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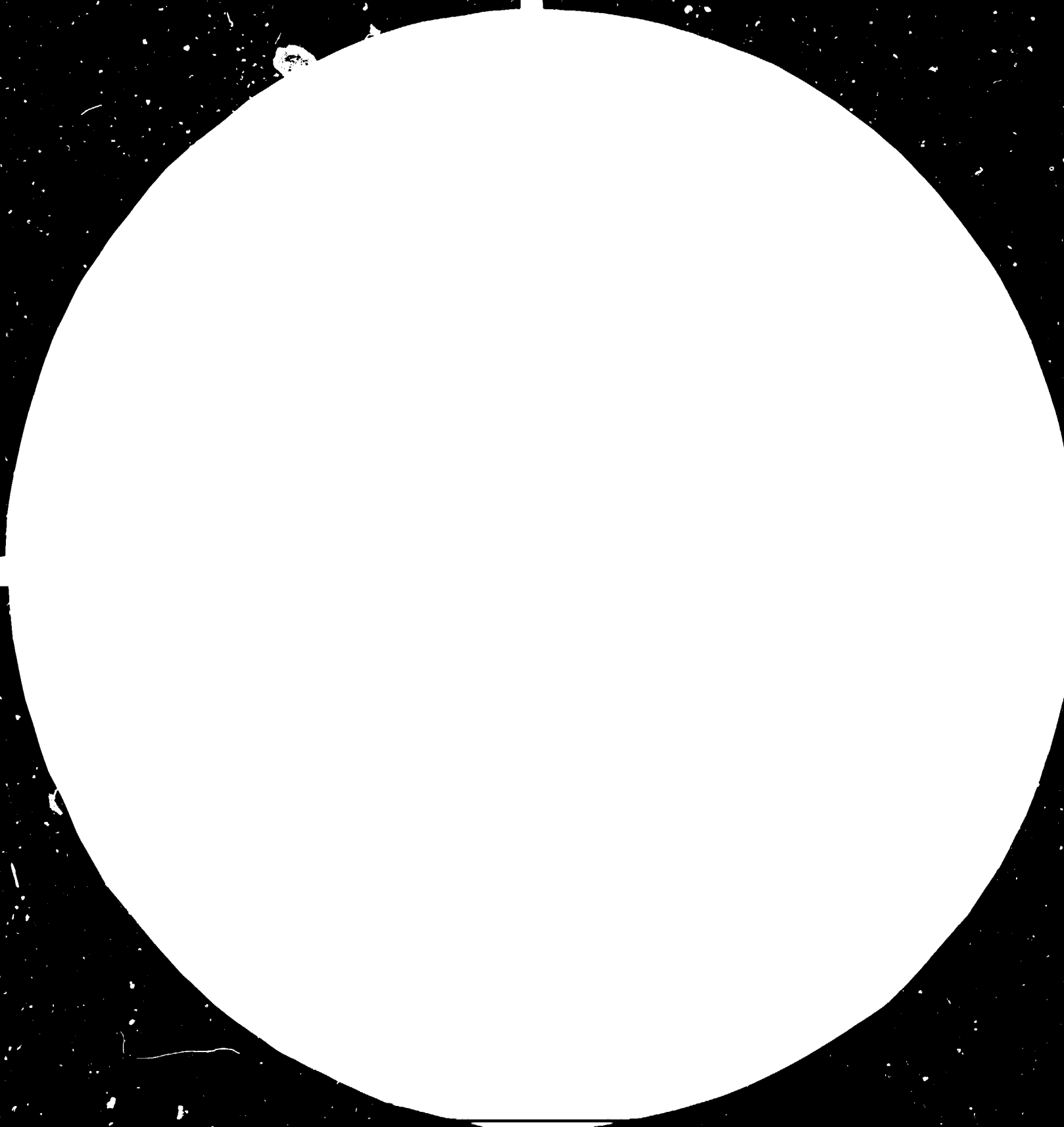
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Third Workshop on Small Hydro Power  
RCTT/UNIDO/REDP/Government of Malaysia  
7 - 15 March 1983, Kuala Lumpur, Malaysia

REPORT\* (Workshop on development of  
small hydroelectric power)

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MEMORANDUM

List of Abbreviations

ADB	-	Asian Development Bank
CARICOM	-	Caribbean Community Secretariat
DTCD	-	United Nations Department of Technical Co-operation for Development (New York, USA)
ESCAP	-	United Nations Economic and Social Commission for Asia and the Pacific (Bangkok, Thailand)
MHG	-	Mini Hydro Power Generation
MHP	-	Mini Hydro Power
NEB	-	National Electricity Board (Kuala Lumpur, Malaysia)
NORAD	-	Norwegian Agency for International Development (Oslo, Norway)
OLADE	-	Latin American Energy Organization
RCTT	-	ESCAP Regional Centre for Technology Transfer (Bangalore, India)
RN-SHP	-	ESCAP Regional Network for Small Hydro Power
SHG	-	Small Hydro Power Generation
SHP	-	Small Hydro Power
SKAT	-	Swiss Centre for Appropriate Technology (St. Gallen, Switzerland)
UNIDO	-	United Nations Industrial Development Organization (Vienna, Austria)
UNDP	-	United Nations Development Programme (New York, USA)

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I. RECOMMENDATIONS

On the basis of the discussions of the two Working Groups, and upon consideration of the four objectives of the Workshop by the Plenary Meeting, the following recommendations emerged:

1A. RE: EXCHANGE OF EXPERIENCE ON THE METHODOLOGY OF CENTRALISED MANAGEMENT OF SHP DEVELOPMENT AS COMPARED TO THE DECENTRALISED APPROACH

It was recommended that:

- a. the question of centralised or decentralised approach was essentially a matter that required a flexible rather than a rigid attitude;
- b. it had to be considered and applied by each country on a case by case basis, taking into consideration local conditions, manpower, experiences, etc., prevailing in the country and overall government policy; and
- c. strategy, policy and planning should be centrally coordinated, while the implementation, operation and management could be decentralised or maintained as a centralised activity.

1B. RE: TRANSLATION AND CONVERSION OF SHP DEVELOPMENT PROGRAMMES INTO PRACTICAL PROJECTS AND THEIR IMPLEMENTATION

It was recommended that:

- a. the sensitization of policy makers through persuasion and demonstration was an important step for securing a favourable political support towards SHP development. The importance of social and other benefits should be stressed in this connection;
- b. a minimum core group of enthusiastic and devoted individuals could play a significant role in the promotion of SHP programmes and its conversion into practical projects; and
- c. a flexible approach was necessary, particularly at the initial stage of promotion of SHP, so organised as to reach an optimal level of contribution towards the national priority concerns, in order to convince the policy makers, lending organisations etc. of the viability of the SHP programme.



2. RE: ELABORATION OF A SIMPLE METHODOLOGY FOR FEASIBILITY AND OTHER STUDIES APPROPRIATE FOR SHP

It was agreed that:

- a. It was necessary that the viability of a SHP project should be based upon a methodology developed for SHP proper rather than depending upon the application of a miniaturised large hydropower feasibility study criteria.
- b. As a first step, it would be useful for RCCT in cooperation with other UN agencies to prepare a compendium for such SHP proper methodologies adopted by various countries, which could be used as a reference for other countries which have not yet developed their own methodology.
- c. It was felt necessary to have, and accordingly recommended by the Working Group that a study be carried out by HRC in cooperation with UN and other international agencies to develop a standardised methodology in the form of a check list for the reconnaissance and feasibility studies suitable for SHP project assessment and evaluation.

3. RE: PROMOTION OF LOCAL DESIGN AND MANUFACTURE OF SMALL HYDROPOWER EQUIPMENT, MACHINERIES AND ANCILLARIES

It was agreed that:

- a. Each country define an SHP equipment policy taking into consideration the principal criteria necessary to formulate such a policy as well as taking into account the unique conditions and requirements of each country.
- b. The choice of the type of technology, particularly as to use of 'appropriate' or 'high level' technology, including the choice of developing indigenous local technology or of buying imported know-how, should be made on the basis of factors that are peculiar for each country.
- c. Third World countries undertake turbine manufacture in conjunction with other products such as pumps because of limited markets. Manufacture of other components should be considered depending on demand.
- d. A Directory of Regional Manufacturers be prepared, as a project of the HRC and/or the RN - SHP. It was expected that international organisations and agencies could assume such a project on a wide international level.

- e. Manuals on design, standardization and manufacture of equipment be developed as a regional effort supplemented by external effort, with the objective of providing 'open' technologies to all countries seeking such help.
- f. Other directories be compiled on the following:-
  - expert capacities
  - consultancy capacities
  - research institutions and their developments.
- g. Reports of local activities should be collated and circulated, covering selection of items, approaches, design adaptations, description of problems and failures, experience in production, maintenance and operation.

4. **RE: COST REDUCTION COMPATIBLE WITH VIABILITY AND UTILITY REQUIREMENTS.**

It was agreed that:

- a. The appropriate UN agency compile and disseminate information regarding the methodology of survey and design of major civil engineering structures such as headworks, water conveyance system, forebay, power house etc. practised in various countries,
- b. The appropriate UN Agency undertake research on the various aspects of cost reduction on the civil engineering works,
- c. SHP Projects use standard generators and switch gear where possible,
- d. A regional and international effort be made to develop soft-ware for SHP application. Training of personnel in this field should also have a high priority;
- e. Further studies should be carried out by UNIDO in cooperation with other UN agencies as appropriate to enhance the productive use of micro processors and electronic technology in the SHP field.

5. RE: RECOMMENDATIONS OF THE AFRICAN PARTICIPANTS, AS APPROVED IN THE PLENARY SESSION

It is recommended that the participants at Kuala Lumpur Workshop should initiate a network of Small Hydropower experts among African countries in order to promote Small Hydropower Development in Africa.

The objective of the network is to promote co-ordinated effort in the initiation and intensification of Small Hydropower plants in Africa.

It is further recommended that UNIDO and/or other appropriate UN Agencies should assist in the implementation of pilot demonstration Small Hydropower plants as a means of sensitization, promotion and intensification of Small Hydropower development for supporting cottage industries and improving socio-economic standards of the rural people.

## II. INTRODUCTION

### Background Information

The significance of Small Hydropower (SHP) as a source of renewable energy in developing countries, particularly in respect to the supply of power to remote and isolated rural areas is being increasingly recognized by developing as well as developed countries. As compared to major-hydro projects, the relatively simple technology required, less financial resources involved and the lesser degree of sophistication for planning and programming, etc., has given a certain impetus for many developing countries to include small and minihydro power programmes in their national development plans. The United Nations Conference on New and Renewable Sources of Energy held in August 1981 at Nairobi, Kenya, and particularly the Panel of Technical Experts on Hydropower emphasized such potentials which could be considered as one of the driving powers for this increased attention.

From the viewpoints of development and transfer on technology and exchange of experiences among developing and developed countries, a series of seminars, workshops and study tours as well as various documents, such as reports relating to the development and application of mini-small hydropower have been published by various organisations.

A first Seminar-Workshop held in Kathmandu, Nepal in 1979 focused on the technological, economical, policy and institutional aspects of mini-hydro planning and project implementation through the exchange of experiences and technology transfer. The Workshop adopted what is known as the "Kathmandu Declaration on International Co-operation in the Field of Minihydro Electric Generation", which emphasized the need for strengthening international co-operation in a systematic, efficient and effective manner. The Second Seminar-Workshop/Study Tour held in Hangzhou, China/Manila, Philippines, provided an opportunity of looking into a system's approach to the establishment of minihydro for industrial promotion and development, and cost reduction schemes. This Second Seminar-Workshop adopted the "Hangzhou-Manila Declaration on Minihydro Power Development" underlining the urgency of the needs to implement programmes for supplying cheap, reliable and renewable energy sources for the rural people, particularly of the developing world.

As a logical sequence to these activities, a number of subjects of importance have emerged for which the further elaboration was desirable.

The Government of Malaysia, which started a small programme for mini-hydro development in the country in late 1979, has developed since then a very impressive programme of activities through its implementing agency, the National Electricity Board of Malaysia (NEB). Over 220 potential sites have

been surveyed, of which about one-half have been planned for implementation, including some 23 projects already under different stages of construction. The mini hydro is defined to have capacities ranging from 50kw to 5000kw, and the minihydro system will cover low, medium and high heads between two meters up to and above 70 meters. NEB is furthermore adopting a centralized planning methodology, as compared to the decentralized planning concept adopted by the Chinese.

It was therefore considered to be of great interest if the Malaysian experience could be shared with other countries, through discussions and exchange of views in respect to the planning, programming and implementation of small hydropower projects.

Accordingly the ESCAP/Regional Centre for Technology Transfer (RCTT) in co-operation with UNIDO and the Regional Energy Development Programme (REDP), and the support of the Government of Malaysia through the National Electricity Board (NEB), organised "Third Workshop on Small Hydropower" from the 7th - 15th March 1983 in Kuala Lumpur.

#### Objectives

The Workshop had the following objectives:

- a) to exchange experience on the methodology of centralized management of small hydropower development as compared to the decentralized approach, including discussions on the translation and conversion of small hydropower development programmes into practical projects and their implementation;
- b) to elaborate on a simple methodology for feasibility and other studies appropriate for SHP;
- c) to review ways and means of promoting local design and manufacturing of small hydropower equipment, machineries and ancillaries;
- d) to exchange views on ways and means of cost reduction compatible with viability and utility requirements; and
- e) exchange of views on cooperative arrangements including regional network systems.

### Organisation

The Workshop was attended by 28 participants from 19 developing countries. Representatives from 4 UN Organisations and Agencies, as well as 1 representative each from the World Bank, the Asian Development Bank and the OLADE (Latin American Energy Organisation) and 45 observers participated in the Workshop. The list of participants is attached as Annex I and the Programme of the Workshop as Annex II to this Report.

At the opening session, Y.B. Tan Sri Dato Abu Zarim bin Haji Omar, the General Manager of the NEB welcomed the participants and referred to the historical background as to how a change in energy strategy on the part of the NEB had turned its attention to the development of mini hydro and the setting up of the Mini Hydro Department in 1979. Since then, he explained, the programme which started on a experimental basis has developed to 22 projects with a costing of about \$42 million of which 8 have already been completed and the rest in various stages of implementation for the schedule completion by the middle of the year. He emphasised the innovative approach which was applied to these projects in order to gain experience in the various designs and methods of construction with special emphasis on cost reduction. He further explained that the Government's plan are taking into consideration medium- and long-term requirements with some 102 projects to be completed within the current Fourth Malaysia Plan which ends in 1985. He then referred to the efforts of their own engineers who have ventured into the design and local manufacture of turbines which was already proving to be competitive with other suppliers abroad and that there was every likelihood that the cost would further be reduced as and when the country went into production on a larger scale. He finally expressed his views that the Workshop was being held at the most opportune moment for Malaysia and that he hoped that the sharing of experience and knowledge amongst all participants would more meaningfully contribute to the attainment of the desired goals.

Mr. B.R. Devarajan, Director of RCTT presented the message from Mr. S.A.M.S. Kibria Executive Secretary of ESCAP. He referred to the importance of small hydropower developments in the ESCAP region and that it was now time to translate the ideas into action. He referred to the programmes been executed by ESCAP alone and in cooperation with other UN Organisations and Agencies which included short-term consultancy services, training and information exchange. He ensured the participants of the continued support by ESCAP within its means to promote energy development in general and new renewable sources of energy in particular in the region. In this respect, he stressed the need for the member countries thus to exert efforts to ensure success.

Mr. B.R. Devarajan then added his own thanks for the excellent preparation that had been made by the NEB and The International Conference Secretariat of the Prime Minister's Department for the organisation of the Workshop.

Mr. W.H. Tanaka, the Head of Development and Transfer of Technology Branch, UNIDO, conveyed the sincere greetings from Dr. Abd-el Rahman Khane, Executive Director of UNIDO, and then emphasised the significance of this Third Workshop which contributed in gathering a group of persons with a common interest, attitude, and knowledge in the transfer, development and application of small hydropower which would be an important precondition and basis for successful international cooperation. He felt that the objectives presented at the Workshop was focussing on such problems that still require further considerations and elaborations, and expressed his hope that this small hydropower "family" would be able to find solutions and make recommendations for the interest and benefit of all.

Dr. A. Arismunandar, Sr. Co-Ordinator, ESCAP Regional Energy Development Programme (REDP), expressed the significance which the deliberations of the present workshop could bring us all in relation to the activities of the achievement, social and economic development of the member countries. He then expressed his hope that the Workshop would be an important milestone in the attempt by the developing member countries to cooperate ever more closely in the field of small hydropower development.

H.E. Datuk Leo Moggie, Minister of Energy, Telecommunications and Posts, Malaysia, after welcoming the participants, referred to the development of small hydropower resources which had direct reference to the countries of the third world. He mentioned that in Malaysia, the development of small hydropower resources on an extensive scale had only just started, but that it was his intention that added impetus be given to the development of this resources so that its utilisation would contribution to socio-economic development of the nation, especially in the area of rural electrification. He expressed his fervent hope that the deliberations of this 3rd Workshop would be both meaningful and constructive and that the exchange of views and experiences would develop into programmes of action that are practical to the needs of the respective countries. He then declared the opening of the 3rd Small Hydropower Workshop.

### III. SUMMARY OF PAPERS

#### PARTICIPANTS

##### BURMA

##### Country Paper on Small Hydro Power Development

The country paper on Burma explained the great potential for hydro power existing in the country and with the energy situation as it is today, the need for development of hydro power which is a replenishable energy source. As to Small Hydro Power a number of projects are being implemented ranging from 60KW to 4000 KW in size.

As to local manufacture the need to supply remote regions with very small machines was explained, and that advice and expertise for local manufacture was still greatly needed.

##### CHINA, PEOPLE'S REPUBLIC OF

- I. General Situation and Fundamental Experiences of Development of SHP in China
- II. Experiences of Independent Operations of Small Hydro Power Grid at Country Level
- III. How to Establish Indigenous Manufacturing Capability of Small Hydro Turbine Equipments

The summary below refers to I.

By the end of 1982, 86,000 or more SHP stations with a total capacity of 8 million KW had been built. The annual electricity generated is 16 billion KWH. High voltage lines provided for SHP amounted to 370,000 km.

The government had paid more and more importance in solving the rural energy problem, and decided to use a certain amount of seasonal energy of SHP for peasant's living consumption such as rice cooking, water heating, foodstuff baking, tea drying etc. in far-off areas, to replace the firewood. A great change in the end users of the rural areas had begun. Good results had been achieved which is of strategic significance in the rural area.



Some important new policies, such as "self-construction, self-management, self-consumption" have been added, the key point of which is "Supporting the development of SHP with the profit gained from itself". These have been and will be more and more effective in further promoting the development of SHP in China.

The progress of development of SHP has been going on from isolated operation of small stations to the formulation of county local grid, usually of 10 - 20 MW total capacity which can either be operated independently or integrated into national grid.

