hydro Electric Power Project "Feasibility Report"

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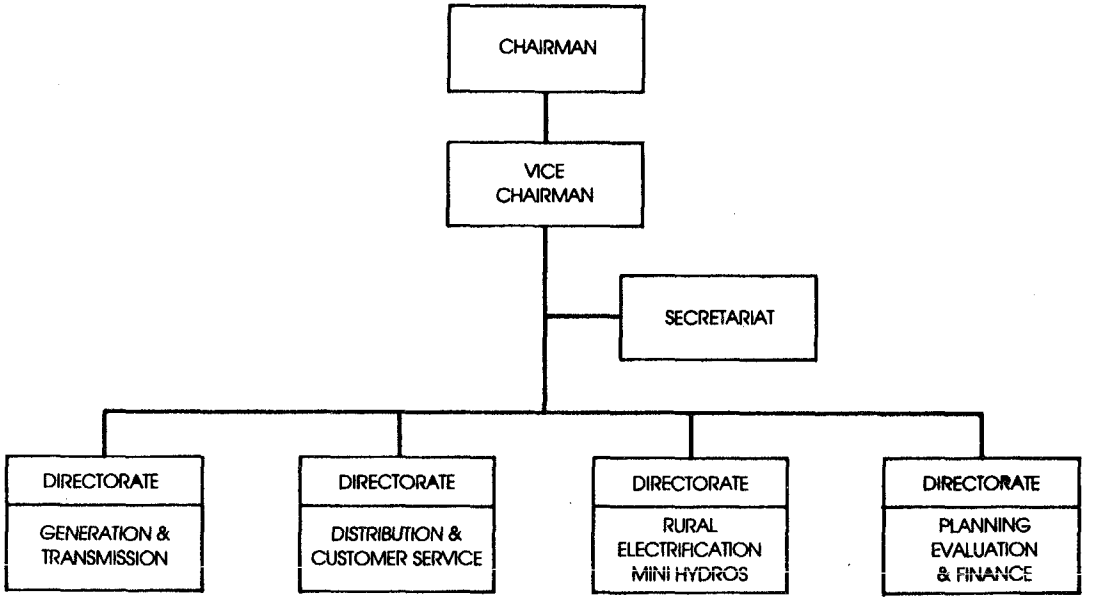
MARSYANGDI HYDROELECTRIC POWER PROJECT
Proposed Nepal Electricity Authority
Proposed Organization Chart



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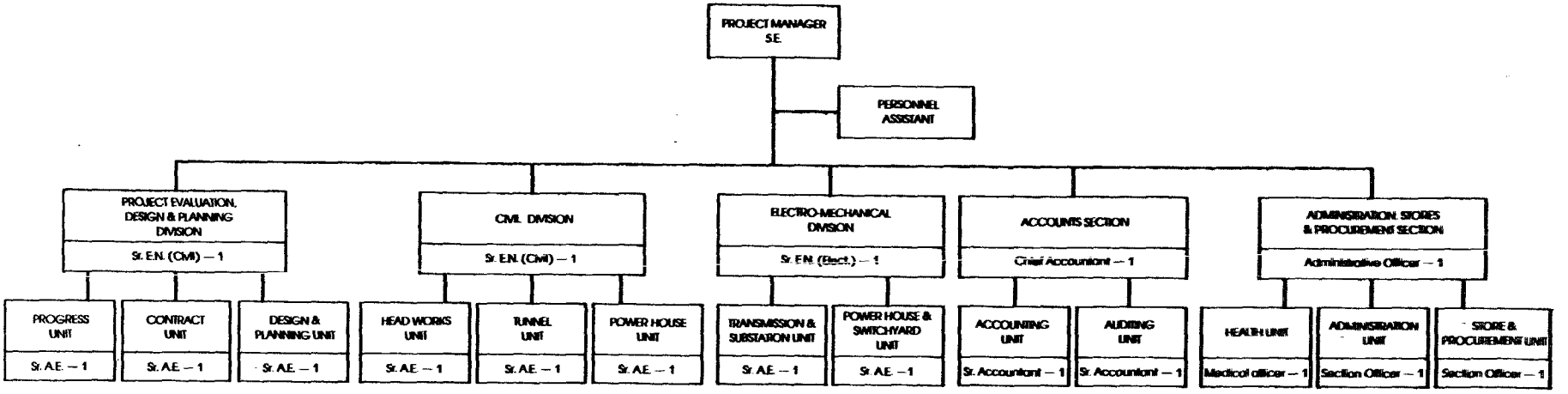
Marsyangdi Hydroelectric Development Board
Organization Chart



Legend
S.E. Superintending Engineer
Sr. E.N. Senior Engineer
Sr. A.E. Senior Assistant Engineer

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FEBRUARY 1984

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POWER SYSTEM