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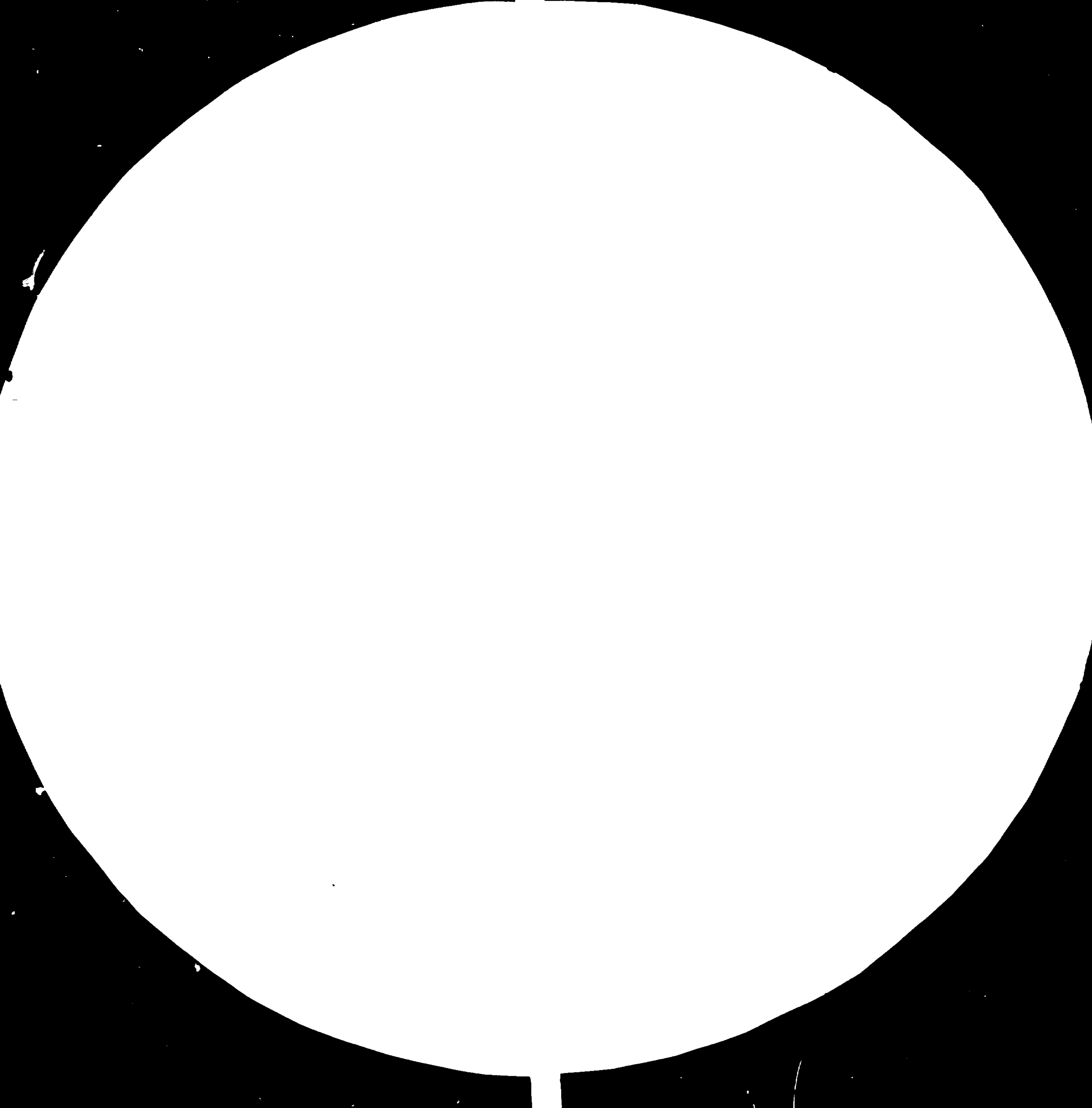

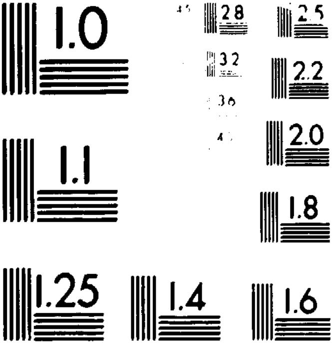

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Regional Network for Small Hydropower (RN-SHP)

Technical Advisory Group (TAG)
First Meeting

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NATIONAL LEVEL PRIORITY SUBJECTS FOR THE PROMOTION AND DEVELOPMENT OF SMALL HYDROPOWER

Information compiled by the UNIDO secretariat on the basis of papers submitted by members of the Technical Advisory Group*

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I. CHINA

1. Priority subjects for workshops and training courses

Feasibility study - In this area, China has developed her own methods suited to the particular conditions in China. However, we are keen to learn from the experiences of other countries, and can help in organizing such a workshop or training courses.