## DOMINICA

### The Status of Small Hydro Power in Dominica

SHP was established in Dominica 32 years ago with the commissioning of Trafalgar Power Station. Today this station has three Pelton turbines each driving a 320KW generator. The second station, Padu is a similar type - high head, run-of-the river scheme. Padu has two Turgo Impulse wheels of 940KW capacity each. These two stations provide about 93 percent of the country's electricity needs. The rest of the energy production represents peaking and dry season production by diesel units.

The development of SHP was stagnant for many years both because of cheap oil and slow growth of the energy consuming sector. Recently there had been an upsurge in this type of activity. A mini hydro station (750KW) is to be installed upstream of Trafalgar also to supply the grid. Four decentralized rural micro schemes are at present at the prefeasibility stage. Funding is being sought for these and for other future schemes.

## ETHIOPIA

### Some Aspects of S.H.G. Planning and Implementation in Ethiopia

The country's hydro power potential is enormous. From the eight major rivers alone an estimated energy of  $60 \times 10^8$  Kwhrs could be developed in one year. This figure does not include the energy obtainable from S.H.G. resources. At present only about 3% of the estimated available energy has been developed and the per capita energy consumption is among the lowest in the world. This is

because commercial electrical energy is made available only to a small number of urban centres which consume most of the energy from major hydro sources.

The Ethiopian Electric Light Power Authority (EELPA) which is responsible for the country's electrical power planning and implementation has two systems of operations. The I.C.S. or the Inter Connected System, the S.C.S. or the Self Contained System. The ICS distributes 95% hydro energy. The S.C.S. on the other hand consists of a number of local and isolated small plants both thermal and hydro ranging from 100 - 7000KW. Only 10% of the energy comes from S.H.G. sources.

In the past EELPA's power planning system has been limited to the installation of a major hydro power plant every 7 - 8 years and extend cost intensive high voltage grid lines to consumption areas when the interconnection proved viable. The S.C.S. was introduced as a government policy to electrify some of the remote areas.

Although S.H.G. installation has been introduced more than 20 years ago the system has not been encouraged to develop. The dramatic comeback made itself felt only after the recent oil crisis. Even to date however, EELPA has not developed the necessary institutional infrastructure to intensify S.H.G. development. In fact the Authority follows strict technical-economical analysis procedures for S.H.G. project studies. This is explained by the absence of a rural electrification plan for the country as well as the lack of a "crash programme" to replace existing oil fired stations by small hydro sources readily available in most regions.

The recent formulation of a ten-year indicative energy plan by the Supreme Planning Council is expected to attract widespread attention regarding problems of rural energy in which S.H.G. can play an important role.

## Fiji

### Small Hydro Power Development in Fiji

#### Introduction

Fiji consists of a group of over 100 islands in the South Pacific, with a total land area of 18,400 sq. km. and population of 650,000.

### The Electricity Supply System

The Fiji Electricity Authority (FEA), a statutory body, is responsible for nearly all the generation and supply of electricity, the exception being outlying rural areas and smaller islands where the Public Works Department is responsible. FEA owns and operates diesel generated power supplies with an installed capacity of 85 MW and a firm capacity of 44 MW.

### Hydro Power development

A 80 MW hydro station is being commissioned this year. This will meet nearly all of the demand on the main island (Viti Levu), leaving remote villages and settlements on this island, including areas on other islands not currently served, to be satisfied by mini hydro developments or other alternatives.

### Mini hydro development

Two micro-hydro schemes (1.5 KW & 5 KW) are in operation. Several studies have been undertaken in the past by overseas consultants, the most recent being on the second largest island (Vanua Levu) where five potential mini hydro sites of about 1 MW capacity each have been identified. Two of these are being further investigated, with a view to obtaining overseas aid.

### Rural Electrification

Mini hydro development is likely to make a significant contribution to rural electrification. Currently some areas have diesel sets which run for a few hours a day only. Study is necessary on whether hydro schemes of equivalent or greater capacity would create increased demand for power, such as required for sawmilling or crop processing etc.

## INDONESIA

### Centralised versus Decentralised System of Project Planning and Implementation of Mini Hydro Power Development - The Indonesian Case

On the question of centralised versus decentralised system of project planning and implementation of mini-hydro power (MHP) development, there is no straight answer as to which is the best to follow. The important thing is how one can achieve the goal of developing mini-hydro in developing countries with the maximum use of indigenous resources and to develop local capabilities.

In the Indonesian case, the centralised system has been practically followed in almost any MHP development in the past. However, some MHP stations which have been developed on a decentralised manner have also shown the same good result.

Both centralised as well as decentralised systems have their own advantages and disadvantages.

To obtain the optimum result of MHP development, it is best to combine both systems in such a way without creating new constraints and trying to avoid the disadvantages resulting from either system. This can be started first with having an overall evaluation of the problem by preparing a good inventory of all data and information available on MHP and making an assessment of MHP development capabilities at all levels.

To have well coordinated efforts in MHP development and to make the maximum use of available resources, it is desirable that the overall responsibility for planning and programming be given to a central body which is also responsible for coordination purposes and to act as an advisory body for MHP development.

A national strategy and policy for the development of MHP should be formulated first, and on which basis a development plan can be further established and to work out an implementation programme.

## JAMAICA

### Cost Reduction Considerations in Small Hydro Power Development

1) Main tasks in MHC Plant developments outlined

2) Means of Capital Cost Reduction

a) Penstock variations (non-traditional materials)

b) Speed Regulation

Use of electronic "Load dumping technique"

- resulting in reduction of cost in vigorous design criteria for equipment such as turbines, governors and penstocks by creating stable conditions under which the equipment is expected to operate.
- possibly improving the viability of more centralised MHC plant by use of "dumped energy" for diversification (e.g. fertilizer production etc.)
- reduced costs vs traditional governors

c) Use of Centrifugal pumps

- with recommendation for need of selection manuals.

d) Pressure relief valves

- reduce cost by substituting for surge tanks.

3) Non-capital cost reductions

a) Inclusion of engineering designs in prefeasibility studies.

b) Maintain perspective of engineering feasibility study costs with respect to total project cost.

## MALAYSIA

### 1. To Exchange Views on Ways and Means of Cost Reduction with Viability and Utility Requirements

The paper covers a brief write-up on the activities of the National Electricity Board on its small hydro power projects with special reference to the ways and means of cost reduction adopted. The subject of cost reduction is discussed from all aspects of Small Hydro Power Generation from the feasibility stage of the project right up to the operation of the station after commissioning.

As a utility, there is the need for the N.E.B. to achieve a compromise between cost reduction and the resulting quality. Hence the methods of cost reduction adopted were such that the end product is still in compliance with the safety requirements and satisfying the local Building Bye Laws, the local Machinery Department and various other authorities. The concept of cost reduction is at all times adhered to during design and construction stages. Whether the result is immediate or only realised through time, cost reduction remains a continuing exercise in the implementation of small hydro power projects in this country. What this paper hopes to achieve is to bring to surface, for purpose of further discussions, both the obvious and the non-obvious areas and aspects of SHP generation where cost can be further reduced or even completely eliminated. In short, the criteria here is 'cost effectiveness' of the design and methodology adopted.

### 2. Centralised System of Mini Hydro Projects Planning and Implementation in Peninsular Malaysia

The paper discussed the role of the National Electricity Board in the project implementation of the mini hydro power in Peninsular Malaysia. The institutional framework of the organisation warrants that the management system in mini hydro projects for the country has got to be a centralised system. A short description of the functions of the appropriate departments in the Board's organisation is indicated and the general approach in supplying energy to the rural areas in Peninsular Malaysia is seen. The centralised system of management of mini hydro schemes covers areas of planning, design and approval, tender and award of contract, supervision of construction, supervision of installation and commissioning, operation of station, maintenance and monitoring system.

The paper only discusses the merits of the centralised system pertaining to the existing network of the National Electricity Board and its contribution to mini hydro development and implementation.

## MEXICO

### Computer Simulation of Hydro Power Stations

Mexico is a country with an increasing demand of power supply. The growth in the electric demand is in the order of 3000 MW/yr. This situation has led to the development of sophisticated tools of design, namely, computer simulation programs (among others) that enable the plant designers to increase their productivity and optimize the hydro power station design.

The paper describes the functional capabilities, mathematical models of the computer simulation model developed in Mexico. The importance of using this kind of powerful tools is explained too.

Finally, an illustrative example of several simulations of a power station in design stage show how this powerful tool can be applied to design.

## NEPAL

### Small Hydro Power Development

The hydro-electric potential of Nepal is estimated at 83 million KW and the first development of hydro-electricity in the country dates back to 1911. But the utilization of hydro-electric potential so far made in the country amounts only to 113 MW and only less than 5% of total population has access to electricity. Due to unavailability of other energy sources, the huge hydro-electric potential of Nepal will in the long run have to play a very important role in the energy balance of the country. The present use as compared to available resources constitutes only about 0.135%. This indicates that Nepal has got a long way to go in the development of hydro-electricity. With a view to paving the way for systematic development, parallel attention and emphasis were given to three categories of development: Large, Medium and Small. Among them "Small/Micro Hydro Development" had been given priority as a quick measure to provide energy for isolated mountainous regions, where the quantum of demand are too low, load centres are very much scattered and promising sites for small hydro development are readily available.

In Nepalese context, the extension of high voltage national grid transmission lines to these locations is still only a vision for some distant future. Therefore for many years to come the majority of small hydro projects will have to be developed and operated as an isolated system.

The success of SHP development in Nepal will depend on building the national capability in project preparation, building techniques to use local construction materials and local manufacture of generating equipments.

### PHILIPPINES

#### Format for Feasibility Studies - Mini Hydro Power Generation Projects

- I. Project Description:  
Project Background, Objective, Base Source, Location Plan and Vicinity Plan, Site Access Information, Plant Ownership and Funding, Existing Electric Facilities, Present Demand and Estimated MHG Plant Potential.
- II. General Project Information:  
Geography and Topography of General Area, Climate, General Conditions of Area, Seismicity and Site Investigation Work.
- III. Site Condition Assessment:  
Topographic Data, Socio-Political and Environmental Assessment, Land and Water Rights, Local Materials Availability.
- IV. Hydrology:  
Drainage Area, Rainfall, Existing Stream Flow Records, Determination of Flow-Duration, Siltation Studies, Water Quality and Flood Studies.
- V. Surface Geology:  
Descriptions of Observations on the major structures.
- VI. Energy and Power Demand Description.



VII. Project Planning:

Layout Concepts, Design Discharge, Hydraulic Heads, Capacity Determination, Generation, Civil Work Features, Electro-mechanical Equipment and Accessories and Project Schedule.

VIII. Project Capital Investment Estimates:

Engineering, Administrative, Construction and Equipment Cost and Contingencies and Escalation.

IX. Operation, Maintenance and Repair Estimates.

X. NEA Project Development Criteria.

XI. Financial and Economic Analysis:

Incremental Cost Analysis, Benefit/Cost Analysis, Economic Benefits, Funding Terms, Operating Revenues, Operation Expenses, Cash Flow, Financial Ratios and Sensitivity Analysis.

XII. Project Summary:

Financial and Technical Summary and Critical Issues.

XIII. Conclusions.

XIV. Recommendations.

REPUBLIC OF KOREA

SHP in Republic of Korea

Small hydro power plants are not a new concept in hydroelectric design and there are no new or simplified method of feasibility study whether it is a small or large hydro power projects.

Among the methods of project evaluation in economical analysis, Korea is employing both the method of benefit to cost ratio and the comparison of production costs since most of the small hydro power plants in Korea are the 'run of river' type power plants which have no capacity values.

To encourage the development of small hydro power plants, the government set up an Appraisal Committee within Korea Electric Power Corporation on March 9, 1982 to review and evaluate the technical and economical feasibility of the projects, and has guaranteed and assured the marketability of electricity generated by the possible developers of small hydro power plants, which will be fed to the national grid at the price of 53 mills/KWH (1982 price).

## SIERRA LEONE

### Progress in Small-scale Hydro Power Development

The priority is to develop small-scale plants with a view to reducing expenditure on oil imports. Some progress had been made in the development of small-scale hydro projects which offered such possibilities. A major scheme is presently being implemented and is expected to be commissioned in 1988. In addition, pre-feasibility studies have been undertaken on three prospective small-scale sites. There is an on-going micro-hydro project for energising a small sodium hydroxide manufacturing industry.

## SRI LANKA

### SHP in Sri Lanka

1. The Ceylon Electricity Board's policy is to concentrate on SHP between 1 MW. - 20 MW. Smaller stations (MHP less than 1 MW) are to be handled by the estate sector and private enterprises.
2. Run-of-the-River mini hydro plants have practically no flows in the dry season. Even large hydro power systems supported by reservoirs require a 30% thermal power standby, to meet the dry weather shortages. Therefore the contribution of mini hydro plants is only in the wet season when excess thermal power provided to firm up power from the major plants is available.

3. Therefore the economics of the mini hydro depends on the cost per Kwh. of mini hydro power as against the fuel cost only of a unit of thermal power. At today's fuel prices, mini hydro power may not be economically feasible, but may become so in the future, when anticipated increases in fuel prices become a reality.
4. There is ample civil engineering capability in Sri Lanka, but regarding electro mechanical equipment, demand is not big enough for Sri Lanka to undertake research and development and local industries to manufacture equipment for mini hydro power development.
5. Other countries in the region where sufficiently developed technology and cheap labor are available, could be sources for small hydro power equipment. Efficiency of these small machines is not all that important as the high desired reliability.

## TANZANIA

### Mini Hydro Development in Tanzania

Tanzania has so far only three mini hydro power plants in operation. In addition there are three small hydro power plants all with an installed capacity of 49MW.

Following the successful villagisation program, the need for a firm low-cost energy for the established villages has been recognised. Bearing in mind the rapid rise in the cost of oil it had been decided to meet this demand for power by mini hydro production. Towards this end a number of potential sites for hydro power development in Tanzania are currently being investigated as to their feasibility and viability. The aim of the Tanzanian Government and the power company is to exploit all sources which will be found to be economically viable.

It is anticipated that the implementation of these mini hydro sources will commence in 1984. Initially all these mini hydro power plants will operate in isolation. However later on they will be integrated in the National grid which is at the moment being extended to cover the major part of the country. It is anticipated that by the year 1987 the National grid will have covered three quarters of the country.

## THAILAND

### Local Design and Manufacture of Equipment and Auxiliary for M.H.G. in Thailand

The local design and manufacturing of equipments used for small scale hydro generation do exist in Thailand. However the production is concentrated on the smaller sizes, due to the economy and marketing constraints. Two types of turbines namely Pelton and Crossflow are currently fabricated. The maximum unit size ever produced is 100 KW. It is anticipated that the largest unit size to be produced would be 500 KW. The load control type of governor is also manufactured under British license. The manufacturers of the electrical equipments have more experience than their mechanical counterparts because they were longer established and have acquired technology from developed countries. Nevertheless these manufacturers need assistance in the form of exchange of information on new technology and experience in the development of related machineries to improve their capabilities.

## TURKEY

### Small Hydro Power (SHP) in Turkey

This brief report about the Small Hydro Power (SHP) potential of Turkey, will try to expose the hydro-electric potential in general of Turkey, the development done thus far from the early days and future work to be done. The report indicated the position of SHP potential, the importance in the past, present and the future. The report is annexed with statistical data such as installed capacities, annual outputs, total power production of Turkey, responsibilities of different organizations involved with the subject, information on installed capacity of units and a computerised data indicating general planning of the total economic hydro-electric potential of Turkey including projects under operation, those under construction and those being planned for the future. With these data it is believed that, it will be easier to understand the situation of SHP projects in the development of Turkey.

## YUGOSLAVIA

### Promotion of Local Initiatives in Small Hydro Power Development in Yugoslavia

Half of Yugoslavia's electricity supply originate from hydro power. Most of the country's HPS are high-power units, each more than 10 MW of capacity. Only 1 PCT of total energy supply is generated by units with less than 10 MW.

Recently, old and/or abandoned MHG units are being repaired and put into operation and new MHG development programmes are being considered or already in progress.

There are four main reasons for this shift in Yugoslav perception of the ways and means of the energy sector:

- (i) Rising prices of crude oil which imposed a heavy burden on the country's Balance of Payments;
- (ii) Country's recently adopted economic policy of stabilisation which include a strict control of investments and foreign capital inflows;
- (iii) National defence reasons.
- (iv) High utilization of major waterways suitable for large hydro power units.

Three case-studies of the Yugoslav approach to the MHG development are offered for consideration;

- (i) The first one, carried out by a local community of Tolmin in Northern Yugoslavia
- (ii) The second one carried out by Huga Lim River hydro-electric plants from Nova Varos in Southern Yugoslavia; and
- (iii) The third one, still under examination, proposed by various subjects in from Federal Republics of Bosnia and Croatia, situated in Central Yugoslavia.

Finally some technological obstacles to the MHG development are being considered.

## ZAMBIA

### Development of Small Hydro Power in the Republic of Zambia

Small hydro power has good prospects in Zambia because of hydro potential, particularly the north and central regions of the country.

Zambia has recognized the vital need to implement the Nairobi United Nations Conference on New and Renewable Sources of Energy held in August, 1981.

It is hoped the recent creation of National Energy Council along with the Department of Energy will overcome attitudes against SHP or MHG by certain sectors. NEC is the national focal point where energy policy and projects will be initiated while the Department of Energy will be responsible for implementation of the decisions on energy resting with the Ministry for Power.

Pre-feasibility study was now completed in the North Western Province aimed at replacing existing four diesel power stations and construction of additional SHP/MHG power stations in the Province. It was intended to carry out country-wide feasibility study on Rural Electrification in the rest of the provinces except in Western Province where feasibility study will be carried out separately as soon as possible. The study reports will give the country a basis to decide and proceed on the strategy for implementation of the project. Since Zambia has not done much on the technology, it is quite alert to the possibility of learning from other participating countries in the Kuala Lumpur Workshop, especially the Philippines and Malaysia who had made tremendous advances in this technology.

Zambia at the present time has no nucleus for the design and manufacture of SHP/MHG equipment locally. Necessary technical manpower was the problem revolving upon the country in this respect.

Zambia's participant at the Workshop urged United Nations Industrial Development Organization to establish a Regional Training Centre in Africa for Transfer of Technology on SHP/MHG as was the case with the Asian Region. Technical co-operation, the sharing of training facilities, exchange of experts and information, joint Research and Development programmes including testing of equipment, mutually beneficial consultancy and related measures were necessary among developed and developing countries in the transfer of technology.

RESOURCE PERSONS, UN AGENCIES AND OBSERVERS

ALFRED HUETER: (AUSTRIA)

How to Start Manufacturing of Equipment for Small Hydro Power Plants in Developing Countries

After the assessment of the demand the initiative to create local supply facilities will follow. The logistics of creating those local supply facilities is divided in 4 Phases:

Phase 1: Policy considerations

- Definktion of goals.

Phase 2: Techno-economic decision making

- Studying local manufacturing capacities.
- Defining the required manufacturing techniques.
- Selection of parts and products for local manufacturing.

Phase 3: Product and design development

(Technology

transfer)

- Development of local design.
- Research on product.
- Training of personnel for manufacturing.
- Upgrading of existing manufacturing capacities.
- Specification and detail design for local manufacturing.

Phase 4: Economic consideration

- Start-up of manufacturing.

S.P. CHANDRA: (ESCAP, UN)

a) Methodology for feasibility and other studies appropriate for small hydro power development

It was mentioned that hydro-electric project being site specific gives little scope for common methodologies for studies applicable to all sites. However, a general approach could be drawn for adoption to the local situation. Although SHP is not a scaled-down version of macro-hydro, the search of simple methodologies for feasibility and other studies lies in simplifying or screening out some steps that are not required or that can be merged with others. The paper gave some schematic approaches that could be followed including resource assessment in simple way.

b) Local Manufacture of SHP Equipment

Beginning with status of fabrication level of SHP equipment in the ESCAP region, the paper suggested to consider local manufacture in three different levels; first-improvement of traditional turbines, second indigenous fabrication through utilization of existing, simple facilities and third-commercial manufacture.

c) Ways and Means of Cost Reduction

The cost of power generation depends on a number of factors such as site condition, type of installation, sources of equipment and material supply, availability of manpower, plant utilization, sources of terms and finance etc. Therefore not only turbine-generator costs but all these factors are potential areas to be carefully studied for cost reduction.

O'LALL, JOSEPH: (GUYANA)

Local Manufacture of Mini Hydro Equipment

The paper dealt with the steps taken in the actual construction of a Banki Turbine using low grade technology.



It was not intended that all the steps be shown, but only those that the author considered to be important. However an attempt was made to supplement this deficiency with drawings.

The article must be seen in the context of having constructed a turbine, how this turbine can be improved by making it on a knock-down basis.

**H. SINDING: (NORWAY)**

**Promotion of Local Design and Manufacture of Equipment and Auxiliaries**

The paper supported the idea of local production of products for small-scale hydro power plants as a means to achieve an industrial development in parallel to the hydro power development. It described various possible cooperation with existing industry. However, there are several local preconditions to be taken into consideration, mainly as to market size and development, local workshops and balance of payment.

The paper recommended four possible steps depending on the local conditions and the kind of cooperation chosen.

High reliability of electricity supply is of paramount importance hence the paper proposed to start with maintenance and repair shop as bases for technological transfer and development.

The importance of balance of payment, i.e. availability of foreign currency for raw materials and spare parts is emphasised.

In conclusion the possible support of the Norwegian industry is described.

**A. VINJAR: (NORWAY)**

(Paper presented on the request of UNIDO)

Factors Affecting the Feasibility of Small-Scale Water Power Plants

Planning of small-scale water power plants requires skills within the full range of power technology.

Developing countries should prepare the ground for establishment of local know-how, i.e. inside industrial plants, supply units and also inside governing bodies and other relevant institutions, to make the country's own people able to handle planning, construction and operation of power plants and power supply systems.

Power technology knowledge is required also for small-scale power plants. Technical education on all levels takes time. It should start at an early stage and such personnel should as much as possible be tied to local projects.

To prevent economic hazardous risks because of lack of sufficient basic material, hydrologic investigations must be started at an earliest possible stage - many years in front of project planning and realization.

Small-scale water power plants lend themselves well to standardization of components and even whole plants, which reduce planning costs and counteract the economies of scale of power plants.

Depending on resources available, power plants should be introduced into the supply system in order of rising costs of supplied power. Because of the exposed economies of scale of power plants, one should investigate carefully if there is a potential market for the energy from the biggest plant before choosing the smaller plants.

Power projects - especially small-scale projects at the initial stage of development - should be planned in conjunction with the power market and the power market should be adapted to the characteristics of the power plant, i.e. to its production capabilities.

The feasibility of projects should be evaluated as a part of the economy of the society which is to be served by the plant.

Loans given on traditional terms represent a barrier for development of power supply in low productive areas. Financing terms should be modified to be more in harmony with the estimated development of the purchasing ability of the society concerned.

E.M. INDACOCHEA: OLADE

Work Programme for the Regional Network for Small Hydro Power (RN - SHP) and the Hangzhou Regional Centre (HRC)

The paper provided a draft outline of a Programme of Activities for the Regional Network (RN-SHP) and the Hangzhou Regional Centre (HRC) for Asia and the Pacific, for the years 1983-1984, with projections for 1985-1986.

Specific objectives for the work to be conducted on Research and Development, Training, Information Services and Advisory Services, are defined and a strategy of execution is proposed.

The document also presented the outline of a group of projects that could be developed by the HRC and/or the RN-SHP, defining their scope, expected results and basic human and material requirements for their execution.

The projects proposed are the following:

a) Research and Development

1. Methodologies for Evaluating Small-scale Hydro Energy Resources and Energy Requirements.
2. Guidelines for Project Formulation, Definition of Scope of Studies and Project Formulation.
3. Manual for Civil Works Design, Construction and Application of non-conventional technologies.
4. Technological and Industrial Profiles for end use of electricity generated by SHP.
5. Design, standardization and manufacture of SHP Equipment; First Phase: Manual on Cross-Flow Turbines and Electrical-Electronic speed regulators with positive flow control.

b) Training

1. Seminar on Regional Capacities for SHP Development
2. Regional Course on SHP Design
3. Regional Training Course for SHP Operators
4. Exchange of Personnel

c) Information Services

1. Publication of SHP Newsletter
2. Data Bank, Reference Library and Information Exchange System
3. Directory of Regional Manufacturers of Equipment and Materials for SHP
4. Survey on Prices of Equipment and SHP Costs
5. Survey on Institutional Arrangements, Problems and Solutions

d) Advisory Services

J.M. DEL ROSARIO: (PHILIPPINES)

Promotion of Local Design and Manufacture of Mini Hydro-electric Equipment in the Philippines

1. What Have We Done?

We have manufactured six (6) units, for three (3) sites, totalling about 1000 KW.

We started about three years ago.

A new project is about to be finished; 2 x 900 KW., or 1,800 KW., bringing total to 2,800 KW.

All units were sold to NEA and then to its cooperatives. There are still obstructions to selling to the private sector.

2. What Have We Learned?

- 1) We can do it

We have the basic technical know-how, acquired more specific know-how, and have the plants and experienced workers.

- 2) Our costs are much lower than Western costs

About 50-60% in fact.

- 3) It's (manufacturing mini-hydro) not a good business if it is all you've got

The market/buyer is only one. Subject to change due to budgetary exigencies. Government policies change. Planning of "mix" or production run, not possible.

A discrete, purpose-built SHP plant is not now feasible.

- 4) It is not even a business unless funding of purchases of units can be assured.

Without funding, no sale.

**M. EISENRING: (SKAT)**

**Local Manufacturing of Water Turbines**

Conditions for implementation of SHP in each country vary. On the other hand, foreign manufacturers are reluctant to provide their services for local turbine manufacture for various reasons.

SKAT which is the Swiss Centre for Appropriate Technology, disseminates the design of a simple, reliable crossflow turbine for local manufacturing. Details are provided.

Institutions such as SKAT, which disseminates information on existing technology, should be strengthened.

**K. GOLDSMITH: UNITED NATIONS (DTCD)**

**Economic Appraisal of Small Hydro Power Projects**

The paper represented a personal contribution towards the work of Group I on feasibility studies; it was not an official communication from the United Nations. The paper described a few of the best known methods of economic appraisal, with special emphasis on simplicity of approach in order to limit the effort put into the study phase of mini-hydro schemes. An example was presented of the economic evaluation of a small-scale hydro power project in Thailand.

**WILLIAM H. TANAKA: (UNIDO)**

**UNIDO Issue Paper**

The paper highlights some of the main issues to be discussed at the meeting on the five objectives of the Third Workshop on Small Hydro Power.

**Draft Work Programme of ESCAP Regional Network System for Small Hydro Power During the Interim Period (1983/1984)**

The paper describes a draft work programme of the proposed regional network for ESCAP region countries during the interim period 1983/1984 which is largely based upon conclusions and recommendations of the 'Senior Expert Group Meeting on the Creation of a Regional Network System and the Assessment of Priority Needs on Research, Development and Training in the field of Mini-small Hydro Power Generation' held in July 1982, Hangzhou, People's Republic of China.

#### IV. PLENARY

At the First Plenary Session, the participants elected the following officers:

Chairman	-	Mr. Jalaluddin bin Zainuddin (Malaysia)
Rapporteur	-	Mr. Juan Miguel del Rosario ( Philippines)
Vice Chairman Group I	-	Mr. Suryono (Indonesia)
Vice Chairman Group II	-	Mr. Chartdanai Chartpolrak (Thailand)
Vice Rapporteur Group I	-	Mr. E. Carlo Fernando (Sri Lanka)
Vice Rapporteur Group II	-	Mr. A.K. Shrestha (Nepal)

It was decided that the participants would be divided into two working groups. Group I to discuss on Objectives a) and b) and Group II on Objectives c) and d). Objective e) was discussed in the plenary meeting which also gave an opportunity for all participants to review and express views on the work of both working groups. The description of the findings are given in Chapter V of this Report.

At the Second Plenary Session, the Workshop reviewed the findings from the visits to six (6) Malaysian SHP stations, discussed regional cooperation and prepared the report of the workshop.

#### Site Visits

Presentations were made by representative teams, and these are attached as ANNEX E.

The discussions centred on various aspects including the costs of electro mechanical equipment, installation and civil work, frequency regulation, use of aerial cables, use of wooden poles, site selection with particular reference to high and medium heads, and maintenance.

With regard to a query concerning electricity in remote areas, the Malaysian representative indicated that in the very remote areas diesel power was used and in some areas, such as the outlying islands, solar energy using panels on roofs was used. The introduction of micro-hydro was also contemplated.

In the discussion on the adaptation of micro processors in SHP, it was brought out that electronic governors might be expensive if imported from developed countries but that most components could be obtained elsewhere while integrated circuits (IC's) could be imported from a developed country, resulting in considerable savings. It was also pointed out by the Malaysian representative that the use of standard mass-produced components, such as heating controllers, suitably adapted, could result in even greater savings.

#### Regional Co-operation Including Regional Network System

##### HRC (Hangzhou Regional Center)

A discussion was initiated in connection with the forthcoming Training Course to be held in HRC, Hangzhou, P.R. of China from 23 May to 24 June 1983. The representative from China reported that:-

- 1) The first building including the Training Room was ready and that building work on the rest would commence in the second half of this year.
- 2) The Government had contributed the sum of 5 million RMB towards the Centre.
- 3) At present thirty (30) senior and middle-level personnel were working in the Centre and ultimately fifty (50) would be the complement of the Centre.
- 4) The Centre was preparing materials for the Training Workshop and requested case studies from other countries.
- 5) Arrangements were being made to commence publication of a Newsletter in the latter part of this year.



ESCAP

In respect to co-operative arrangements within the ESCAP region, the participants from the region held a Sub-Working Group Meeting to exchange views regarding the proposed Work Programme of the RN-SHP, elaborated by UNIDO on basis of the findings and recommendations of the Senior Experts' Workshop held in July 1982 in Hangzhou, P.R. of China. The Sub-Working Group agreed to the following:-

- i) In order that the member countries can benefit from such activities, the importance of initiating practical work as soon as possible was emphasised.
- ii) The organisational arrangements of an official RN-SHP based upon the agreement and endorsement of member Governments should be worked out in parallel to such activities.
- iii) The joint activities should involve institutions and persons directly engaged in the promotion and implementation of SHP activities in their own countries. It was felt that such activities could favourably support the case for securing the official agreement for the RN-SHP at the Government level.
- iv) Accordingly, the activities included in the tentative Work Programme summarised in the draft work programme for the interim period 1983/1984, relating to Information, Research and Development, and Training, should be initiated as soon as appropriate funding could be secured.
- v) As to the First Training Workshop proposed to be held during May/June 1983 in Hangzhou, P.R. of China, it was suggested and so recommended that the participation of lecturers in addition to the Chinese resource persons would be most important in retaining the international characteristic of the training workshop. In this context, the participating UN Agencies and Organisations should provide the required financial resources to cover those lecture items having specific relevance to their mandated activities, and in line with their respective spheres of responsibilities.

In response to the comments from non-REDP participants in Asia and the Pacific who expressed their wishes to be able to participate in the Training Courses, RCTT agreed to provide necessary resources.

The tentative schedule of the RN-SHP activities to be carried out during 1983/1984, as well as the Draft Aide Memoire on the First Training/Training Workshop on SHP, are attached to this Report as Annex F and G respectively.

#### ASEAN - MH Working Group

##### Asean Co-operation in Mini-Hydro Development

The meeting was informed on the progress of ASEAN Co-operation in Mini-Hydro Development, which among other things has established the ASEAN Mini-Hydro Information Exchange (MHINEX) with Indonesia as the focal-point. The objective of this ASEAN MHINEX is to identify and exchange information that would be useful in the implementation of the mini-hydro program of each respective country.

The ASEAN Group welcomed the opportunity to provide linkages with other external information systems with respect to data pertinent to mini-hydro development through its focal point.

#### RRED Station

A Regional Renewable Energy Development Station (RREDS) is being established in the Caribbean area to:

- i) undertake adaptive and other applied research and development.
- ii) carry out pilot scale and/or demonstration work.
- iii) provide training for private and public sector professionals.
- iv) provide consultancy services and limited project management.
- v) establish direct contacts with organizations in other countries and regions which are engaged in similar activities and exchange experiences for mutual benefits.

It will have "Local Outpost Units" in each territory to provide outlets for renewable energy know-how via demonstration centres and associated extension and trouble-shooting services relevant to each territory.

The Station will have as its overall goal, the propagation and exploitation of minihydro and other renewable energy technology in the sub-region.

It has reached the stage of feasibility/preliminary design which was commissioned by the CARICOM Secretariat and is being undertaken with the assistance of UNIDO and other international and national institutions and organisations.

#### OLADE

OLADE, through its Regional Programme on SHP is carrying out and promoting activities on Research and Development, Training, Exchange of Information and provision of Technical Assistance in the Latin American and Caribbean Region. The organization is particularly interested in promoting inter-regional co-operation as a means of strengthening links between third world countries. OLADE therefore confirms its willingness to exchange experience and assistance to promote SHP development.

#### OTHER MATTERS

The representatives of various African countries presented a recommendation as follows:-

#### RECOMMENDATIONS OF THE AFRICAN PARTICIPANTS, AS APPROVED IN THE PLENARY SESSION

It is recommended that the participants at Kuala Lumpur Workshop should initiate a network of Small Hydropower experts among African countries in order to promote Small Hydropower Development in Africa.

The objective of the network is to promote co-ordinated effort in the initiation and intensification of Small Hydropower plants in Africa.

It is further recommended that UNIDO and/or other appropriate UN Agencies should assist in the implementation of pilot demonstration Small Hydropower plants as a means of sensitization, promotion and intensification of Small Hydropower development for supporting cottage industries and improving socio-economic standards of the rural people.

This was accepted by the Plenary Session for adoption as one of its principal recommendations.

Preparation of Report

In the Second and Third Plenary Sessions, the preliminary draft of the Working Group reports among others were presented.

All participants took part in the preparation of the report. It was presented and duly adopted on 15 March 1983. The meeting expressly recommended that the report be given the widest possible distribution.

Participants in the Workshop were unanimous in their appreciation of the facilities provided by the Government of Malaysia for hosting the Workshop in particular the National Electricity Board (NEB). They wished to record their gratitude to the efficiency of the International Convention Secretariat of the Prime Minister's Department in the reception arrangement, the documentation and reporting service and the services that contributed to the success of this Workshop. The experience of Malaysia in SHP development was of special value to all; the visits to various SHP sites were found to be extremely instructive.

Participants thanked RCTT, UNIDO and REDP for having sponsored this Workshop, in association with the Government of Malaysia. They also noted with appreciation the contribution from participants from outside the Asia and the Pacific Region, the United Nations Department for Technical Cooperation for Development, Latin American Energy Organisation, the World Bank and the Asian Development Bank, the Resource Persons and Observers.

V. GROUP REPORTS

GROUP I: CONCLUSIONS AND RECOMMENDATIONS

IA. EXCHANGE OF EXPERIENCE ON THE METHODOLOGY OF CENTRALISED MANAGEMENT OF SHP DEVELOPMENT AS COMPARED TO THE DECENTRALISED APPROACH

1. The Group recognised that there were a variety of approaches, experience and policies on this question.
  - a. Centralisation and decentralisation could be discussed at various levels such as:
    - strategy and policy making;
    - administrative infrastructure;
    - implementation;
    - management, operation and maintenance.
  - b. Strategy and policy making should be a centralised activity whereas the other aspects could be decentralised. It was however to be noted that when a large number of SHP installations have been established and were functioning, it would often lead to some type of centralisation due to the necessity of interlinking and integrating them to meet situations of shortage or excess supply of power.
  - c. The cases of two developed countries were recalled where in one country, more than 200 supply units were operating quite independently while a central government agency coordinates the management of the total supply, in the other country, one single government agency was in charge of the entire production and supply of electricity.
  - d. During the initial process of introducing SHP in a country, some centrally taken initiatives were necessary, and that policy, planning and promotion could be best dealt with as centralised activities. Implementation, operation, maintenance and management could be decentralised to local authorities or cooperatives.
  - e. It was noted that in general, the lower the development level of a country, the greater was the need for a centralised approach.

- f. A decentralised implementation, operation and management system could, on the other hand, lead to a higher degree of effective utilisation of the power through the direct involvement of initiatives taken at the local level.
- g. Training was inevitably an activity that would best be served if carried out on a centralised pattern; however, for certain levels and functions, decentralised sources in the form of on-the-job training would be more economical and effective.
- h. In connection with development loans and fundings, a centralised approach would permit the grouping together of several SHP schemes into a programme for loans significantly large enough to justify the costs of their assessment and consideration.
- i. A centralized approach allows the grouping of several specific, smaller SHP projects such that pre-investment costs (geology, cartography, hydrology, etc.) can be shared over a wider base.

2. **RECOMMENDATION**

The consensus of the Group was that:

- a. the question of centralised or decentralised approach was essentially a matter that required a flexible rather than a rigid attitude;
- b. it had to be considered and applied by each country on a case by case basis, taking into consideration local conditions, manpower, experiences, etc., prevailing in the country and overall government policy.
- c. Strategy, policy and planning should be centrally coordinated, while the implementation, operation and management could be decentralised or maintained as a centralised activity.

1B. **TRANSLATION AND CONVERSION OF SHP DEVELOPMENT PROGRAMMES INTO PRACTICAL PROJECTS AND THEIR IMPLEMENTATION**

- 1. It was observed that in countries where such process was successfully carried through, the success was due to the combination of factors that brought about a thrust strong enough to make the breakthrough of the obstacles and hinderances typical in many countries.