2. Joint/co-operative research projects

i) Electronic Load Controller - China has already completed a first stage research project on the testing and trial operation of an ELC in conjunction with the Intermediate Technology Development Group (ITDG). The results of this showed that two major problem areas are "how to reduce the cost" and "how to more effectively utilize the ballast load".

China is therefore embarking on the second stage involving the local assembly of 60kW ELC kits supplied by ITDG, and with the testings to be carried out in China and two other Asia-Pacific countries.

The results of this can then be disseminated throughout the RN-SHP to promote the wider use of ELCs.

ii) Remote control and automation of SHP stations - China is working on telemetry in cascade stations in Panxi River and commissioning of the system is expected during the first half of 1985. The experience obtained from this project could be disseminated through the publication of research reports and direct site visits.

3. China is willing to organize a training course, for example on "low-cost civil engineering design" in 1986, with the preparation of teaching materials to be done with lecturing in conjunction with other experts from the Asia-Pacific region.

The inauguration of the Phase-II HRC building is planned for second half of 1986, and China is willing to host a "High-level Policy-Makers' Symposium" to coincide with this opening ceremony.

China supports the work of the RN-SHP Secretariat in the field of information; China is actively compiling data on her own SHP stations and experts. Furthermore, China can participate in consultation teams where required.

II. MALAYSIA

1. Recommendation on Priority Subjects for future RN-SHP Expert Group Meeting/Workshop

In the development of small/mini hydro power for a developing country in particular, the main aspect that should be considered would be whether the country is willing to develop the technology in line with the country's energy requirements as well as its capability in adapting foreign technologies to suit its priorities. Otherwise the venture might result in very expensive systems and may be a failure in the end, putting the country into debts unforeseen at the first instance. As such, there are several areas which should be considered when small/mini hydro is adopted by a country. Mini hydro development and technology can only be acquired through experience. From this statement, pilot and trial projects are necessary to gauge the ability of available manpower resources of the country in handling such projects, especially if large scale implementation is desired. In Peninsular Malaysia trial and pilot schemes have presented a new outlook into the issue. The areas that need to be studied in detail are the following:

a) Current civil designs in areas having heavy rainfall and high incidence of land slides

Particularly in Peninsular Malaysia, the tr pical rain especially during the monsoon season spans over many months which can result in the hillside areas to be water logged. Landslides are frequent and these can have disastrous effects on the total mini hydropower station system. Landslides normally occur at strategic positions, e.g. cutting roads leading to power stations; landslides at pipelines anchor blocks; landslides at pole or tower position of transmission lines; landslides remote but at a higher level than the power stations and pipelines causing large rocks rolling down and damaging some parts of the system etc. The study in this area can mean:

i) Changes in designing of anchor blocks for pipelines e.g. having deep rooted pole structures rather than flat boxes.

ii) Ensuring proper anchoring of mini hydropower system, i.e. the pipelines and the power station anchored to solid immovable rock structures, if available.

iii) The building of specially designed non-metallized roads at specific locations with proper drainage.

iv) Studying the landslide phenomena and its reduction; say the planting of deep rooted trees at strategic positions.

The overall effect of this would mean that in putting up a mini hydro station a bird's eye view of the terrain, forest, fauna and geology have to be looked into from the mentioned problem.

b) <u>Hydrology of tropical forest areas and the factors affecting these due to deforestation and the recovery of the total system thereafter.</u>

Where logging activities take place, hydrology in tropical forest alters tremendously. Recovery of the affected area takes some time but due to its inherent nature, it can be considered rapid. The change in hydrology can be seen due to the initial clearing of the area and the subsequent growth of small plants. The total picture of the situation means on the onset of logging activity: large amount of silt; branches, logs and leaves are brought down by the river affecting the mini hydro system. Flood levels are high and may result in drowning of the power station. The high siltation shortens the life span in pipelines and turbines. The recovery of the system depends upon the type of plants that covers bare areas and this can possibly emphasize the proper replanting of trees in exposed areas of the forest.

c) <u>The effects of mining and development causing sedimentation and high suspension in water system meant for mini hydro projects</u>

In Peninsular Malaysia, mining industry is extremely active and mining can be in the form of opening large areas or can be digging up of river beds on small scale by illegal miners. The building of roads and open spaces simultaneously with deforestation have caused large amounts of sediments to appear in the water system. The abrasive nature of the products of these developments are disastrous in the mini hydro projects. Controlled mining is necessary to keep the water from being polluted. There is a need to look into the means of reducing sedimentation caused by such activities.

d) Methodology of transporting materials and equipment to site

Transporting materials and equipment to site has been a problem in this area especially during the rainy season. The terrain does not allow the use of vehicles at times and the heavily forested area makes it difficult to transport material by means of helicopters. As the cutting of trees is discouraged, methodologies have to be developed for transporting material and equipment into such areas. Excessive earth movements mixed with the tropical rain can be a hazard.

e) Construction methods using cable system

From experience, it was found that the best system of construction in this area is using cable systems for transporting pipes, cement, steel and all constructional material necessary at site. The cable system stretches from a convenient location of storage of material covering the total mini hydro system, i.e. from the weir to the power station. Methodologies have to be developed considering that every site has its own peculiarity and its contours and anchoring methods have to be developed individually. A standardized system can be created for all mini hydro sites.

f) Type and design of machinery to be used in implementation of projects and the minimum number of equipment that can be used in the construction

In putting up mini hydro stations the difficulty in transportation of materials to site means the need to design specific equipment for such system. The number of equipment used in the construction should be minimized and if implementation is to be carried out on a large scale, studies of this topic are necessary to cut down construction costs.

g) Training of manpower for constructional purposes

The training of manpower for constructional purposes is essential when working on a difficult terrain in the tropical jungle, as well as when trying to introduce a technology in these remote areas. The handling of tools and equipment in difficult areas with makeshift construction pads and dangerous situations calls for the need for such training.