- a. A major factor was the enthusiasm and foresight of a few individuals who appreciated the potential of SHP.
  - b. The sensitization of policy makers and financing agencies and organisations was important to enlist their support of the SHP programme. This could be done for instance through a carefully selected and presented demonstration case where there was an optimal degree of success with benefits in terms of its specific contribution to the priority concerns of the country.
  - c. A successful demonstration unit could eventually stimulate a political will that would favourably support and encourage SHP development.
  - d. The experiences of other countries brought to the notice of policy makers could also be useful in convincing them of the benefits of SHP.
  - e. An important factor common in successful cases was the assignment of the responsibilities of SHP development to a unit, section or department that was specialised in SHP only within the overall electrification or energy authority of the country.
  - f. International agencies and intergovernmental organizations were urged to provide more information and documentation concerning SHP development.
2. The Group agreed that a critical issue was the obtaining of proper financial support for SHP development. In this connection, the following points were discussed.
- a. It was of greatest importance that the government accord SHP due priority in the national development programme.
  - b. It was necessary to formulate a "packaged development programme" for SHP development that would involve sizable loans to make the preliminary assessment, implementation, monitoring, evaluation and other costs worthwhile.

- c. The criteria for cost benefit assessment imposed by some financing agencies were felt to be sometimes too strict, whereas the social and other benefits deriving from SHP schemes tended to be neglected. In this respect, it was questioned whether it was possible to evolve a methodology that could quantify such benefits so as to assess them in an agreeable manner.
  - d. It was noted that a well considered and carefully prepared feasibility study, such as the cases of three countries represented at the Workshop, could successfully convince lending organisations to extend financial support for national SHP development programmes.
  - e. It was noted that various methods of implementing SHP could be considered; in particular, self-help in the form of voluntary labour, self-financing by the project and bilateral programmes in addition to assistance from financing agencies.
  - f. The attention of governments and financing institutions should be drawn to the need for flexibility in the financing terms for SHP so that they can be accommodated within the economic life of the project.
- 3.. Manpower building through training activities, particularly at the regional and global level, was also highlighted as an important aspect in formulating and implementing practical projects of SHP.
- a. The existence of a core of qualified personnel in all aspects of SHP development was considered to be an important pre-requisite for successful project implementation.
  - b. In this respect, the case of the ESCAP Regional Centre on SHP in Hangzhou, People's Republic of China, and the proposed Regional Network for Research and Training in SHP in the ESCAP region was cited as useful supportive measures to serve identified needs of the member countries.
  - c. The need for similar measures to respond to the requirements of the countries in the African and other regions was emphasized and action in this respect by UN organisations was strongly recommended.



4. RECOMMENDATIONS

The Group reached the consensus that:

- a. the sensitization of policy makers through persuasion and demonstration was an important step for securing a favourable political support towards SHP development. The importance of social and other benefits should be stressed in this connection.
- b. a minimum core group of enthusiastic and devoted individuals could play a significant role in the promotion of SHP programmes and its conversion into practical projects.
- c. a flexible approach was necessary, particularly at the initial stage of promotion of SHP, so organised as to reach an optimal level of contribution towards the national priority concerns, in order to convince the policy makers, lending organisations etc. of the viability of the SHP programme.

II. ELABORATION OF A SIMPLE METHODOLOGY FOR FEASIBILITY AND OTHER STUDIES APPROPRIATE FOR SHP

1. It was observed that the lack of a methodology for feasibility and other studies appropriate for SHP often caused difficulties in that the criteria developed for a large hydropower was applied to projects for SHP in a miniaturised form. The following discussions emerged in reviewing this subject:-
  - a. A number of countries which already had initiated their SHP development programmes have accumulated experiences on a SHP proper methodology of a feasibility study. In this respect, it was recommended that the HRC with other United Nations and international organisations might jointly collaborate to prepare a compendium of such methodologies developed in the various countries, for dissemination.
  - b. While observing that a number of documents submitted to the present workshop by the participants did cover their information on methodologies, the following might give an indication as to the type of documents that might be included in the compendium:-

- i) A check list of elements to be considered in electrification projects based upon SHP (Workshop document of the Philippines).
  - ii) Comments on main elements to make decision makers aware of the importance of each element and in particular, which element could be included in certain cases - especially when mini and micro hydropower projects are considered (Workshop document by Vinjar).
  - iii) Example of the selection and evaluation criteria for mini hydro schemes attached as Annex D.
  - iv) General documents on socio-economic and socio-political benefits to be derived from electrification of rural and remote areas.
  - v) Other examples of methodologies adopted by various countries.
- c. It was emphasised that such methodology should be adopted by each country according to their own needs as well as purpose of the decision making, which could be for the viability of the project implementation by the implementing organisation, policy makers within the government, for submission of proposals to lending institutions for securing financial support, etc.
- d. Since the main characteristic of SHP development was its simplicity, low-cost and easy operation, it should be borne in mind that whatever methodology was to be developed, it should be kept as simple as possible.
- e. Special attention was drawn to the fact that in taking decisions on the viability of a SHP project, the socio-economic as well as socio-political aspects should be given due consideration, since this was a matter of critical importance, particularly to the developing countries.
- f. In connection with the socio-economic and socio-political effects of electrification of remote areas, it was observed that besides the direct benefits from the electricity supply to a community in the form of better lighting, application of household

equipment, energy for handicraft and industry etc, electrification creates a significant multiplier effect in the development of the community as such. It should also be noticed that electricity supply is a prerequisite for economic and social development. SHP is important as one element in rural development where suitable water power sites are available.

- g. The Group was informed of the plan of UNIDO and other UN agencies to carry out a study for the development of a standardised methodology in the form of a check list for the reconnaissance and feasibility studies, suitable for SHP project assessment and evaluation which should be continued, in co-operation with other organisations as appropriate, and made available to all interested countries at the earliest possibility.

## 2. RECOMMENDATIONS

The Group reached the consensus that:

- a. It was necessary that the viability of a SHP project should be based upon a methodology developed for SHP proper rather than depending upon the application of a miniaturised large hydropower feasibility study criteria.
- b. As a first step, it would be useful for RCTT in cooperation with other UN agencies to prepare a compendium for such SHP proper methodologies adopted by various countries, which could be used as a reference for other countries which have not yet developed their own methodology.
- c. It was felt necessary to have, and accordingly recommended by the Working Group that a study be carried out by HRC in cooperation with UN and other international agencies to develop a standardised methodology in the form of a check list for the reconnaissance and feasibility studies suitable for SHP project assessment and evaluation.

**GROUP II: CONCLUSIONS AND RECOMMENDATIONS**

**II.A TO REVIEW WAYS AND MEANS OF PROMOTING LOCAL DESIGN AND MANUFACTURING OF SMALL HYDRO POWER EQUIPMENT, MACHINERIES AND ANCILLARIES**

**1. EQUIPMENT SUPPLY AND MANUFACTURING POLICIES**

- a. Each country should have a well defined SHP equipment policy. The aspects to be considered in the definition of such a policy can be valid for all countries, but the actual policy to be outlined should be specific for each country.
- b. The following aspects should be considered to establish a national policy for equipment supply and manufacture:
  - i) Socio-Economic and Political System of the country.
  - ii) National objectives and programmes for rural development and energy development.
  - iii) General Industrial Policies.
  - iv) The policies outlined should provide specific solutions for the different equipment components and even also for various sizes or types of the same piece of equipment.
  - v) For each equipment component and for various types and sizes, it should be decided if the best alternative is to import or develop local manufacture. If the latter is decided, it should be defined if it is necessary to buy foreign manufacturing technology or if it is possible to develop or assimilate technologies on an "open" (available free) basis.
  - vi) Existing or potential manufacturing capacities.

- vii) Availability of human resources required for design and manufacture (engineers, technicians, skilled workers).
- viii) Training requirements for developing local manufacturing capacities.
- ix) Size of the market, depending on the SHP implementation programmes, possibilities for exports; scale of production and its economies.
- x) Manufacturing costs.
- xi) Impact over the Balance of Payments (Imports of equipment, Imports of components, licence fees, raw materials, etc.,)
- xii) International standards as a point of reference, where applicable and feasible.

## 2. TECHNOLOGICAL ALTERNATIVES

a. There was a wide discussion regarding the technologies for establishing manufacture in third world countries. Some of the participants advocated the intensive use of locally applicable technologies and some others, the use of "high level" technologies. It was agreed however, that the choice of the type of technology depended on many factors that should be assessed for the particular situation in each country, in the following way:

- i) Technologies that are generally simple, accessible, and adaptable to produce low-cost equipment. Relatively lower efficiencies and shorter life expectancy.

More adequate for the smaller sizes of equipment, requiring low investments, and when life expectancy and efficiency is not the most important factor. More adoptable in countries and areas with limited manufacturing capacities.

- ii) Technologies that are generally more complex and more difficult. High cost of technology and equipment; high efficiencies; high expected life terms of equipment and highly reliable.

More suitable for the larger units, when efficiency, life term and reliability are more important than initial investment. Probably limited to countries with relatively higher levels of industrial development.

- iii) The best option could be a mix of the above technologies taking into account the specific reality of each country.

b. One of the choices is to buy technology on a licencing basis. In this respect it was agreed to:

- i) Limit the term for assimilating the technology, after which no further payment of royalties should be required.
- ii) Avoid unnecessary restriction on the extension of manufacturing components or to limit the activities to assembly work.
- iii) Define clearly which components should be bought from the owner of the technology and for how long.
- iv) Avoid geographical limitation of market.
- v) Define clearly if the equipment characteristics and their cost is compatible with the requirements of the country.

c. If it is decided to use local technology, the following factors should be taken into consideration:

- i) Is there any technology already available and 'open'? Assess its quality and coverage (functional design, and/or mechanical design, and/or detailed design and materials selection and/or development of standardized series).
- ii) If it is necessary to develop local technologies, to assess the capacity of research and engineering institutions, their experience and prospects of results, manufacturing and testing of prototypes etc.

- iii) Available or locally developed technologies in general permit obtaining designs that are suited to the requirements of SHP development in the country, maximizing the use of local materials and manufacturing capacities, and lower costs. On the other hand, if the quality is not adequate they could present problems regarding reliability, safety, efficiency and expected life term.

### 3. TYPES OF EQUIPMENT FOR MANUFACTURE

#### a. Equipment exclusively used by SHP

##### i) Turbines

- For capacities up to 1000 kW, (approximately) medium heads (and part of the low and high head field), Cross Flow turbines are the best known option because of their low cost, simplicity of manufacture, availability of designs, reliability and flat efficiency characteristic that make their operation at variable loads highly efficient, in spite of its inherent low peak efficiency.
- For high heads, Pelton turbines are the best choice. Their manufacture is relatively easy but require adequate foundry capacities.
- For very low heads, axial flow turbines are the best choice, in spite of their high cost and more demanding manufacturing requirements.
- Francis turbines are the most adequate for medium heads and relatively higher capacities.
- Turbine manufacture in third world countries should be done as a line of production of existing engineering shops which produce related equipment, such as pumps, because of the limited markets which would not justify specialized plants.
- It should be noted that when the technology is available and there are adequate human resources for production, in general it is cheaper to produce small turbines in third world countries, considering the lower labour costs and the fact that the manufacture of turbines at the most is carried out by 'batch production' and never by mass production.

ii) Speed Regulator

- Hydraulic or mechanical speed regulators can be manufactured at the same facilities as the turbines.
- Electronic speed regulators require a specific plant for their assembly.
- Electronic load controllers with energy dissipation are justified when there is a possibility of productive utilization of off-peak energy or when lowering the level of the excess water flow has no economic or social significance. Otherwise it is better to use electrical - electronic governors with positive flow control.

b. Equipment that require specific adaptation for their use in SHP

i) Valves

Should be geared to a wider market with specific models of butterfly and gate valves adequate for SHP applications.

ii) Gates, grids, etc.

Can be manufactured by small shops to cover other applications such as irrigation.

iii) Generators

Produced in large batches; design must be adapted to operate with water turbines, considering their specific over-speed characteristics.

Asynchronous generators (inverted induction motors) are an interesting low cost option but require an adequate system of excitation for independent operation, or to work interconnected with an existing electrical system. Their production is not specific to SHP but to the larger market of electric motors, with the exception of some additional components.



- c. Equipment and materials that are developed for other applications but can be used in SHP development.

It is necessary to assess the prospects, problems and methods of selection and application to SHP, of existing production, without any expectations that SHP development could become a motivating factor for their production.

It is possible to identify the following:

- Tubes for penstocks;
- Electrical instruments and switchgear;
- Transformers;
- Electrical cables and insulators;
- Standard components of specific equipments (roller bearings, bolts and nuts, washers, etc.)
- Cement
- Construction steel, etc.

#### 4. REGIONAL AND INTRA REGIONAL CO-OPERATION

- a. It was agreed that a "Directory of Regional Manufacturers" should be prepared, as a project for the HRC and/ or the RN - SHP. Its preparation should have an inquiry stage by filling suitable questionnaires, processing of information with an existing format and then produce the directory.
- b. The meeting recommended that it was necessary to develop manuals on design, standard series and manufacture of equipment, as a regional effort supplemented by external support and with the objective of providing "open technologies" to the countries that may be interested in using them for the production of equipment.
- c. Even though it was agreed that it would be ideal to reach a point in which each country could be specialized on specific production, as to attain better economies of scale, it was recognized that this target required a political effort of integration that was beyond the scope of this Workshop.

- d. It was also agreed that other directories should be prepared regarding the following:
  - Expert capacities
  - Consultancy capacities
  - Research institutions and their developments.
  
- e. It was further agreed that reports of local activities should be collated and circulated, covering selection of items, approaches, design adaptations, description of problems and failures, experience in production, maintenance and operation.

5. RECOMMENDATIONS

The Group recommended that:

- a. Each country define an SHP equipment policy taking into consideration the principal criteria necessary to formulate such a policy as well as taking into account the unique conditions and requirements of each country.
  
- b. The choice of the type of technology, particularly as to use of "appropriate" or "high level" technology, including the choice of developing indigenous local technology or of buying imported know-how, should be made on the basis of factors that are peculiar for each country.
  
- c. Third World countries undertake turbine manufacture in conjunction with other products such as pumps because of limited markets. Manufacture of other components should be considered depending on demand.
  
- d. A Directory of Regional Manufacturers be prepared, as a project of the HRC and/or the RN or SHP. It was expected that international organisations and agencies could assume such a project on a wide international level.
  
- e. Manuals on design, standard series and manufacture of equipment be developed as a regional effort supplemented by external effort, with the objective of providing "open" technologies to all countries seeking such help.

- f. Other directories be compiled on the following:-
- expert capacities
  - consultancy capacities
  - research institutions and their developments.
- g. Reports of local activities should be collated and circulated, covering selection of items, approaches, design adaptations, description of problems and failures, experience in production, maintenance and operation.

11. B. TO EXCHANGE VIEWS ON WAYS AND MEANS OF COST REDUCTION COMPATIBLE WITH VIABILITY AND UTILITY REQUIREMENTS.

Generally speaking, cost of development of SHP is a function of site topography, geology, hydrological conditions, availability of construction materials and generating equipment, site accessibility, design approach and functional requirement of the plant. Many of these factors need in-depth study vis-a-vis with the conditions of the specific country. However, joint regional or even international efforts are needed to find ways and means to reduce the cost of SHP development so that SHP obtains sharper focus on the priority scale of development of national governments in general and rural electrification in particular.

1. CIVIL ENGINEERING WORKS

A careful survey in selection of intake site, power canal alignment, power house, etc. is the necessary pre-condition to achieve cost reduction in SHP development. Views were expressed to adopt a non-conventional approach in design of various structures to achieve simpler construction of head-works, canals, penstocks, power house using locally available materials such as boulders, wooden planks, bamboos etc. Suggestions were also made to investigate the possibility of wider application of pre-fabricated concrete blocks and weirs recently developed and used in some countries. Discussions were also carried on the various types of intake arrangement such as simpler drop-type weirs which are most suited for hill rivers, under certain conditions. Suggestions were made to use pressurised water accumulator, multiple vertical pipe instead of the costly conventional surge tanks. Where possible, multiple purpose projects (irrigation, flood control, domestic water supply etc.) can lower the cost of civil work applicable to SHP component of the project.

## 2. EQUIPMENT AND CONTROL

The use of "off-the-shelf" centrifugal pumps can be a cheaper alternative where efficiency can be sacrificed for reduced cost.

Some countries have experienced good results using electronic load controller dumping excess load. But countries which do have wide variation in discharge and have multiple water use, feel this system of speed regulation is not compatible with requirement and are even more expensive.

Mexico has successfully used micro-computers in automation of operation of bigger scale power plants and the possibility of using such systems in SHP was discussed widely. Views were expressed that emphasis on low technology for turbines for SHP may not be compatible with the use of sophisticated technology as micro-computers for operation of SHP plants. More so, micro-computers have the disadvantage of the necessity of maintenance of sensors and interface. However, the perspective of use of electronic equipment in SHP development must not be lost.

## 3. PENSTOCK

There was wide discussion on the issue of various types of penstocks being used in different countries. It was brought out that different countries are trying different means so as to reduce cost in materials, fabrication and transport. China which used woodstave pipes till some 30 years ago, is now widely using pre-fabricated cement pipes for up to 100 m. or more head and maximum diameter of up to 1.3m. Above 800 mm. diameter, these pipes are fabricated at site for reasons of economy in transport etc. Malaysia is using either steel or polyethylene pipe for penstock and felt that fabrication of penstock to the nearest higher size is cheaper than wasting material and labour in making the tailor-made size. Nepal had experience with steel pipe fabricated in small lengths at the factory and having extensive welding at site. All these constitute a process of trial and error to achieve economy both in terms of material, fabrication and transport. Asbestos cement pipes also offer a low cost alternative and ease of installation. Hence it can be summarized that the factors that affect the choice are

- a. availability of materials;
- b. production facilities and
- c. technological status of the country.

4. PROJECT DESIGN

Computers are useful for simplifying design procedures and reducing routine calculations. However, the best perspective used is in the preparation of design curves and methodologies, optimisation of design involving complex numerical calculations but it should not be forgotten that the computers cannot become substitutes for human ingenuity. In some cases they can be useful for analysing alternatives for specific projects. However, the most important scope is for the overall analysis of the small hydro power development and optimisation.

5. RECOMMENDATIONS

Considering the various alternatives available or possible the Group recommends that:

- a. The appropriate UN agency compile and disseminate information regarding the methodology of survey and design of major civil engineering structures such as headworks, water conveyance system, forebay, power house etc. practised in various countries;
- b. The appropriate UN agencies undertake research on the various aspects of cost reduction on the civil engineering works;
- c. SHP Projects use standard generators and switch gear where possible;
- d. A regional and international effort be made to develop soft-ware for SHP application. Training of personnel in this field should also have a high priority;
- e. Further studies should be carried out by UNIDO in cooperation with other UN agencies as appropriate to enhance the productive use of micro processor and electronic technology in the SHP field.