Apart from normal training in constructional methods, the men should be trained for difficult terrain work as well. The training involves climbing, working suspended in mid-air, along cliffs, on river beds, etc.

h) Method of building roads to power station

The building of roads to mini hydropower stations is not easy due to the terrain and nature of land in this country. There is a lot of experience to be gathered from loggers who build their tracks that seem to have lasted for many years. The roads to the power stations have been thought to cover the minimum requirements only, are subjected to landslides and also the rapid growth of fauna can mean slippery and unreliable roads. The maintenance of such roads can be expensive and as such, the design of roads has to be looked into bearing in mind that the capital spent is small in order to place the project outside the economic constraint of the financing agency.

i) Fitting designs into the environment; minimizing blasting, cutting of trees and steps to be taken to avoid damage to pipelines from fallen trees

The environmental effect of cutting down trees and blasting of rocks is normally not called for as disturbances to the environment are highly undesirable in this country. Designs of mini hydro systems have to fit into the environment. The cutting of trees has to be avoided and damage to pipelines from fallen trees has to be looked into. The nature of a tree falling in the jungle is an unknown phenomena and can be caused by winds, animals or age. Falling trees close to pipelines seldom damage them, but those further away seem to have more effect. It can be deduced that the height and type of tree and its distance from the pipeline and power station has a strong bearing on the degree of damage that these trees can do. Minimizing the blasting is essential to cut down the security constraints of construction in such areas in this country.

j) Effect of flooding and generation of electricity while under flood conditions

In the event of flood occurring it is usually that the weirs and connecting intake area of the mini hydropower station is covered with water. The tailrace water level at the power station rises resulting in overall decrease in head available for power generation. Decrease in head results in inavailability of the power station to generate sufficient power and there may be vibrations and fluctuations in the overall system due to this. Power station foundations are subjected to severe errosion and backwater effect due to constriction of the river downstream from the tailrace. The operation of power station under flood condition needs to be studied as in Peninsular Malaysia flood occurs very frequently.

k) Effect of water hammer on pipelines

Water hammer on pipelines in mini hydro systems occur only when the power station machinery is subjected to sudden stoppage or due to a sudden closure of the main valves. Water hammer can also occur during the operation of the machine due to the inherent characteristics of the machinery. A study on the effect of water hammer on the pipelines and its solution is essential for the protection of the pipeline and the machinery. Each power station is peculiar in this aspect and means of correcting this phenomena is necessary in order to extend the life span of the mini hydro system.

l) Machinery and seed designs for manufacturing

In order to reduce costs, it is necessary for countries to manufacture their own turbines where possible. There is a need to produce seed designs as these form a basis for design or other sizes needed. The design of the machinery must take into consideration the capability of the country in terms of local manufacturing especially where precision is demanded. A venture in this area can have vast implications on the future of manufacturing in an undeveloped country.

m) Simplification of turbine governors of load ballast type and electronic types

Current types of governors, mechanical or electronic are complex in nature and requires skilled workmanship in developing them. There is a need to simplify such governors in order to reduce its cost, bearing in mind also that the degree of precision influences the standard of the electrical power generated. Hybrid designs are recommended and may be a solution to many areas of governor design.

n) Machine transportation, installation and commissioning

The transportation of machinery to mini hydro stations as well as its installation and commissioning demand certain skills. It is essential to ensure that this is correctly done, possibly through a system checklist and a guide manual of procedures in handling machinery, checking of levels, dynamic testing, etc. Some degree of training is required in this area especially where larger systems are being installed. The safety aspects of machinery training installation and commissioning must be stressed to avoid mishaps to personnel involved and to ensure long life to turbine and generating machinery. Simplification of the total machinery installation by having the whole power station in preassembled containers is the target. This can be an interesting aspect for a study.

o) Fault of generating systems and their protection methods. Computerized control of machine operation, remote sensing for remote operation

In the long run, mini hydro generating systems can have faults and in such cases the protection system must be adequate to prevent damage. Where a large number of mini hydropower stations have been established, computerized control of machine operation may be necessary especially in the area of remote sensing for remote operation. This is to cut down manpower as well as to increase reliability of centralized control of these power stations as their contribution has a considerable effect on the grid system.

p) Transmission and distribution designs, grid connections and reliabilty of systems