ANNEX A

LIST OF PARTICIPANTS AND OBSERVERS

Country Organization	Name	Designation
<b><u>PARTICIPANTS</u></b>		
BURMA	1. Mr. U Zaw Win	Asst. Director (Planning), Heavy Industries Corporation, Rangoon.
	2. Mr. U Myint Aung	Executive Engineer, Electric Power Corporation Rangoon.
DOMINICA	3. Mr. Rawlins Brunev	Electrical Engineer, Dominica Electricity Services.
ETHIOPIA	4. Mr. Hailu G. Mariam	Senior Engineer in Ethiopian, Electric Light & Power Authority.
FIJI	5. Mr. Rhuwan Dutt	Permanent Secretary, Ministry of Energy & Mineral Resources. Suva.
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MALAYSIA	10. Mr. Jalaluddin Zainuddin (Chairman)	Deputy General Manager, National Electricity Board, Kuala Lumpur.

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PEOPLE'S REPUBLIC OF CHINA	15. Mr. Zhu Xiaozhang	Deputy Director/Chief Engineer, ESCAP Regional Centre of SHP, Hangzhou.
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	18. Mr. Romeo Indiongco	Manager, Mini Hydro Dev. Office, National Electrification Administration (NEA).
REPUBLIC OF KOREA	19. Mr. Chun Yun Wook	Deputy General Manager, Korea Electric Power Corporation, Seoul.

Country/ Organisation	Name	Designation
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	22. Mr. W.J.K. de Mel	Electrical Engineer, Ceylon Electricity Board, Colombo.
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	25. Mr. Chartdanai Chartpolrak (Vice Chairman)	Project Manager, National Energy Administration, Pibultham Villa, Bangkok.
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<b><u>UN AGENCIES AND ORGANISATIONS</u></b>		
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Country/ Organisation	Name	Designation
<b><u>OTHER INTERGOVERNMENTAL INTERNATIONAL AND NATIONAL ORGANISATIONS</u></b>		
OLADE	41. Mr. E.M. Indacochea	Chief of Hydro Energy Regional Programme , Quito, Ecuador
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ADB	43. Mr. James E. Rockett	Senior Project Engineer, Asian Development Bank, Manila, Phil.
NORAD	44. Mr. Holger Sinding	Industrial Advisor, Oslo, Norway
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<b><u>MALAYSIAN OBSERVERS</u></b>		
	49. Mr. Lee Chock Seng	Senior Planning Engineer, Drainage and Irrigation Department,
	50. Mr. K. J. Abraham	Senior Design Engineer, Drainage and Irrigation Department.
	51. Mr. Lui Shee Yang	Chief Engineer, Sabah Electricity Board.
	52. Mr. Nicholas Santani	Civil Engineer, Sahah Electricity Board.

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	53. Dr. Ariff b. Ariff	Senior Research and Development Engineer, NEB.
	54. Mr. Wong Mean	Senior Mechanical Engineer, Waterworks Section, Public Works Department.
	55. Dr. Masjuki b. Hj. Hassan	Lecturer, University of Malaya.
	56. Mr. Alizan b. Abd. Manan	Planning Engineer, Ministry of Energy, Telecommunications and Posts.
	57. Mr. Md. Puat b. Romli	Administrative Officer, Ministry of Energy, Telecommunications and Posts.
	58. Mr. Mohd. Afzal a/l Mohd. Ditali	Mechanical Engineer, E.P.U.
	59. Mr. Soon Choon Huie	Chief Engineer, SESCO.
	60. Mr. Ng Yew Tsiung	Civil Engineer, SESCO.
	61. Mr. Mokhtar Isa	Deputy State Director of Forestry, Kelantan.
	62. Mr. Thai See Kiam	Forest Planning Officer, Forestry Department, Pahang.
	63. Mr. Joseph Francis Chong	Generation Engineer, NEB.
	64. Mr. Ibrahim b. Ahmad	Senior Management Analyst, NEB.
	65. Mr. Rosli Alias	Project Engineer, NEB.
	66. Mr. Latip Sedali	Project Engineer, NEB.

Country/ Organisation	Name	Designation
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	68. Mr. Kamaruzaman Mohd. Jamil	Engineer, NEB.
	69. Mr. Mohd Noh Ahmad	Civil Engineer, NEB.
	70. Mr. Aminuddin Ariffin	Civil Engineer, NEB.
	71. Mdm. Mashitah Jamaludin	Asst. Project Engineer, NEB.
	72. Mr. Zaini Abdullah	Civil Engineer, NEB.
	73. Mr. Hardeep Singh	Asst. Project Engineer, NEB.
	74. Mr. Zulkifle Osman	Asst. Project Engineer, NEB.
	75. Mr. Ammil Mahamud	Engineer, NEB.
	76. Mr. Ahmad Rasidi Tak	Engineer, NEB.
	77. Mr. Adnan Sulaiman	Asst. Secretary, NEB.
	78. Mr. Thng Yong Huat	Deputy Chief Civil Engineer, NEB.
	79. Mr. Mohd. Ariffin Abd. Rahman	Chief Engineer, NEB.
	80. Mr. Nik Yahya Abdul Rahman	Lecturer, University of Technology, Malaysia.
	81. Mr. Zainal Abidin Wan Chik	Lecturer, University of Technology, Malaysia.
	82. Mr. Khairudin Md. Yunus	Senior Training Engineer, (Mechanical), NEB.

ANNEX B

WORK PROGRAMME

Sunday, March 6, 1983

Arrival of participants and registration at Merlin Hotel, Kuala Lumpur.

Monday, March 7, 1983

0800 - 0900

-

Registration of participants.

0900 - 1030

-

Opening Ceremony.

1130

-

Coaches leave Merlin Hotel for site visits:

Group 1: Visit to Ulu Dong Mini Hydro Station.

Group 2: Visit to Kongkoi Mini Hydro Station.

Tuesday, March 8, 1983

General discussions and country papers.

Wednesday, March 9, 1983

Discussions on country papers.

Participants and observers will be divided into two groups to discuss the following objectives of the Workshop:

GROUP 1: a. Exchange experiences on the methodology of centralized management of small hydropower development as compared to decentralized approach, including discussions on the translation and conversion of small hydropower development programmes into practical projects and their implementation.

b. Elaborate a simple methodology for feasibility and other studies appropriate for small hydropower.

GROUP 2: a. Review ways and means of promoting local design and manufacturing of small hydropower equipment, machineries and ancillaries.

b. Exchange views on ways and means of cost reduction compatible with viability and utility requirements.

Thursday, March 10, 1983

- 0830 - 1230 - Group discussions.
- 1500 - 1800 - Joint Plenary Session.

Friday, March 11, 1983

Coaches leave for Ipoh. Site visit to Robinson Falls Power Station Cameron Highlands.

Saturday, March 12, 1983

Coaches leave for Kuala Kangsar. Site visits to Sungei Chempias and Sungei Gebul Mini Hydro Schemes.

Sunday, March 13, 1983

Coaches leave Ipoh for Kuala Lumpur.

Monday, March 14, 1983

- 0830 - 1230 - Joint Plenary Session.
- 1400 - 1500 - ESCAP Region Sub-Working Group.
- 1500 - 1700 - Continuation of Joint Plenary Session.  
Plenary Session discussions:
  - a. Review and exchange of views on site visits.
  - b. Exchange views on co-operative arrangements including Regional Network System.
  - c. Preparation of report.

Tuesday, March 15, 1983

- 0900 - 1230 - Consideration of draft report.
- 1400 - 1500 - Adoption of report and recommendations.
- 1500 - 1530 - Closing Ceremony.

ANNEX C

LIST OF DOCUMENTS

- ID/WG.403/1      Computer Optimization of Hydro Power Station Design and Reliability by Dynamic Simulation by Rodolfo Susa Cordero
- ID/WG.403/2      Small Hydro Power Development - The Socialist Republic of the Union of Burma by U Zaw Win and U Myint Aung
- ID/WG.403/3      Small Hydro Power Development - Fiji by D.S. Pickering
- ID/WG.403/4      Mini Hydro Power Development - United Republic of Tanzania by B.E.A.T. Luhanga
- ID/WG.403/5      Centralized Versus Decentralized System of Project Planning and Implementation of Mini-Hydro Power Development - The Indonesian Case by Hartoyo Notodipuro
- ID/WG.403/6      Methodology for Feasibility Studies - Republic of Korea by Chun Yun Wook
- ID/WG.403/7      Ways and Means of Cost Reduction Compatible with Viability and Utility Requirements by Mohamed Zubir Bin Zainal Abidin
- ID/WG.403/8      Centralized System of Mini Hydro Projects Planning and Implementation in Peninsular Malaysia by Hoesni Nasaruddin
- ID/WG.403/9      Small Hydro Power Development - The Kingdom of Nepal by Atma Krishna Shrestha and Har' Man Shrestha
- ID/WG.403/10     The Status of Small Hydro Power Development in The Commonwealth of Dominica by Rawlins Bruney
- ID/WG.403/11     Report Format Outline for Feasibility Studies Mini-Hydro Power Generation Projects; and Mini-Hydro Power Generation Project Study Guidelines (As used in the Republic of the Philippines) by Zenaida A. Santos
- ID/WG.403/12     Promotion of Local Design and Manufacture of Mini Hydroelectric Equipment in the Republic of the Philippines by Juan Miguel V. del Rosario

- ID/WG.403/13      Small Hydro Power Development -  
People's Republic of China
- I. General Situation and Fundamental Experiences of  
Development of Small Hydro Power (SHP) in China  
by Deng Bingli and Zhu Xiaozhang
- II. Experiences of Independent Operation of  
Small Hydro Power Grid at County Level  
by Yang Yupeng, Huang Zhongli and Zhang Beichen
- III. How to Establish Indigenous Manufacturing  
Capability of Small Hydro Turbine Equipments  
by Song Shengyi
- ID/WG.403/14      Small Hydro Power Development -  
The Democratic Socialist Republic of Sri Lanka  
by Carlo Fernando
- ID/WG.403/15      Local Design and Manufacture of Equipment and  
Auxiliary for Mini Hydro Power Generation in  
the Kingdom of Thailand  
by K. Bhadrakom and C. Chartpolrak
- ID/WG.403/16      Development of Small Hydro Power in  
the Republic of Zambia  
by Johannes Kalolo Chanda
- ID/WG.403/17      Small Hydro Power in the Republic of Turkey  
by Suat Pasin
- ID/WG.403/18      Some Aspects of Small Hydro Power Planning and  
Implementation in Ethiopia  
by Hailu G. Mariam
- ID/WG.403/19      Promotion of Local Initiatives in Small Hydro Power  
Development in The Socialist Federal Republic of Yugoslavia  
by Darko Bekić
- ID/WG.403/20      Progress in Small Hydro Power Development  
in The Republic of Sierra Leone  
by D.L.B. Kamara
- ID/WG.403/21      Cost Reduction Considerations in  
Small Hydro Power Development  
by Dennis A. Minott and Richard A. Delisser
- ID/WG.403/22      Factors Affecting the Feasibility of  
Small-Scale Water Power Plants  
by Asbjørn Vinjar



- ID/WG.403/23      How to Start Manufacturing of Equipment for  
Small Hydro Power Plants in Developing Countries  
by Alfred Hueter
- ID/WG.403/24      Local Manufacture of Mini Hydro Equipment  
by Joseph O'Lall
- ID/WG.403/25      Local Manufacturing of Waterturbines  
by Markus Eisenring
- ID/WG.403/26      Micro Hydro Power for Rural Development -  
Lessons Drawn from the Experience of the  
Intermediate Technology Development Group  
by Ray E. Holland
- ID/WG.403/27      Promotion of Local Design and Manufacturing of  
Equipment and Auxiliaries  
by H. Sinding
- ID/WG.403/28      Work Programme for the Regional Network for Small Hydro  
Power (RN-SHP) at the Hangzhou Regional Centre (HRC)  
by Enrique Indacochea
- ID/WG.403/29      Economic Appraisal of Small-Scale Hydro Power Projects  
by K. Goldsmith
- ID/WG.403/30      Small Hydro Power Development  
I.    Methodology for Feasibility and other Studies  
      Appropriate for Small Hydro Power Development  
II.   Local Manufacture of Small Hydro Power Equipment  
      (Turbine)  
III.  Ways and Means of Cost Reduction Compatible with  
      Viability and Utility Requirements  
by ESCAP Secretariat
- ID/WG.403/31      UNIDO Issue Paper
- ID/WG.403/32      Draft Work Programme (1983/1984) of ESCAP Regional  
Network System for Small Hydro Power  
During the Interim Period  
by UNIDO Secretariat
- ID/WG.403/33      Report

ANNEX D

**EXAMPLE OF SELECTION AND EVALUATION CRITERIA FOR MINI HYDRO SCHEMES**

(AS USED BY A LENDING AGENCY)

A. Technical Criteria

1. In all cases, the mini hydro scheme shall be designed for eventual interconnection to the central supply system either through the existing or soon to be established rural distribution network, or through the sub-stations supplying the Kampung.

2. In considering the suitability of mini hydro schemes for project financing, the Executing Agency shall be guided by the following general criteria:

- the installed capacity of the schemes proposed for project financing should generally fall within the range of 50 KW to 1.5 MW;
- first priority, will be afforded to schemes designed to supply Kampung which at present do not have the benefit of supply;
- second priority, will be afforded to schemes designed to replace existing diesel generation; and
- third priority, will be afforded to schemes designed to provide voltage support to an existing rural distribution network.

3. In seeking project financing for a proposed scheme, the Executing Agency shall furnish to the Project Financing Agency a Mini-Feasibility Study and Preliminary Design Report on each scheme containing the information requirements according to the format given in the Schedule attached hereto.

B. Economic Selection Criteria

4. The Economic Internal Rate of Return (EIRR) of the proposed scheme shall be that discount rate which equates the present value of the scheme's expected benefits stream to its expected cost stream.

5. A mini hydro scheme shall qualify for project financing in cases where the estimated EIRR of the proposed scheme is greater than or equal to \_\_\_ per cent. A narrative account of the unquantified socio-economic benefits and costs of each scheme shall be incorporated in the Mini-Feasibility Study and Preliminary Design Report for each scheme referred to in paragraph 3.

6. In cases where the estimated EIRR of the proposed scheme is less than \_\_\_ per cent, the scheme shall not qualify for project financing.

c. Quantification of Benefits and Costs

7. The mini hydro schemes for each stage of development will generally fall within one of the three following categories:

- I. those which will be connected to the grid immediately on commissioning;
- II. those which are isolated from the grid initially and will replace existing diesel generation; and
- III. those which will serve isolated communities not likely to have supply from other sources in the near future.

8. The justification for implementing schemes in the first category will be based on the demonstrated ability of the scheme to provide energy at a lower cost than the long-run marginal cost of alternative supply from the grid. For the second category of schemes, the justification will be based on the demonstrated ability of the scheme to provide energy at a lower cost than the long-run marginal cost of alternative supply from diesel generation. For the third category of schemes, the justification will be based on the ability of the scheme to provide energy at a lower cost than the long-run marginal cost of supply from alternative kerosene lamps used in the Kampung. The valuation of costs and benefits for the three categories of schemes referred to in paragraph 7 is elaborated in paragraphs 9 to 12 below.

9. The mini hydro scheme cost stream shall comprise the sum of the capital cost of the mini hydro scheme plus interconnecting transmission system (if required).

10. For Category I schemes, the mini hydro scheme's benefits stream shall comprise: (a) a fuel cost savings credit determined on the basis of the proposed schemes energy output, the current delivered price of Bunker-C oil <sup>1/</sup> and specific fuel consumption of oil-fired thermal power plant present connected to the grid; (b) a capacity cost credit determined on the basis of the dependable capacity of the scheme, the current cost of alternative grid-thermal power plant and supporting grid transmission line, and the difference in economic life between grid-thermal and mini hydro plant; and (c) an operation and maintenance cost savings credit determined on the basis of the difference between the operation and maintenance costs of grid-thermal and mini hydro plant.

11. For Category II schemes, the mini hydro scheme benefits stream shall comprise: (a) a fuel cost savings credit determined on the basis of the proposed scheme energy output, the current price of diesel oil <sup>1/</sup> delivered to the existing diesel station located in the Kampung and the specific fuel consumption of the diesel power station; (b) a capacity cost credit determined on the basis of the dependable capacity of the scheme, the current cost of alternative diesel plant, and the difference in economic life between diesel and mini hydro plant; and (c) an operation and maintenance cost savings credit determined on the basis of the difference in cost between the operation and maintenance costs of diesel and the mini hydro plant.

12. For Category III schemes, the mini hydro scheme benefits stream shall comprise: (a) a fuel cost savings credit determined on the basis of the amount of kerosene <sup>1/</sup> backed-out of the Kampung, and (b) an operation and maintenance cost savings credit determined on the basis of the difference in cost between the operation and maintenance costs of kerosene lamps presently used in the Kampung and the mini hydro plant.

D. Determination of EIRR for Staged-Schemes

13. Recognizing that:

- (a) the quality of hydrological information currently available in respect of streams proposed for mini-hydro development is presently limited; and

---

<sup>1/</sup> In calculating the benefit of the fuel cost savings, the cost of fuel shall not be escalated in real terms vis-a-vis other costs in the comparison. The prices for Bunker-C oil, diesel and kerosene to be used shall be the relevant world prices.

- (b) in some cases, it may be necessary for the Executing Agency:
- (i) to estimate in advance the flow duration curve for the stream on the basis of the hydrological information currently available and the size, geology and vegetation cover of the catchment; and
  - (ii) to develop the mini hydro scheme in stages <sup>2/</sup> as additional hydrological information is collected from a weir-calibration of the scheme in its first-stage development;

the Executing Agency shall determine the EIRR of a staged-scheme on the basis of the estimated quantifiable benefits and costs of the scheme in its first-stage development.

14. In practice, the staged-scheme's ultimate capacity and optimal design flow will be determined only after adequate hydrological information is available on the stream proposed for development.

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<sup>2/</sup> Under the proposed Project, only the first stage of development of selected schemes is to be considered for project financing.

SCHEDULE TO SELECTION CRITERIA FOR MINI HYDRO SCHEMES

PROJECT DATA

---

River :	Map Sheet :
State :	<u>Co-ordinates</u>
District :	Intake :
	Powerhouse :

---

Catchment Area  
Average flow  
1 in 100 year flood flow  
Average gross head  
Design flow

---

Dam:

Maximum height  
Crest length  
Type

Low Pressure Pipeline:

Alignment  
Length  
Diameter  
Type

Hcadtank:

Area  
Height  
Type

---

CAPITAL COST SUMMARY

---

River :  
State :  
District :

---

Item	Component Cost		Total Cost
	Foreign	Local	
<u>Civil</u>			
General			
Site Establishment			
Weir and Intake			
Low Pressure Pipeline*			
Headtank			
Penstock			
Powerhouse			
Equipment installation			
<u>E &amp; M</u>			
Turbine, generator and control equipment			
Transformer and miscellaneous equipment			
Transmission to nearest Kampung or grid			
Engineering and supervision			
Contingency			
Interest during construction			
TOTAL			

---

\*This item includes that part of the access road along the pipeline mounting to:

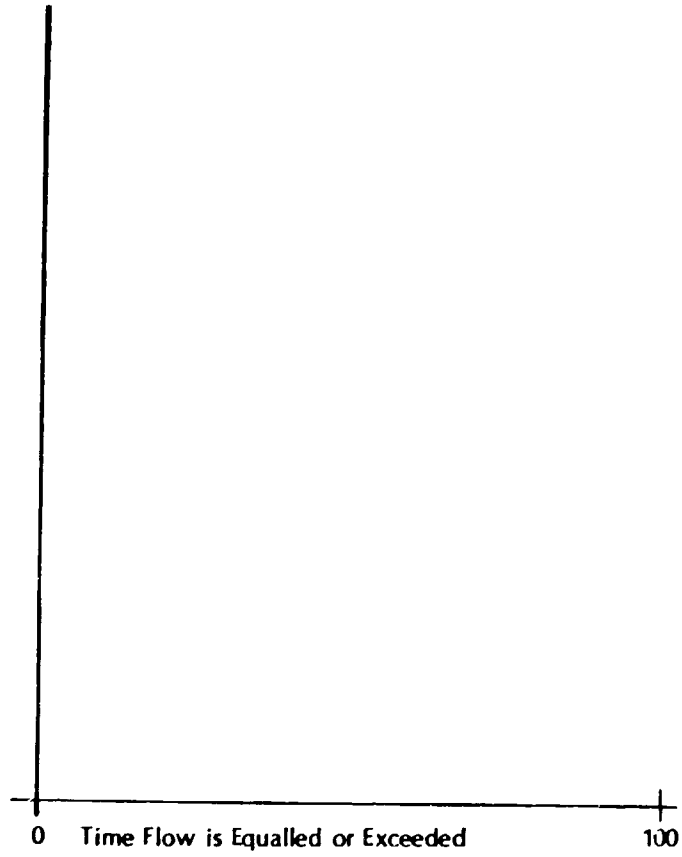
---

FLOW DURATION CURVE

River:

Catchment Size:      km<sup>2</sup>

Flow  
m<sup>3</sup>/sec





---

Penstock:

Length

Diameter

Type

Turbine:

Net head

Flow

Type

Power:

Installed

Maximum

Average

P<sub>95</sub>

Capacity factor

Energy at 100% load factor (delivered)

Transmission to nearest Kampung or grid

Access:

To powerhouse

Elevation of powerhouse

---

Capital Cost

Installed capacity

Unit Cost

Internal rate of return (after design and costing)

Annual cost

Average cost of energy delivered

---

CALCULATION SHEET FOR SCHEME'S IRR

(M\$ thousands)

---

Year	Cost Stream	Fuel Cost Savings Credit	Capacity Cost Credit	Differential O & M Cost Credit	Net Benefits Stream	Remarks
	(A)	(B)	(C)	(D)	(B+C+D-A)	

---

IRR =

ANNEX E

REPORTS ON SITE VISITS

VISIT TO THE ULU DONG MINI HYDRO STATION AT RAUB

ZENDRA PERMANA ZEN: (INDONESIA)

Ulu Dong Mini Hydro Project is located at the upstream of Sungai Dong about 32 km from Raub in the state of Pahang, Malaysia. Kampong Dong is about 16 km from Raub on the way to Kuala Lipis and Ulu Dong is about 16 km to the east of Kampong Dong.

Potential Power and Demand

The rate of flow that had been taken is  $1.133 \text{ m}^3/\text{s}$  at 54% of flow time and the head is 57 m. The expected power is 550 KW.

General Description of Civil Works

The works consist of the intake structure, pipeline, power station and tailrace.

Intake Structure

Intake structure consists of a weir and settling basin. A sluice gate is provided along the weir for the purpose of scouring sand and silt. At the settling basin, stop-log barricade is provided which acts as a screen. At the end of the settling basin there is the intake chamber which consists of screen and stacked - log weir. This intake chamber is an anti-vortex structure.

Pipeline (mild steel)

It consists of low pressure and high pressure pipeline. A surge tank is situated where the two pipes meet.

### Power Station

Power station is being anchored to the boulders and it has been back - filled with earth right up to the floor level. The size of power station is 10 m x 8.2 m.

### Electromechanical Equipment

The major electromechanical equipment consists of:

- 1) Horizontally mounted Francis Turbine of 550 KW capacity. Rated speed - 1000 RPM.
- 2) Governor - govern electrically and mechanically.
- 3) Synchronous Generator, 625 kVA, 1000 RPM - Capacity: 500 KW, 415 volt, 3 phase - 0.85 p.f.
- 4) Automatic control cabinet and power control for cabinet.
- 5) Isolator Breaker (ON/OFF)

One unit step-up transformer 0.415/11 KV is installed outside the power station.

### Transmission and Distribution

The generator output voltage is 415 V and is stepped up to 11 kV by the 625 kVA step-up transformer provided outside the power station. Aerial cable (35 mm<sup>2</sup>) is used in the jungle and remote area to the nearest village from where underground cable is then used to the existing substation 11 kV in Kampung Dong. 11 kV substation in Kampung Dong is fed from the national grid supply. The supply from the machine is synchronised to the 11 kV grid network system coming from Raub main intake.

From Kampung Dong to the mini hydro power station, there are about 6 villages with about 700 consumers. Along these villages, five nos. of pole - mounted step down distribution transformer 11 kV/0.415 kV are installed for domestic and small industries.

### Costing (in Malaysian Ringgit)

a)	Capital cost (include civil work and electro-mechanical equipment)	-	M\$ 1,700,000*
b)	Transmission cost	-	\$ 1,100,000
c)	Distribution cost	-	<u>\$ 1,100,000</u>
	Total cost		M\$ 3,900,000

\*US\$1.00 = M\$2.30

VISIT TO THE MINI HYDRO POWER STATION AT SG. KONGKOI

DAVID L.B. KAMARA: (SIERRA LEONE) AND HARTOYO NOTODIPURO (INDONESIA)

TECHNICAL DATA: See leaflets.

COMMENTS FROM THE VISIT:

The site is an ideal example of a mini hydro installation for pilot demonstration. It is in a remote location and the site exhibits ideal characteristics for development at low cost. However, a few technical criticisms are evident:

- 1) According to information obtained at the site, the peak load of the plant is about 20 KW and occurs at night. This is far below the installed capacity of 75 KW and the system is therefore highly underused. It might have been cheaper to install a smaller plant say 40 KW with provision for a second plant at a later date. This would have a marked effect on transportation costs which we learnt was a high proportion of the total system costs. However, past experience in rural electrification in Malaysia has proved a very high growth and this more than anything else influenced the installation of the 75 KW plant.
- 2) The location of the Power station relative to the river bed, gives cause for concern during flood periods.
- 3) For safety reasons, it is suggested to provide protective shielding and railing around the governor belt.

VISIT TO THE ROBINSON FALLS WATER POWER PLANT

A. VINJAR: (NORWAY) AND ZHU XIAOZHANG: (PEOPLE'S REPUBLIC OF CHINA)

Characteristics of the Plant

Turbines:

Pelton type : 345/324 KW  
RPM : 1000  
Governor : Mechanical type

Generators:

Synchronous Type; Three phase; 375 kVA; 415 Volts; 50 Hz  
Year : 1958

Transformer:

375 kVA; 400/11000 Volts

Waterways:

No forebay

Penstock: Steel

Plant outlet to pond, which is also supplied through tunnel from Telom intakes and serves as intake to the Habu power plant.

### General

The plant was commissioned in 1959, as the first of several plants in the same water course. Initially this station was on isolated operation and was later integrated with the Batang Padang major hydro electric scheme of the Cameron Highlands. It utilises a fall stretch of 232 m of a tributary to the main river and consists of three identical generating sets. The plant is of conventional design. The power house was designed to provide good ventilation, a point which should be observed even with small scale hydro power stations in tropical and sub-tropical regions. The use of small chloride batteries for auxiliaries was noticed. It was noticed that the station was in good condition after having been in operation for 24 years.

The flow diverted to the power station is only a part of the total available flow in order to retain water in the waterfall for touristic reason.

### VISIT TO THE HABU WATER POWER PLANT

A. VINJAR: (NORWAY) AND ZHU XIAOZHANG: (PEOPLE'S REPUBLIC OF CHINA)

### Characteristics of the Plant

#### Turbines:

Francis horizontal

3044 KW, 91 m head

RPM : 500

Governor : Hydraulic type

#### Generators:

Synchronous type; Three phase: 3055 kVA; 11000 + 5% Vols; 50 Hz

### General

The plant consists of two identical generating sets. This plant has been in operation for nineteen years, and is of regular design. It is connected to the main grid.

The station is subject to silting problems which is taken care of once a month (twice a month during the rainy season) by a de-silting device at the intake pond at the tailrace of the Robinson Falls power plant.

### VISIT TO THE MINI HYDRO SCHEME AT SG. GEBUL

CHARTDANAI CHARTPOLRAK: (THAILAND) AND E. M. INDACOCHEA (OLADE)

#### Location and Site Condition

The project is located about 18 km from Kuala Kangsar, Perak. Access to the site is on an all weather road except for the last 3 km which is a logging track. The catchment area is about 8 sq. kms. The design flow which was taken from 90% of annual river flow is about 0.113 m<sup>3</sup>/sec and the total head is approximately 140 m.

#### Civil Works

A concrete weir of buttress type about 1.5 m in height and 10 m in length was constructed across the stream. The intake was arranged on the crest of the weir such that the water will flow over the crest into the intake. At the middle span of the weir, a sluice gate for de-silting the forebay was installed. A low pressure pipe made of fabricated steel of 610 mm diameter connects the intake to the settling basin, and then an asbestos-cement pipe connects the settling basin with the surge tank. The penstock from the surge tank to the power house which is made of fabricated steel of 381 mm diameter is placed on rock with steel structure supports at some locations. The pipeline route is very steep due to the high head and rocky environment. All the work was executed by the contractor.



### Generating Equipment

A Pelton turbine of 750 rpm coupled with a generator of 113 KW was installed in the power house. The governor used is of hydraulic type. The project is envisaged to be connected to the grid by an 11 kV line. However, at the time of the site visit, the power line had not been completed.

### Cost of The Construction

The total cost of the project is M\$652,857 of which \$500,000 is for the civil work. The cost per kilowatt installed is computed at M\$5,777 (US\$1.00 = M\$2.30).

## VISIT TO THE MINI HYDRO POWER STATION AT SUNGAI CHEMPIAS

J. KALOLO CHANDA: (ZAMBIA) AND MARKUS EISENRING: (SWITZERLAND)

This power station, still under construction, is one of the 22 pilot schemes of NEB's Mini Hydro Department, and is located in the Bt. Larut area, state of Perak. It is located about 14 km from Kuala Kangsar, the last 3 km accessible only by Land Rover on a former logging track.

### Brief Background Information on The Project

The first survey in 1980 was based on topographic considerations. It was followed by a desk study, which considered aspects like hydrology, flood flow and design flow among others. Construction started in July 1982.

### Specification of The Project

The construction consisted of intake, structure, de-silting basin, low pressure pipe, surge tank, pressure pipe, power house and electro mechanic equipment. The penstock was made out of welded pipe sections, which are flanged together. Anchor blocks are fixed at each bend of the penstock and in between each anchor block there is an expansion joint. At the end of the pressure pipe there will be a butterfly valve.

The electro-mechanical equipment is still at the port awaiting delivery to the site. The proposed crossflow turbine will generate 133 KW under a net head of 59.74 m and a discharge of 283 litres/s. The generator is rated for 150 kVA. The turbine will be regulated by hydraulic governor.

#### Cost

The estimated cost of the project, is M\$1,044,264 excluding the cost of transmission and distribution works. Out of this total, 68.1% has been for civil works, 15.2% for electro mechanical works and 16.7% for overhead cost. A detailed cost breakdown, as well as a revised cost estimate was not available at site.

#### Progress of Construction

The dam had not yet been completed. Just a part of the foundation is completed. A part of the low pressure pipe is about to be completed, whereas the de-silting basin, surge tank and pressure pipe are completed. The power house building was completed and the concreting of the machinery basement is ready for the installation of the electro mechanical equipment. The power station will be connected to the grid. The civil works are expected to be completed after two months and the whole station should be completed after three months, depending on the progress on the civil works and the erection of the electro mechanical equipment.

#### Difficulties During Construction

The implementation is five months behind the original schedule. The main delaying factor at the time of the visit was the heavy rain in the area, which had greatly slowed down the civil works. NEB was also finding difficulties in replacing the existing 6.6 KV transmission line with 11 KV, but this would be easily overcome. There was a shortage of poles and the contractor had not delivered any poles on site. It was reported that this was likely due to pressure of work on the part of the contractor to fulfill similar contracted obligations to other SHP projects.

The civil contractor had extreme difficulties in transporting the pipes to the construction site and handling of the pipes, which was being done by cables. The civil contractor started concreting the intake on Friday, 11 March 1983. There were difficulties in erection of a coffer-dam until plastic was used to avoid water from reaching the concrete work at the intake.

Remarks

In the original design the position of the power station was about 15 m more towards the hillside. But when the excavation was started, it was found that the ground at the original site was not good, so the position was changed to the existing place. The power house is now built on big boulders, which might be a bit risky, considering a 10 or 20- years flood.

The design of the dam makes good use of large boulders.

Inspite of difficult construction more power could have been developed by increasing the head upstream, as the intake area is just below a kind of a waterfall with a steep gradient.

The anchor blocks and the power house seem to be unnecessarily large.

## EXPLANATORY NOTES ON THE MINI HYDRO PROJECTS UNDER CONSTRUCTION

### MINI HYDRO FOR SG. KONGKOI JELEBU N.S.

#### 1.0 Location and Access to Site

The general location of Sg. Kongkoi Mini Hydro is situated in the district of Jelebu in Negeri Sembilan. The nearest Village is Kg. Chennah which is around 20 miles from Kuala Kelawang (Jelebu).

#### 2.0 Catchment Area

The catchment area of this scheme is estimated around 22.9 sq. miles.

The intake site is built on solid rock foundation.

#### 3.0 Potential Power and Demand

The design flow of the river is about 17 ft. 3/sec. with a gross head of 76 ft. and output power of generator is 75 kW.

The electricity generated is supplied to Kg. Chennal and Kampung Puom with a total of approximately 180 consumers.

#### 4.0 General Description of Civil Works

The works consists of the intake structure, pipeline, power station and tailrace.

##### 4.1 Intake Structures

This consist of weir and settling basin. The weir is made of reinforced concrete structure and at the overflow section it is made up of 6" x 6" hardwood timber about 10'0" long and the height is 7'0" for overflow and flush out water. The settling basin is a reinforced concrete structure provided with two mild steel screens at the front portion and at the inlet pipe.

4.2 Pipeline

The pipeline is to convey water from the intake (settling basin) to the turbine in the power station. The pipe is of mild steel with 30" diameter and total length is about 320 ft. (65 ft. low pressure; 255 ft. with pressure).

4.3 Power Station And Tail Race

This houses the turbine, generator and control panel. It is a reinforced concrete frame structure with asbestos cement sheets for its roofing. The wall is made up of corrugated zinc sheets and folding door of 12' 0" x 12' 0".

The tailrace is where the used water from the turbine flows back into the river.

5.0 Electromechanical Equipment

The electromechanical equipment consists of Turbine including flywheel and two journal bearing, Generator set, semi auto Governor and Control panel. All the equipment was supplied by FUJIAN NANPINK ELECTRIC MACHINERY WORKS CHINA.

5.1 Turbine

Main parameters of the turbine.

Design head : 76 ft.  
Design flow : 17 cusec.  
Capacity : 87 KW  
Rated speed : 600 rpm.  
Runaway speed : 897 rpm.

Description of the turbine type :

Type: HL-110-WJ-50  
HL-Francis Turbine  
110-Specific Speed  
W-Horizontal Shaft  
J-Metal Spiral Casing  
50-Runner diameter.

## 5.2 Generator

The AC generator is a 3-phase, horizontal type and is connected directly to the turbine with a shaft coupling:

### Parameters of the generator

Capacity	:	75 KW
Speed	:	600 rpm.
Voltage	:	415 volt
Power Factor	:	0.8 (lagging)

## 5.3 Semi-Auto Governor

Governor is basically a speed control device for the hydroelectric mover.

### Basic parameters of governor;

operating capacity	:	75 kg.m.
Installed position of the speed governing shaft;		
Horizontal	:	
Max. turning angle	:	35° 20'
Rated speed of the oil pump	:	750 rpm.
Discharge of the oil pump	:	0.4 l/s
Max. oil pressure	:	18 kg/cm <sup>2</sup>
Rated speed of the pendulum	:	910 rpm.
Servomotor stroke	:	100 mm.
Permanent Speed deviation Factor	:	0 to 6%
Closing time	:	2 to 4 sec.

## 5.4 Control Panel

Low voltage generator control panel is applicable to three phase, four wire system, 415/240 V, rated capacity of approximately 100 KW. The output voltage at various load changes is kept constant by the automatic voltage regulator. This control panel is equipped with protection relay against over load and short circuiting.

6.0 Transmission And Distribution

The generator terminal voltage is 415V and is stepped-up to 11 kV by means of a 100 kVA pole mounted step-up transformer. Transmission to Kg. Channah and Kg. Puom is by an underground 11 kV cable which is approximately 2 km and 4 km in length respectively from the main step-up transformer. There is a 50 kVA pole mounted step down distribution transformer 11kV/415V situated at each of the two villages mentioned above. (Refer diagram attached).

7.0 Consumers

An estimated 183 consumers will benefit from the scheme.