The transmission and distribution of the electrical energy where the mini hydro station is connected to the grid can determine the reliability of the total system. Where a large number of mini hydro stations are connected to the grid and they represent considerable value of power input to the grid, the sum effect of these stations to the grid system is large and must be studied from total power generation point of view. Assessment must be made on the reliability of the system, the stability of the system, the effect of faults in large power stations on the operation of these small stations, the effect of voltage swings, etc.

q) Social and economic effect of small/mini hydro systems

On the establishment of mini hydropower generating system the social and economic effect of the benefitting rural population must be taken into account in order to quantify what was earlier considered as intangibles contributed by such power stations. The social and economic studies will determine the rate of growth of the area, the contribution of the generating station as a nucleus for development, as well as the future projections in order to cater for demands of the area. The implication of such a system for the rural population must be considered.

r) Use of tailrace water for irrigation and drinking water

Water available from mini hydropower station, i.e. from the tailrace can be used for irrigation or drinking water for the rural population. In each instance, a study should be done especially on the design and type of water collecting intakes for these purposes. Methodologies to effect these systems must be considered in order to obtain the maximum benefit for the rural area as well as minimizing its effect on power generation by the mini hydro stations.

s) Pricing of electrical energy when connected to the grid for economic/financial evaluation purposes

In evaluating a mini hydro station, the pricing of electrical energy must be considered for the economic and financial evaluation of the system to determine availability of the projects and the degree to which the project can recover capital investments injected into it. The pricing of electrical energy is normally inadequately done especially in small hydro stations or run-of-river types when these are compared to major hydro installations. Pricing of the electrical energy transmitted to the grid must be looked into in order to testify that these stations prove to be economical. Methodologies and approach of the pricing system should be laid out so that each country can evaluate its mini hydro stations, as well as to determine the size of the loan needed from international banks. Proper pricing should also ensure that the benefits obtained are real and will not unnecessarily put a country into debts which it cannot afford. An international agreement on this matter and its approach is necessary. International banks must be convinced of the approach to pricing of the electrical energy generated by mini hydropower stations.

t) <u>The effect of mini hydro on agricultural development upstream on ungazetted catchment area</u>

Having installed the mini hydro stations, it is expected that the rural population would increase activities to enhance living standards. There is a possibility that increased agricultural activities will result in development of upstream, especially ungazetted catchment areas. The social and economic effect including the effect on the power stations must be looked into to ensure certain possibilities to be included. In certain developing countries such an incident may not be avoidable, but steps must be taken to ensure that minimum effect is seen on mini hydro stations already built. There may be a need to gazette catchment areas but there is also a need for the rural population to prosper and feed themselves by the use of these areas discriminatingly to ensure that the total ecology and well being of the catchment areas and the mini hydropower station is safe from undesirable effects.

u) <u>Types of new mini hydro systems and research work into these areas</u>

Innovation and new designs are necessary to produce machinery and systems that can harvest water energy to the maximum. Current designs are limited and can only harvest water designs above a certain head. Research must be done to look into these areas of harvesting water energy to the lowest level and at the highest efficiency. Different turbine designs and new concepts have to be considered, as not all the terrain along a river have adequate potential head. Energy in free flowing rivers with no head are enormous but cannot be harvested at the present moment. Efforts have been made to create new engines but insufficient enthusiasm is currently predominant. The aim is to increase the efficiency of the total system with maximum harvest from these rivers.

2. Priority areas for Joint Research Project

a) Study into the use and manufacture of the crossflow or Banki turbine for medium and low head mini hydropower stations

The crossflow or Banki water turbine has been known for many years to be a versatile turbine, easily manufactured, but unfortunately has a relatively low efficiency when compared to the Francis turbine or Pelton wheel. It is known that only one manufacturer has been able to raise the efficiency of such a turbine to value comparable to that of the Francis. This means that it is possible to develop a crossflow turbine that has a high efficiency. The ability of the crossflow turbine to function over a large range of heads as well as over a wide range of water flow, makes the turbine an essential item in the development of mini hydro technology in the developing countries. The fact that the turbine has minimum casting requirements and can be easily fabricated in small workshops makes it more reasonable for developing countries to venture into the manufacture of this type of turbine. Unfortunately, little work has been carried out by institutions on the turbine other than those done by private enterprises. It is therefore suggested that work be considered in this area to take advantage of the inherent simplicity of the machinery and its capabilities as a mini hydro turbine. Malaysia has acquired the designs of the basic turbine from OLADE (Latin American Energy Development Organization) and is in the process of developing the turbine for use in this country.

b) <u>Joint research into the development of turgo impulse turbine for medium and high head designs</u>

The turgo impulse turbine is a hybrid and links the opoerational field of the Francis turbine and the Pelton Wheel. Castings or fabricated turgo impulse wheel are easily made and this turbine can be developed easily for use in developing countries. The fact that it covers a large range of operation from that of the crossflow turbine to fringe areas of the Pelton Wheel operational chart gives this turbine an advantage over the Francis turbine. The complexity of the Francis turbine gives the turgo impulse wheel a definite edge over it. Development of this particular turbine therefore completes the scenario of development required in the turbine area.

c) <u>Research into governing systems for mini hydro stations that includes load distribution, ballast load system</u>

The governing systems for mini hydropower machinery determines the reliability and standard supply available to the rural consumer. Currently developing governors are based on complex design and there is a need to develop governors either mechanical, electronic or hybrid types for the mini hydro turbine. Research into this area can be very fruitful if steps are taken to use alternative parts from tractors and motor cars as parts in the governor design. An alternate and appropriate design using available parts would mean low cost development programme for developing countries in this context. Maximum use of these parts should be considered bearing in mind that these parts are available at low cost due to mass production. The use of electronics in the governing system should be minimized where possible as spare parts become the issue in the long run.

d) <u>Research into the systems for energy utilization and use in rural areas such as hot water system, refrigeration systems, etc.</u>

The generation of electrical energy in the rural area would not be helpful to the rural consumer if the energy is limited in use for lighting, radio and T.V. only. As a nucleus of development mini hydro energy must be used wisely in a manner to augment the progress of the rural sector. Research into the area of energy utilization and use in the rural area for hot water system, refrigeration, electrolytic use in agricultural, industrial and rural sectors must be considered.

e) <u>Use of water resistance for testing of mini hydro turbines</u>

The testing of water turbines requires loads to be varied over a large range of the water turbine generating systems loading. The problem of transportation of large banks of resistors for commissioning makes it necessary to use water as a variable resistance representing the loads for testing purposes. Research into the use of water as well as the design of the rigs to create water resistance and the safety aspects can be looked into in order to minimize transportation problems. Current turnkey projects in the Malaysian mini hydro programme makes use of water resistance for loading purposes and it has been found that there is a need to better design and increase safety features.

f) <u>The methods of supply to rural villages using battery charger systems</u>

For certain developing countries having populated areas very remote from town centres but where a small hydro station can be put up, the output from the system may not be able to cater for the number of potential consumers. As such, a method of supplying these areas using the battery charger systems (currently being developed in Malaysia) is being considered. The system makes use of the concept of storage of electrical energy in batteries. The advantage of this system is the low maximum demand on the generating station as well as its ability to function at long lines at low voltages upto a distance of 16 kilometers. This is an interesting area for research which can mean supply of electrical energy to the rural area for small generating systems, similar to the water supply system where each household maintains a water tank for storage purposes. This method makes possible the combination of a micro hydro system with solar and or wind energy combination or even with a biogas generator. A total integrated system can be adapted where the battery charger system is introduced.

g) Study in maximizing the harvesting of water energy

In a large number of cases in Malaysia where the rural sector has been developed there exist rivers with very good potential for energy harvesting. As these rivers are close to the grid there is a need to study the means of maximizing the harvesting of water energy and transmitting it to the national grid. Such a mini hydro station normally employs induction machines and turbines with no governors. The total concept of the mini hydro generating station must be evaluated and researched into to ensure optimization in terms of capital invested to the project.

3. Decentralization of RN-SHP Activities

The number of appropriate projects can be entrusted to member countries and, in particular, Malaysia could carry out the following:

i) Hybrid governor system, electrical/mechanical

It is thought that the hybrid governor consisting of a load controller system and a slow speed mechanical governor would be useful in reducing the cost of the governor system. In areas where there is insufficient water, the turbines would be subjected to peculiar operating conditions when using a load controller. The pipeline may be subjected to fluctuation of the head. It is essential that water must remain at a certain minimum level at the intake to ensure that the pipe is filled with water at all times. The hybrid governor system operates in similar manner to the load controller but the ballast load resistance banks should consist of a short time load resistances able to absorb heat from full load dumping by the generator for a period of not more than (say) five minutes. This temporary load dumping means that the mechanical governor will be able to operate within this period to adjust the machinery inlet valve to the appropriate position. Little demand is made on mechanical unit in terms of time response, as well as the load resistor banks need not be large as it functions only as a short operating time device.

ii) Micro-processor control of power station operation and system protection

The country is looking forward to building a large number of mini hydro stations for both rural electrification and energy harvesting aspects. Micro-processor control of power system operation and system protection would be essential as it is foreseen in the future that there will be a reduction in manpower operating these plants. There is also a need for centralized control for a group of plants within the vicinity of a control centre. Coupled to this would be the need to conduct research in terms of data, transmission and the remote control of small hydro station to ensure optimum operation of these stations. Low cost solutions to these systems are necessary and need to be looked into.

iii) Use of water resistance for testing of mini hydro turbines

As mentioned earlier under the same title this subject shall be of interest to many countries as it is the means of eliminating the need for resistance banks for load commissioning of the mini hydro generating output. The important aspects to be seen in this areas is the use of high voltage (say 11kV) on the resistance banks can mean excluding heavy equipment to site. The available water at the tailrace or the river bed makes this system suitable for commissioning purposes. The research project should include building the rigs, as well as determining the configuration and the material to be used. A certain desired standard can be achieved from this equipment.

iv) Development of turbines for local manufacture

This covers projects that can be entrusted to member countries, as mentioned earlier, as the need to manufacture turbines in order to cut down costs of such an equipment in the developing countries. In particular, the OLADE design should be considered as a basis for starting.