8. Costing

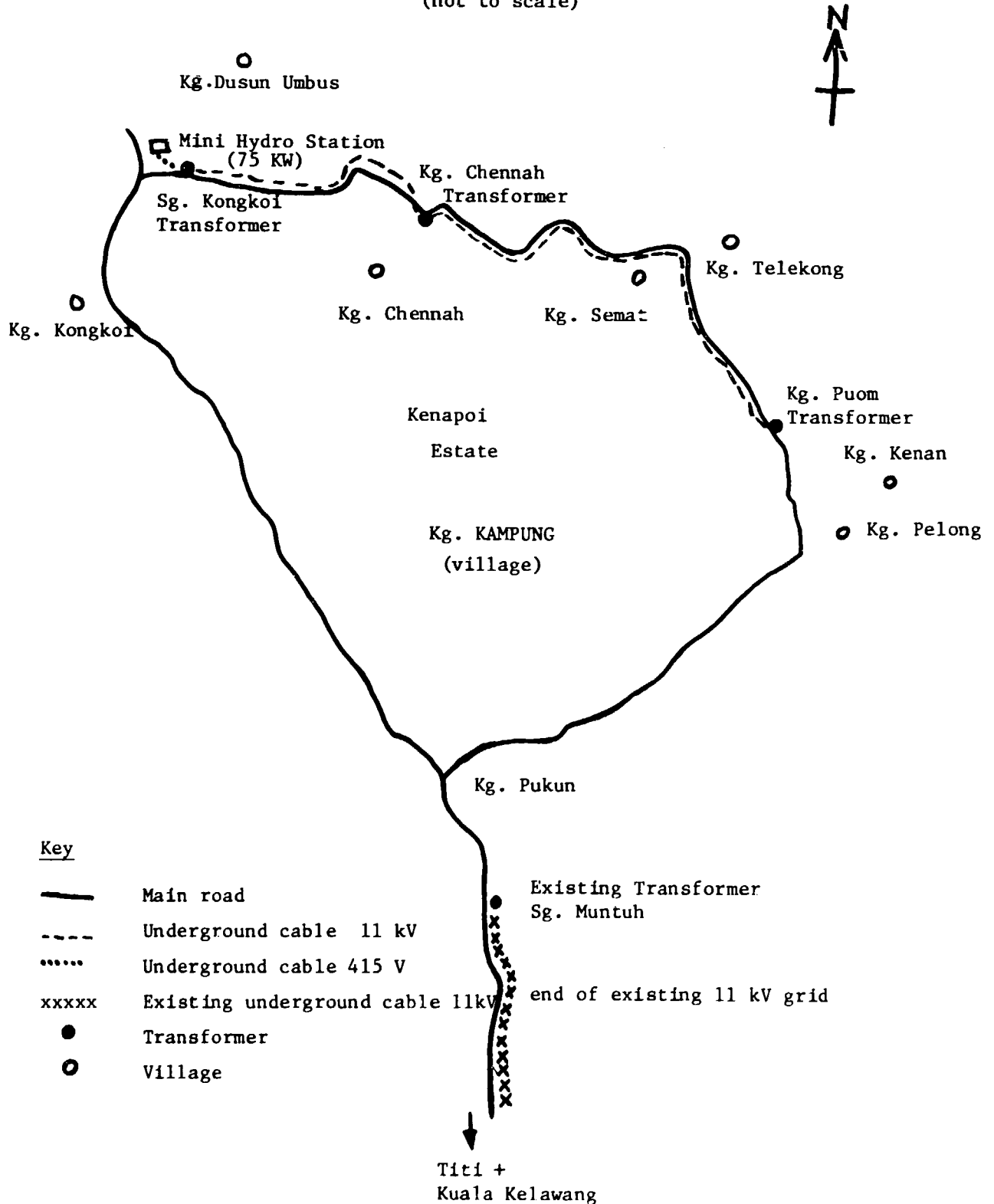
Total cost for civil work	:	\$341,231.92
Total cost for Electromechanical equipment	:	\$ 83,276.00
Transportation of equipment from K.L. to Sg. Kongkoi & lower down to P. Station	:	\$ 22,000.00
Instal, alignment and commissioning	:	\$ 3,500.00
Miscellaneous	:	\$ 10,000.00
		TOTAL: <u>\$460,007.92</u>

(Prices are in Malaysian Ringgit)

LOCATION PLAN OF

MINI HYDRO SG. KONGKOI SCHEME

(not to scale)





## SG. GEBUL MINI HYDRO SCHEME

### Introduction

Sg. Gebul mini hydro project is one of the pilot projects carried out by NEB with the potential of 120 KW. The objective of the project was originally to supply electricity to Kg. Gebul and Kg. Jeliang.

Potential number of consumers is estimated about 60 for Kg. Gebul and 245 for Kg. Jeliang. Since the electricity has been supplied before the completion of the project to the proposed areas, the generated power of the project is to be connected to the grid system.

### Location and Site Condition

The project is located about 18 km from Kuala Kangsar, Perak. The distance from the project site to the main road is about 3 km. The access road was originally used as logging track. The catchment area of the project is about 3.07 sq. miles of tropical jungle. Logging activities was still going on during the project implementation, but the silting of the river was not critical. The potential head is about 140 meter and the design flow of the project taken from 90% of the annual river flow is about 4 cusecs ( $0.113 \text{ m}^3/\text{sec}$ ).

The pipeline route is very steep especially for the penstock due to the high head and the rocky environment. A location plan is attached herewith for reference.

### Civil Work Construction

The civil work construction was awarded to one of the local contractors namely Syarikat Jeliang Jaya of Kuala Kangsar. The tender was awarded on 26th. September, 1980 under the contract of LLN 197/80. Under the original contract, the project was supposed to be completed by 31st. March, 1982, but due to late starting of the project and some difficulties during construction works, the contract was extended to 30th. September, 1982. The main problem and difficulty faced by the contractor was bad weather.

The total cost of the civil works which includes the weir, pipeline and the power station building is expected to reach approximately M\$500,000.

### Electromechanical

The machine for the project was supplied by Jyoti Ltd. of India at the cost of US\$56,470.00. The equipment include the following:-

1. Pelton Wheel Turbine c/w accessories.
2. Generator.
3. Hydromechanical oil governor.
4. Butterfly Valve.
5. Control Cubicle.
6. Spare parts and tools.

The installation work of the generating set began in early August 1982 by an engineer from the supplier with the assistance of electromechanical group of Mini Hydro Department. The installation work took about three weeks.

The type and specification of the machine are as follows:

#### Turbine

Type	: Pelton Wheel (horizontal)
Speed	: 750 rpm
Runaway speed	: 1350 rpm
Deflector closing time	: 2.5 sec.
GD <sup>2</sup> value	: 280 kgm <sup>2</sup>

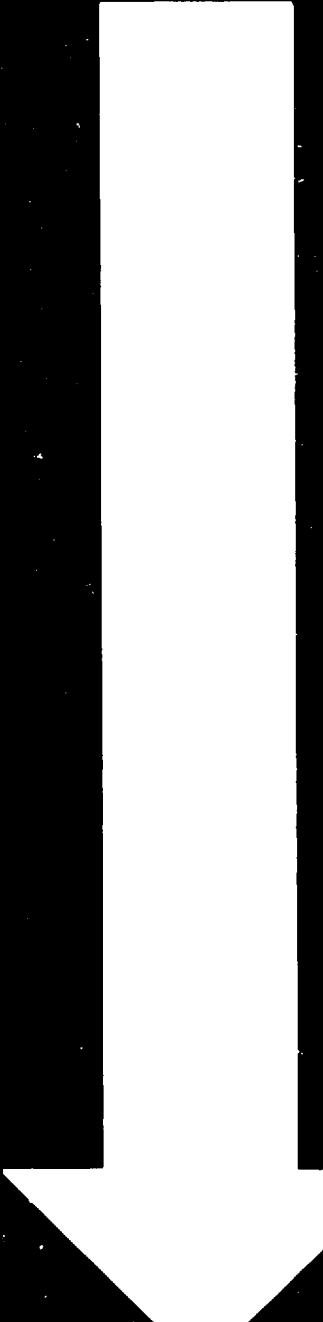
#### Generator

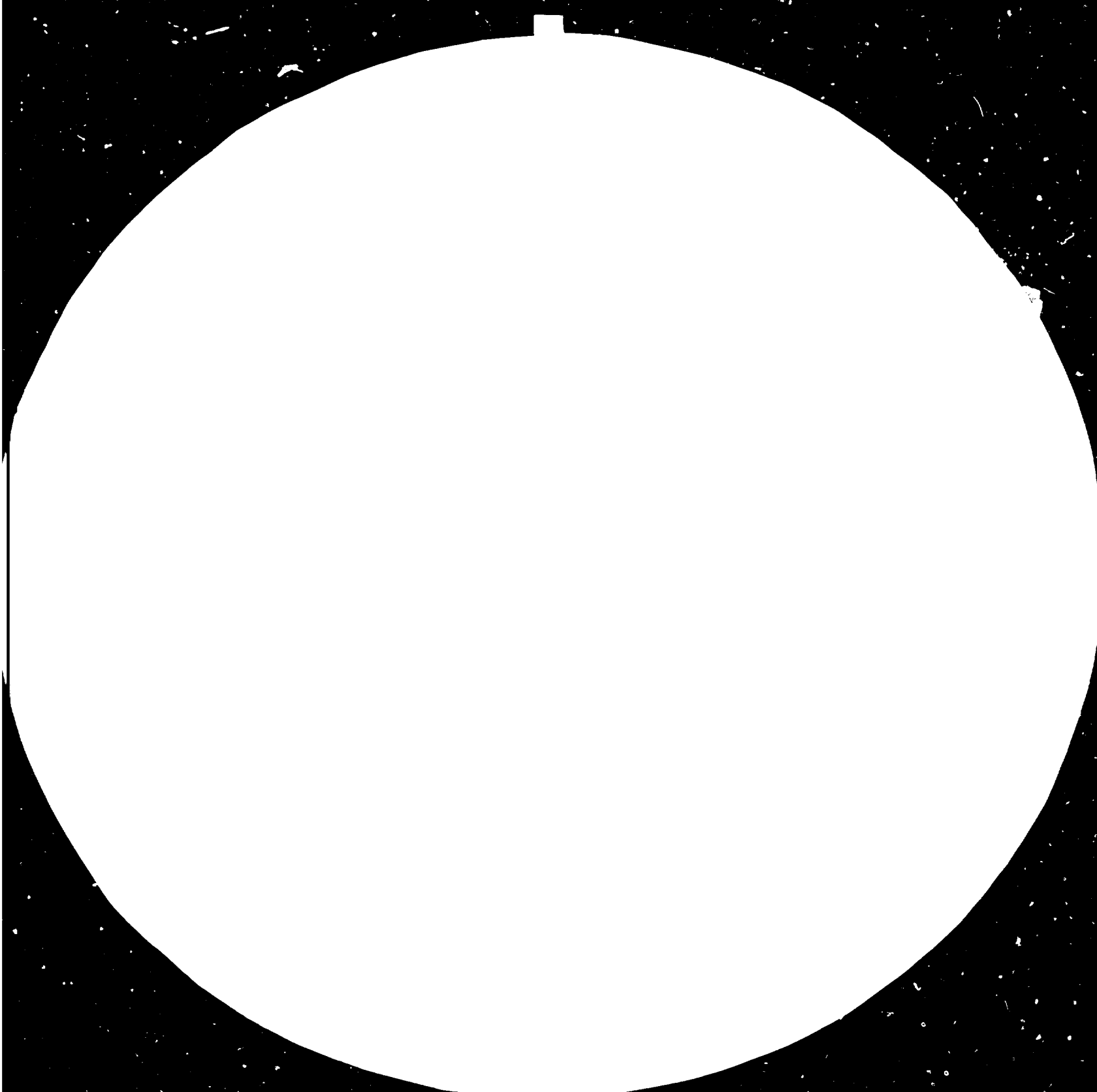
Power	: 113 KW
Speed	: 750 rpm
Overspeed	: 175% of normal speed
Voltage	: 415 V
Frequency	: 50 HZ
Power Factor	: 0.8
Insulation	: Class F

#### Governor

Type	: Hydro mechanical oil governor
Pendulum pulley speed	: 750 rpm

84.04.12  
AD.85.03







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MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS  
STANDARD REFERENCE MATERIAL 1500A  
APR 1963 EDITION TEST CHART NO. 2

Droop setting : 0-4%  
Pump pulley speed : 400 rpm  
Oil Pressure : 8 kg/cm<sup>2</sup>  
Stroke of Servomotor : 120 mm  
Bore : 130 mm

Butterfly Valve

Type : 200 BFVJ IT 619  
Bore : 150 mm  
Stroke : 165 MM  
Working fluid : water

The machine component also include a control cubicle. The cubicle houses the ACB with overcurrent and undervoltage protection. There is also the earth fault relay and reverse power relay to ensure the safety operation of the set. A separate system that checks and sense

- i - belt break
- ii - low oil pressure
- iii - overspeed

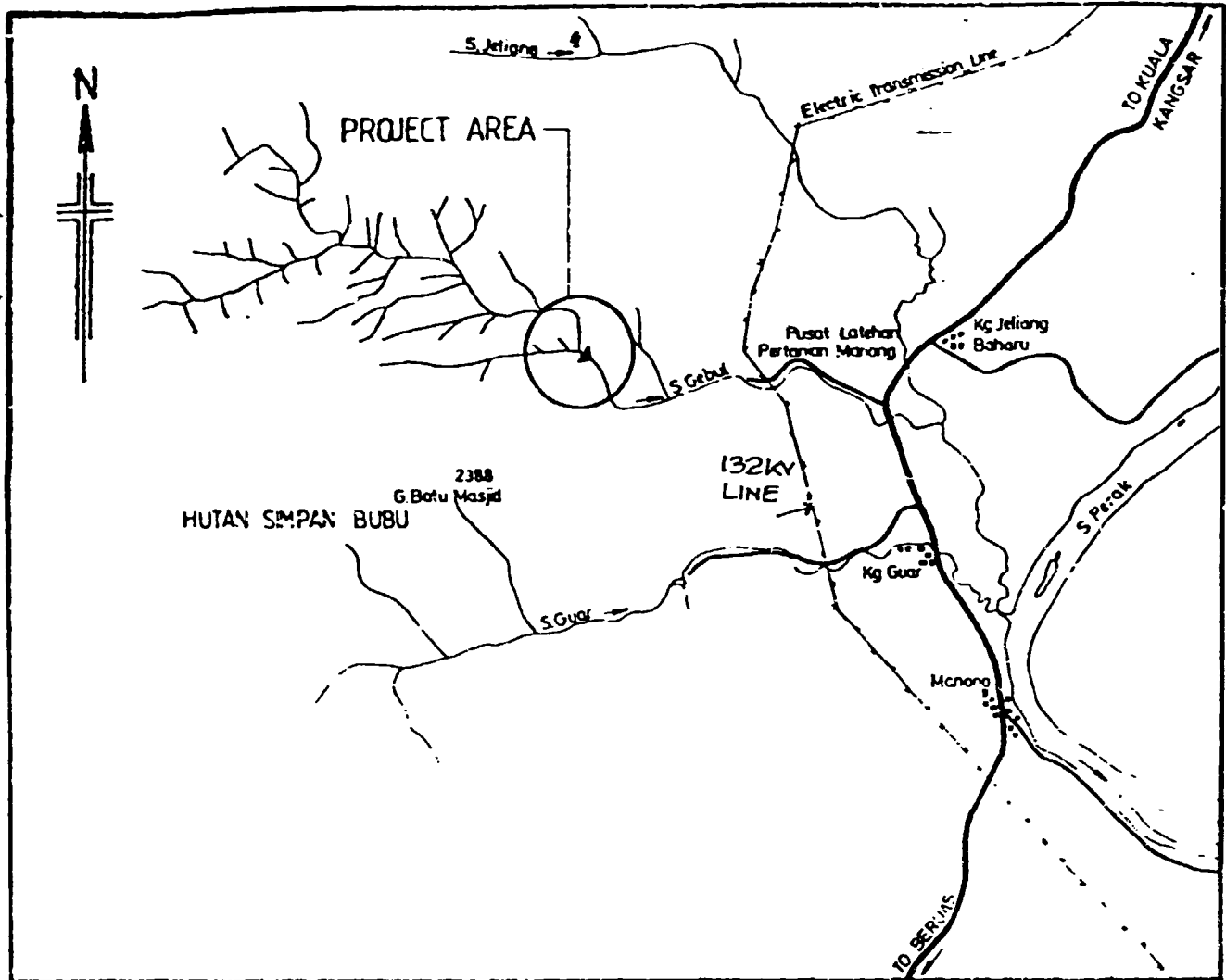
is connected to a solenoid valve that closes the butterfly valve.

Cost of Electromechanical

a) cost of generating set : US \$56,470	@	MR \$124,234.00
b) supervision cost for installation and commissioning US \$8,643.55	@	MR \$ 19,016.00
c) cost for local transportation to site and unloading cost	@	MR \$ 2,800.00
d) expected cost for commissioning plus return air ticket US \$3,094	@	<u>MR \$ 6,807.00</u>
Total E/M cost		<u>MR \$152,857.00</u>

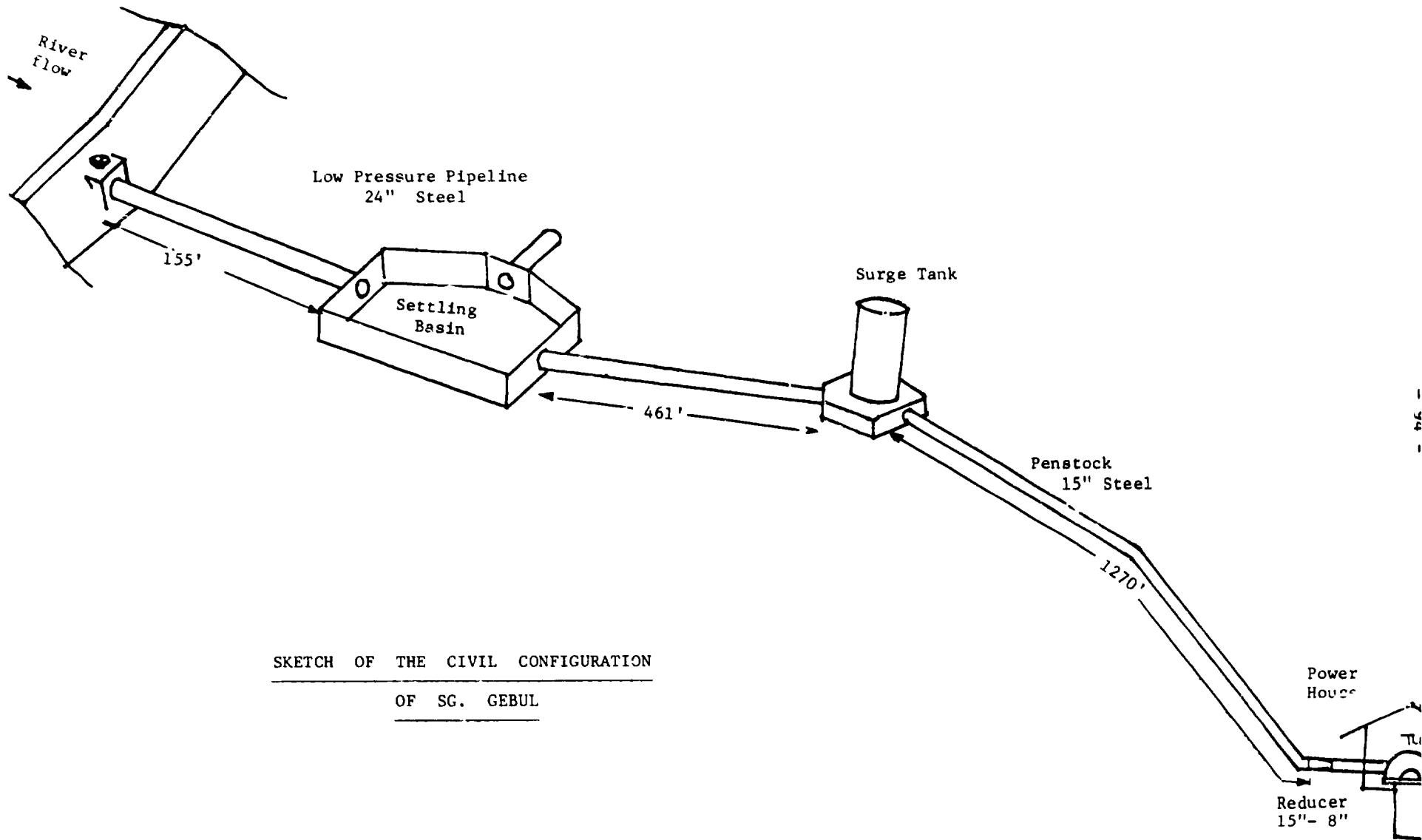
Transmission and Distribution

At the moment, the transmission work is still being carried out. Wooden poles have already been planted and 'saxka' cable 11 KV cable will be erected soon. The output of the project will be injected into the existing grid system.