III. NEPAL

1. Priority subjects

The Small Hydel Development Board (SHDB) of Nepal, with its ten years of experience in SHP development has identified the following needs and priority subject areas and projects, which are also of regional significance:

i) Establish hydrological analysis method suitable for ungauged streams for SHP generation in Nepal

Most of the SHP sites in Nepal are located in the very remote part of the country and to establish and manage proper (permanent) gauging station in all these small streams is practically impossible. However, without proper hydrological studies, estimates of flow in the river will continue to be in error with the consequent high cost of over- or under-designed hydropower projects.

Therefore, SHDB believes an analytical method should be worked out to obtain the hydrological data from these ungauged and partially gauged steams. The analytical method if developed properly could also be utilized by other countries within and outside the ESCAP region with similar conditions.

ii) Rationalized design for SHP civil works (Design manual)

SHDB has undertaken a number of SHP projects in different hilly areas of the country. The demand for construction of such projects are increasing quite rapidly. SHDB with its limited technical manpower resources is facing a tremendous task to cope with the increasing number of investigatory and design works.

Therefore, if there are several SHP projects at hand, the design could be rationalized and relatively inexperienced engineer and other manpower could be trained and used in this field.

A rationalized design is one in which design principle and construction details are standardized but the overall sizing is adopted to match the site. Unlike diesel plants, SHP plants cannot be mass produced, each must be designed individually as each site is quite unique and has its own peculiar problems. Design rationalization will reduce job repetition and consequently utilization of the scarce technical manpower can be maximized. SHDB considers this subject to be also of regional significance.

iii) Utilization of computer facilities for SHP development

For the ever increasing tasks of SHDB, the benefits deriving from the use of computer facilities are quite obvious. Besides storing a number of different information, it can also help in design computation.

Recently, a research proposal on optimum design system for SHP projects using the computer programme has been submitted to SHDB by a local consultant (IDS). SHDB is seriously considering the application of computer facilities, especially to also develop point ii) above, i.e. a design manual.

iv) To improve the present technical capability of local Electro-Mechanical Equipment Manufacturers

At the moment, only few turbines upto 100 KW capacity have been manufactured locally. So far, only crossflow turbines have been tested with the imported generator. Several improvements are required in this field. Collaboration with experienced foreign manufacturers could be very useful.

v) To develop economic criteria for selection of most feasible SHP generation - Development of Master Plan for SHP in Nepal

SHDB has certain criteria and priority for the selection and development of SHP projects in Nepal. But after electrification of a few villages, the demand for electricity in a large number of villages and settlements in the remote, hilly areas of Nepal are growing very fast. Taking this into account, with the existence of large number of perennial streams in the mountains, the development of a Master Plan for SHP in Nepal seems to be an urgent necessity.

2. Priority subject areas for joint/co-operative research projects

Some of the activities and items mentioned under section 1. can be incorporated in this section 2. However, some of the joint/co-operative research projects are briefly mentioned below:

i) Electronic Load Controller - ELC

Local Manufacturers in Nepal are producing turbines of less than 100KW capacity, with the imported generators. However, due to high cost, the electromechanical equipment supplied by local manufacturers generally do not include any automatic governor. In Nepal the delicencing policy of SHP projects up to 100KW has encouraged village community and private entrepreneurs to come forward with more mini hydro projects.
However, in order to implement such programme on a large-scale, it would require cheap as well as reliable electromechanical system.

In this context, the research project on Electronic Load Controller (ELC), undertaken by the HRC, could be quite useful in Nepal. The research project could be further developed in co-operation with HRC and SHDB.

ii) Maximum utilization of local materials - reduction of cement use

As mentioned earlier, most of the SHP projects in Nepal are located in the very remote part of the country where road transportation facilities are not available. Therefore, the transportation cost of construction materials, which are not available at the site is very high. For example, the transportation cost of cement at some sites are 7 to 8 times higher than the actual cement price at the factory.

Therefore, joint research programme could be worked out on the design of hydraulic structure for SHP, where the use of cement can be minimized and the use of local materials can be maximized.

iii) Optimum design systems for SHP projects

SHDB, at the moment, is considering a research project proposal for optimum design systems for SHP project, submitted by a local consultant (IDS).

The primary objective of the proposed research is to improve the technical and economic efficiency of SHP projects by developing a computer-based design system.

The estimated total budget for this research project is about US$100,000 for three-year period. However, the cost and total time could be reduced with the further review of the proposal and availability of specialist manpower in this field.
The most immediate benefit of this research will be the savings in the cost of design and construction of SHP projects. It will provide considerable savings of scarce technical manpower and project time; and also improve technical efficiency of facilitating rational site selection and quality control.

At this moment, this research proposal has not been implemented due to financial and manpower constraints. SHDB considers this research proposal useful not only for Nepal, but with some modifications, it can equally be applied to other countries from the region as well. Therefore, SHDB suggests that this be taken up as a joint/co-operative research project.

3, Decentralization of RN-SHP activities

i) A Seminar/Workshop could be organized on Design of Hydraulic Structure for SHP projects in 1986 in Nepal, provided that financial resources can be secured.

ii) The SHDB would welcome any activity in the future to promote the decentralization of SHP programme.

IV. PHILIPPINES

1. Priority subjects

i) Expert Group Meetings

a) Assessment of prior accomplishments and present programme

b) Plans and programme for the future (e.g. establishment of a special school for hydropower planning, engineering, etc.)

c) Funding requirement and sources.

ii) Workshops and Training Courses

The Second Meeting of the ASEAN Working Group on Co-operation in Micro/Mini-hydro Development identified the priority areas for its training programme as follows:

a) Technical Planning

- Hydrology
  - Correlation methods
  - Appropriate flow measuring techniques

- Geotechnics (modern)
  - Latest developments in low-cost methods applicable to micro/mini-hydro development.

- Socio-economic aspects
  - Techniques on the determination of tangible and intangible benefits.

- Feasibility study
  - Development of a simplified and standardized format to meet the requirements for decision-making purposes.

b) Construction

- Engineering design
  - Low-cost, simple design utilizing to the maximum content possible locally available materials.

  - Recommendations for the standardization of civil and electro-mechnical works components.

- Contract administration
  - Engineering and supervision
  - Construction
  - Procurement matters

- Local manufacturing capability

c) Management

- Development of effective management systems for micro/mini-hydro programmes.

- Operation and maintenance.

The Philippines feels there is also a need for training on environmental impact assessment and mitigation. Planners and decision makers should be able to identify the critical areas which may be adversely affected by the mini-hydro project and (a) see if something can be done to remedy the effects; and (b) decide whether to push through with the project or not.

2. Priority Subject Areas for Joint Co-operative "Research" Projects

i) Standardization of civil and electro-mechanical works design. The Philippines is currently working on this project, in co-operation with its consultants.

ii) Hydrology - setting up of stream gaging stations; gathering of rainfall and precipitation data; and use of correlation method.

iii) Geology - sub-surface exploration, particularly for the dam, intake, headrace and power plant locations; erosion protection and drainage design for headrace, penstock and other structures.

iv) Diversion Dam - types of dam and criteria for the type of gate to be used.

v) Intake Structure - sediment transport and siltation (maintenance).

vi) Headrace - selection of type of headrace (open or close; steel, concrete or fiberglass).

vii) Surge Protection - design of surge pressure protection for forebay, surge shaft and surge tank.

viii) Penstock - type/material to be used for penstock (steel or fiberglass, etc.).

ix) Power Plant - economical design of power plant using locally available material.

x) Equipment Selection - type and size of mini-hydro equipment units to be used to maximize site potential based on latest performance data.

3. Areas and Types of Activities where the Philippines could take the Lead for Organizing Projects

i) Training

The first and second training workshops on SHP for Asia-Pacific region were held in Hangzhou, People's Republic of China in 1983 and 1984, respectively. A total of twenty six (26) participants from nine (9) countries attended the two (2) training workshops.

Decentralization of training activities may allow to conduct more training courses and workshops in a year. A larger number of people can participate. Some ways in which training activities can be decentralized are briefly discussed below:

a) Holding of training courses outside China.

b) Grouping the member countries by region (or according to certain criteria such as level of SHP technology used, status of SHP programme, etc.); and holding the training courses by region, instead of having all the member-countries participate in every training. This will be more effective since the discussions and examples will focus on areas/problems which are common to the group/region.

c) Establishment of training units, either government agencies or specified groups, in selected member-countries to organize training workshops. One training unit per region/group may be organized which will take charge of the training activities of the region. Training courses may be conducted in different regions/groups simultaneously; they may also be conducted from one region to another (which may be more economical). For example, a group of lecturers may conduct a course in region A. This may be composed of foreign lecturers and experts from region A. The course can be revised to suit the conditions of region B and experts (from region B) can be invited as resource persons.

d) Sub-contracting the training courses to government utilities or specialized groups of member-countries. They may be invited to submit proposals on specific topics. UNIDO/HRC can evaluate the proposal and decide who will conduct the course. The courses can be implemented in the same manner as c) above.

ii) Video Tapes on SHP

HRC has made nine (9) video tapes of its activities for the past years. These tapes have to be reviewed first before work on other tapes can be started. Some scenes/shots from these tapes can be used in future projects. As discussed by the Consultation Mission during its visit to the Philippines, a group of video and SHP experts may be invited to meet and discuss the preparation of video tapes. This group can determine the coverage, the number of tapes, objectives and other criteria/guidelines for the video tapes. Implementation can be done in two ways:

a) Given the guidelines set up during the meeting, HRC can implement the project, hiring video experts as needed. This can be done in co-operation with countries that will be covered in making the tapes.

b) Sub-contract the making of tapes to a member-country or a group of video/SHP experts.

It is recommended that at least three (3) tapes be done at a time. Some shots needed by three (3) films can be taken in the same sites, hence, minimizing travel cost and time.