# LOCATION PLAN

SCALE: ONE INCH TO A MILE



SKETCH OF THE CIVIL CONFIGURATION  
OF SG. GEBUL



## SG. CHEMPIAS

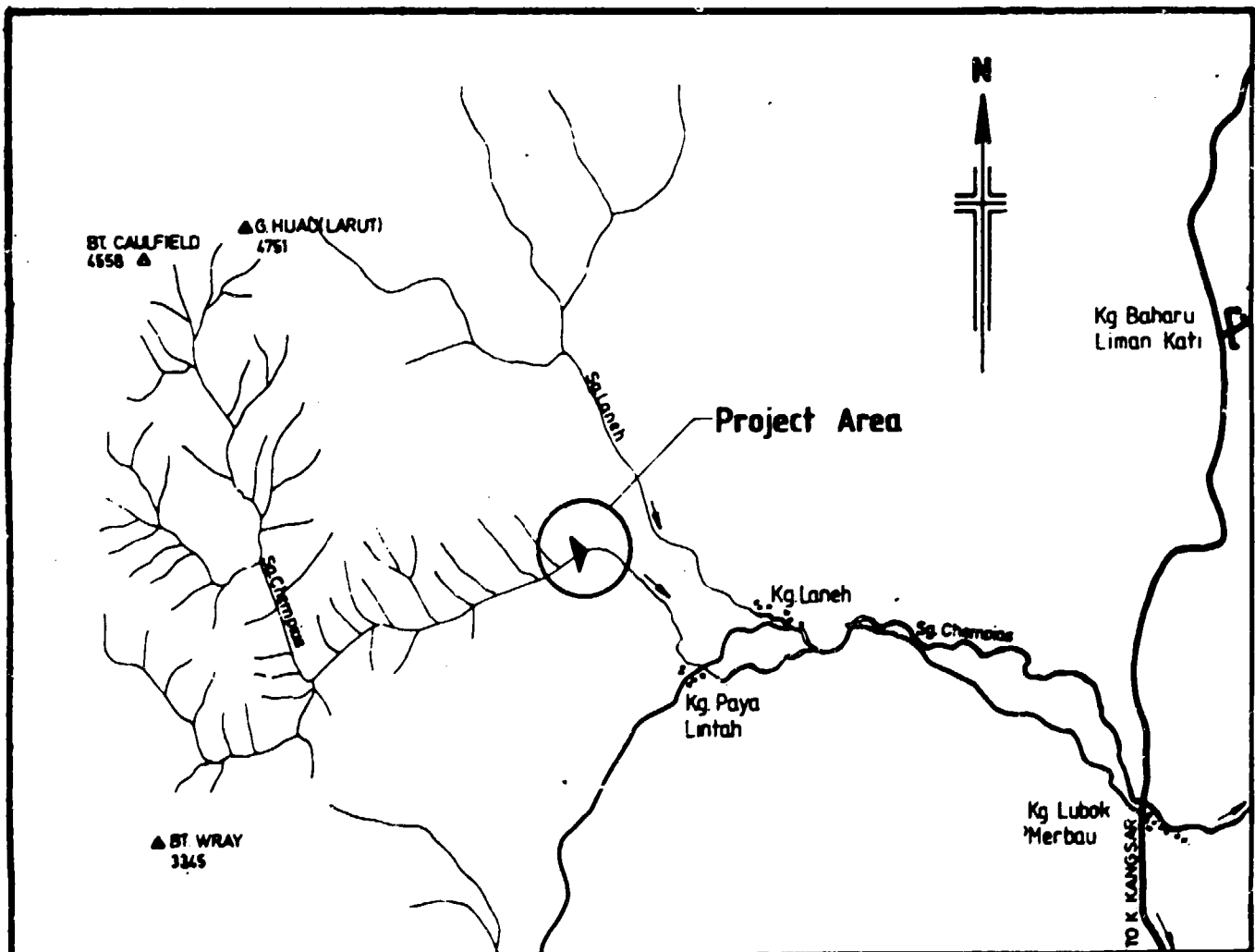
### Introduction

The Sg. Champias Mini Hydro Project is one of the twenty two pilot schemes to be implemented in Peninsular Malaysia. It is located in the district of Kuala Kangsar, Perak.

The power that will be generated by the Sg. Champias hydro station will be transmitted not only to the nearby villages but also will be injected to the grid.

### Location and Access

The scheme is located in the Hutan Simpanan, Bt. Larut area. Kg Paya Lintah which is the nearest village is 2 1/2 miles away. The distance from this village to Kuala Kangsar town is about 7 miles. A location map is shown below:-



## LOCATION PLAN

SCALE 1" TO A MILE

Catchment and Geology

The catchment area of this scheme is an estimated 6 sq. miles.

The intake and power station site are mainly on rock outcrop of granitic nature with scattered surface loose boulders.

General Description of Civil Works

The works consist of the construction of :-

- (1) Intake Structures
- (2) The forebay
- (3) The power station and tailrace
- (4) Anchor blocks
- (5) Excavation for the pipeline route

Cost

An estimated M\$1,044,264 is allocated to this project. A breakdown of the cost is shown below:-

Civil works	. .	\$ 711,220
Electromechanical works	. .	159,000
Overheads (20%)	. .	<u>\$ 174,044</u>
Total cost	. .	<u>\$1,044,264</u>

This total does not include the cost of transmission and distribution works.

Award of Contract

The civil works contract was awarded to Lien Fatt Construction Co. for a tendered price of M\$461,771.60.

The contract to supply the electromechanical equipments was given to Mitsui & Co. Ltd. of Japan. The equipment, however, is manufactured by Nikki Corporation of Japan. For a total of M\$108,460/- Mitsui Co. Ltd. will supply, transport and supervise the installation of the machine.

Electromechanical Equipment

1.	Gross head	200 ft. (60.96m)
2.	Net head	196 ft. (59.74m)
3.	(a) Max output required from generator	120 KW
	(b) Frequency	50 Hz
	(c) Power factor for generator	0.8
	(d) Voltage	415
4.	Firm Flow Available	10 cusec
5.	(a) Length of pressure penstock	1000 ft.
	(b) Internal diameter of pressure penstock	24 in.
6.	Climate	Tropical
7.	<u>Water</u>	
	(a)	Yes
	(b) Silt carrying	No
	(c) Temperature	25°C
8.	Manufacturer	Nikki Corporation, Japan
9.	<u>Turbine</u>	
	Capacity at shaft	133 KW
	Type	Cross Flow
	Horizontal/Vertical	Horizontal
	Turbine speed	1000 r.p.m.
	Specific speed	69 meter - KW
	Runaway speed	2100 r.p.m.
	Turbine/Generator	
	Mechanical coupling	Rigid coupling
	Guide mechanism	Hydraulic operation
	Max. Water Flow	0.283m <sup>3</sup> /Sec.
	Runner diameter	0.3m.
	Width of impeller	0.135m.
	Metals of Runner	SS 41 (Rolled Steel for General Structure)
	Net positive suction head	3m.

10.	<u>Inlet Valve</u>	
	Type	Butterfly valve
	Operating mechanism	Manual opening and D.C. solenoid trip
	Material	JIS FC25 (Gray Iron Casting)
	Internal diameter	).3m.
11.	<u>Speed Regulation</u>	
	(a) Governor	
	Oil pressure system	Consist of oil tank and motor driven pump.
	(b) Speed rise during swinging	5%
	(c) Speed fall during swinging	3%
	Governor and closing time	3 sec.
	Momentary speed rise	50%
	Flywheel effect	120 kg. M <sup>2</sup>
12.	<u>Generator</u>	
	Type	Synchronous generator
	Rating	150 KVA
	Voltage	415 V
	Frequency	50 Hz.
	Power Factor	0.8
	No. of poles	6
	Synchronising speed	1000
	Excitation system	Separate excitation (Brushless)
	Class of insulation	Class F
	Overspeed	200%

ANNEX F

TENTATIVE SCHEDULE OF JOINT ACTIVITIES TO BE CARRIED OUT DURING 1983-1984 LEADING TO THE ESTABLISHMENT OF RN-SHP

<u>Activity</u>	<u>Lead Agency/Organisation</u>	<u>Tentative Date</u>
1. The Regional-Secretariat staff to visit national focal points	HRC	July/Aug 1983
2. Publish Network Newsletter	HRC in cooperation with UNIDO	July 1983
3. First Training-Workshop on Small Hydro Power	HRC/UNIDO/ESCAP/REDP	May/June 1983
4. Compilation of information on ongoing MHG related research, including facilities, researchers, etc. through national focal points	HRC/UNIDO/RCTT/ESCAP/REDP	April-June 1983
5. Research and Development Activities in close co-operation with national focal points:		
a) application of electronic load controller in SHP station	HRC	March 1983
b) establishment of trial station for Telemechanization in Rivulet Cascade	HRC	March 1983
c) optimum development and dispatching design for Rivulet Cascade	HRC	March 1983

<u>Activity</u>	<u>Lead Agency/Organisation</u>	<u>Tentative Date</u>
d) research on use of indigenous materials with regard to penstock, poles and cement substitute	HRC in cooperation with national focal points	April 1983
6. Publish MHG Bibliography	HRC/UNIDO	July 1983
7. Publish MHG Expert Roster	HRC/ESCAP	October 1983
8. Short Term Consultancy Service on SHP Development	ESCAP/DTCD	July/Dec. 1983
9. Publish Directory of SHP Equipment Manufacturers	HRC/UNIDO/OLADE	July 1983

ANNEX G

ESCAP(REDP)/UNIDO/DTCB/RCTT/GOVERNMENT OF P.R. CHINA

First Training-Workshop on Mini-Small Hydro Power (SHP)

23 May - 24 June 1983, Hangzhou, P.R. China

**DRAFT AIDE-MEMOIRE**

A. Background Information

Most of the developing countries have rich and hitherto often not fully exploited hydrological resources in terms of scattered streams, rivulets, waterfalls, etc. It is felt that these resources could be profitably exploited through the establishment of Mini-Small Hydro Electric Generation Capacities.

In recognition of the important role which Mini-Small Hydro Power can play in the overall industrial development of the developing countries in general, and as an energy input for the remote and isolated areas in particular, UNIDO organized three important Workshops, namely "The First Expert Group Workshop on Mini Hydro Power Generation (MHG)" in September 1979, Kathmandu, Nepal, together with ESCAP-RCTT. A Second Workshop, combined with a Study Tour was held in October/November 1980, Hangzhou and Manila. The Third Workshop of Senior Experts on Small Hydro Power Development was held in March 1983, Kuala Lumpur, Malaysia.

A Senior Expert Group Meeting on the Creation of a Regional Network and the Assessment of Priority Needs on Research, Development and Training in the field of Mini-Small Hydro Power Generation was held in July 1982, in Hangzhou, P.R. China.

All these meetings urged the need of a Regional Network to strengthen and support the activities of Mini-Small Hydro Power establishment in the developing countries, particularly in the ESCAP region.

The People's Republic of China has volunteered to set up a Regional Centre for Small Hydro Power (HRC) as an extension of their National Centre. In view of China having constructed a very large number of Small Hydro Power Stations and acquired considerable know-how, the creation of the Centre was welcomed by the member countries of the ESCAP region.

The Hangzhou Meeting in July 1982 which was organized within the framework of the Regional Energy Development Programme (REDP) recommended, inter-alia, that an ESCAP Regional Network System for Small Hydro Power (RN-SHP) should be established, that the RN-SHP should be started in an interim form for the period of two years and that the Regional Secretariat of the RN-SHP should be located at HRC.

The Draft Work Programme for both HRC and RN-SHP will consist of the following four major activities:

- Training
- Research and Development
- Information Services
- Advisory Services

Accordingly, it has been decided that the First Training Workshop on SHP should be organized under ESCAP's REDP by UNIDO in close co-operation with ESCAP, DTCD, RCTT and the Government of the P.R. of China.

B. Objectives

Development Objectives

The First Training Workshop is intended;

- (i) To strengthen and support the activities of Mini-Small Hydro Power Establishment in the participating countries.
- (ii) To promote the utilization of the domestic water power resources in the developing countries in an effective way.
- (iii) To develop small hydro power works to contribute in solving their problems of the energy crisis.

The immediate objectives of the Training Workshop are as follows:

- (i) To understand and to have a preliminary command of the overall process of SHP planning, programming, construction, operation and maintenance and its methodology of implementation.



- (ii) To exchange experiences on the methodology of national policy formulation.

C. Organization of the Training Workshop

The training workshop will take place at HRC, Hangzhou from 23 May 1983 a period of 5 weeks (24 June 1983).

About 30 middle-high level SHP Managers from mainly the Asia region will be invited. The participants should have a University Degree with a basic knowledge of Hydro Power, as well as some practical experience. It is preferable that the participants should be directly responsible for Mini-Small Hydro Power Programme Development and Implementation in their own country.

The Training-Workshop will be for a period of about four weeks through lectures and discussions, and field visits to actual SHP sites as well as to equipment manufacturers for approximately one week.

The courses will be presented not only by the Chinese but also others.

The courses also will include case studies, group discussions and exercises based on real developing country issues. Each participant will be required to deliver indepth presentation of their own country's present situation regarding Hydro Power resources and plans for future development.

Because of the extensive nature of the Training-Workshop, as well as limited accommodation, participants are discouraged from bringing spouses or other family members with them.

The tentative programme of the Training-Workshop is as follows:

- I. Basic experiences of SHP Development in P.R. China.
  - Definition of SHP.
  - A historical review on the development of SHP in P.R. China.
  - The policies related to development of SHP.
  - Solving the problems of SHP equipment manufacture and supply.
  - Overall planning and economic utilization of SHP resources.
  - Adjusting and modifying to its local conditions, using local materials, utilizing new techniques and cost reduction schemes in SHP construction.
  - Significance of SHP in the development of rural economy.

- II. Composition of rural energy and rural electricity consumption in P.R. China.
  - Composition of energy resources and its consumption structure in rural areas of P.R. China.
  - Fundamental situation of energy usages in rural areas of P.R. China.
  - Proportion, position and prospect of SHP in rural energy consumption.
  - Present situation of electric power consumption and its development in rural areas of P.R. China.
  
- III. Plan for rural power supply and cascade development of rivulet.
  - Planning of power supply in rural areas.
  - Planning of rural grid.
  - Planning of cascade development of a rivulet.
  
- IV. Exploitation survey and design work for SHP project and hydrology.
  - Preliminary designing stage.
  - Engineering drawing stage.
  - Collection and analysis of the surveying materials.
  
- V. Power and energy capacity of the project and its justification.
  - methodology and programme of the selection of installed capacity to SHP station.
  - Different methods for energy economic comparison.
  - Analysis of economical benefits of the capital invested to SHP project.
  
- VI. Economic layouts and design for the civil structure of SHP projects.
  - Type of exploitation of SHP generation.
  - Engineering layout and composition of main structures.
  - Selection of the types of main structures.
  - Foundation treatment.
  - A brief introduction on hoisting devices of gates.
  - Measure for reducing the building cost of hydrologic structures.

VII. Manufacture and supply of SHP Electro-Mechanical Equipment.

- Series of electro-mechanical equipment of SHP stations in P.R. China.
- Present situation of SHP equipment manufacturers in P.R. China.
- Introduction on the experience of development of SHP equipment manufacturing abilities in a prefecture.
- Experiences in establishing a typical SHP equipment factory.
- Engineering of some typical parts of SHP equipment.
- Electro-mechanical equipment supply of SHP station.

VIII. SHP Electro-Mechanical design and layout in the Powerhouse

- Hydro-mechanical design.
- Electrical design.
- SHP simplified design and selection of complete set of equipment.
- Layout of the station district and powerhouse.

IX. Operation and Management of SHP and Small Grid.

- Peculiarity and tasks of operation and management of SHP station and small grid.
- Administrative system of SHP Generation in P.R. China and SHP corporations.
- The contents and regulations of relevant technical management.
- Financial management.
- Energy exchange between SHP grid and State grid.

X. International Co-operation

D. Participant Selection by UNIDO

UNIDO will send an invitation letter to the member governments to nominate and submit at least three candidates from which the participants will be selected.

The selected participant will be requested to submit to UNIDO a statement related to the Training-Workshop, i.e.

- Relationship between your work and the Training-Workshop.
- Expected outcome from the Training-Workshop.
- Describe briefly how you would like to make use of the knowledge which you gained through the Training-Workshop.
- Personal history form.

In order to speed up the selection of the participants, the potential participants are requested to submit the above by 29 April 1983.

E. Language

The Training-Workshop will be carried out and course documents prepared in the English language only. The participants should, therefore, have a good command in reading, writing, speaking and hearing of English.

F. Finance

The organisers will provide participants:

- a) Round trip economy air transportation between the airport of departure in the participant's home country and Hangzhou.
- b) A subsistence allowance at the current UN rate, i.e. 95 Yuan RMB per participant per day in Chinese currency. This amount covers board and lodging and incidentals (incidentals are only payable to participants upon arrival in Hangzhou).

G. Liabilities

The participants will be required to bear the following costs:

- All expenses in the home country incidental to travel abroad including expenditures for passport, visa, inoculations and other miscellaneous items, as well as internal travel to and from the airport of departure in the participant's home country.

Organisers will not assume any responsibility for the following expenditures in connection with the participant's attendance at the activity:

- Compensation for salary or related allowances for the participants during the period of the meeting,
- Any costs incurred with respect to insurance, medical bills and hospitalization fees,
- Compensation in the event of death, disability or illness;
- Loss or damage to personal property of participants while attending the meeting;
- Purchase of personal property.

H. For further information please refer to:

Mr. W.H. Tanaka, Head  
Development and Transfer of Technology Branch  
UNIDO, Vienna International Centre  
P.O. Box 300,A-1400 Vienna, Austria.

Telex: 135 612  
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