4. Suggestions to Facilitate the Implementation of Information Exchange among Member Countries

The ASEAN Working Group on Micro/Mini-Hydro Development has set up the MHINEX - Micro/Mini-Hydro Information Exchange System, where member countries are expected to submit quarterly, various data/information agreed upon during its second meeting. MHINEX (for ASEAN) and other regional organizations can be tapped by HRC to send contributions or other data it needs for its publications. This will entail less time and cost, and may be done more efficiently.

During the meetings (senior experts, TAG, etc.) the participants may agree to submit certain data/information that HRC needs, and the frequency of submittals. A deadline can also be set for regular publications. For example, members should know when they should submit their contribution if they want it to be included in the first quarter issue of the newsletter.

V. SRI LANKA

1. Priority Subjects

The establishment of the Regional Network for Small Hydro Power (RN-SHP) in itself underlines the necessity for co-operation and dissemination of information for development in our region and the respective countries where small hydropower activities are concerned. The vital areas of dissemination of information could include the following:

i) Emphasis on training courses to develop human resources.
ii) Manufacturers and suppliers of SHP equipment in the region.
iii) Encouragement and incentives for the publication of all R&D activities already accomplished in the region.

i) Education and Training Needs:

Education and training needs stem from the national goal objectives and aspirations and the scope of activities that have to be undertaken to realise these goals and objectives. Such activities and parameters for consideration with regard to the mini-hydro power development would encompass:

- Identification of potential sites
- Collection and analysis of hydrological topological and geological data
- Power and energy potential evaluation
- Diversion dams and storage facilities
- Intake structures and water conveyance systems
- Penstocks and surge tanks
- Turbines and generators
- Speed, load and voltage control equipment and protective gear
- Power house and anciliary equipment
- Energy supply and demand features and load dispatching equipment
- Cost benefit and other economic considerations of financing mechanisms
- Construction management
- Operation, maintenance, trouble shooting and overhauling
- Social and environmental aspects

ii) Manufacturers and Suppliers of SHP Equipment

The feeling prevalent among most of our planners which presumably is still inherited by us from our colonial rulers, is that "the best performing equipment can only be imported from developed countries". This is not only a myth but hazardous for the successful implementation of an effective SHP development project. It would be true to say that this may have been the case some decades back when the local industries in this region were in their infancy. There is sufficient evidence to believe that at present local manufacturing industry of small machinery has reached a level of maturity to be able to well compete with the high cost, high technology equipment from the developed countries. It would be unwise to state here that this equipment is redundant but the fact should be emphasized that each piece of equipment should be evaluated on its cost effectiveness.

The above should always be complimented with a proper alternative suggestion of encouragement, provision of incentives and popularisation of local machinery. Without such scheme to popularize, advertise and market the SHP equipment that could be produced locally the results may be discouraging. Hence the necessity for a proper scheme to popularize, advertise and market this equipment is inevitable.

Popularization could be achieved by demonstration. This could be done by Government sponsored projects or projects sponsored by an international funding agency, always using well proven technologies with simple, unsophisticated parts that could easily be substituted or manufactured by a local craftsman.

The advertising and marketing facilities would evolve with the popularization effort and this could further be supported by distribution of brochures, news bulletins and popular magazines.

iii) Dissemination of R&D Efforts

Much effort is being wasted in this aspect mainly by duplicating the work carried out already by established organizations geared for these activities. On the other hand less R&D work is being undertaken in certain areas of SHP development such as cost reduction techniques, effective technologies and adaptability of already existing technologies.

The other aspect of R&D activities in the region should be to encourage the researchers to do much wanted and relevant research work and proper dissemination of this work hence it is very important that all research organizations be identified firstly under the RN-SHP Sub-Focal Points then also under the RN-SHP itself. It would be a worthwhile effort to co-ordinate these activities both at national and at regional levels and all the activities be properly documented so as to give wide publicity to such important activities and to encourage other users in the region of the facility to avail themselves with the latest technique and technologies developed.

2. Joint Research Project

High priority area in the region could be classified as follows:

a) Simulation of climatological condition
b) Remote controlled and unattended operations
c) System cost optimisation of SHP

The above three priority areas are to a great extent interrelated to each other and need greater attention in our future SHP development activities.

a) Simulation of climatological condition

This is one of the most unreliable parameters of the design of a proper SHP project but, nevertheless, one of the most important in the whole exercise of the design. In almost all the cases of sites selected for SHP development it has been observed that the rainfall patterns, river-flow data are very scarce and unreliable. Nevertheless the designs will have to adopt some criteria of flow duration curves and other required data. Hence the need for the development of appropriate mathematical models or empirical relations is very essential. The development of such a programme has to be given much needed co-ordination by our eminent researchers in the region both in the organized establishments and in the universities offering hydrology as subjects.

b) Remote controlling and unattended operations

It is our experience that many SHP projects fail to materialize for the lack of available trained personnel to handle such projects and also for operation and maintenance of these plants. Many of the plants now abandoned or ruined are due to this fact. Therefore, it will be a worthwhile exercise to focus our attention on remote control facilities. Taking advantage of the fact that these SHP schemes could be connected to the national grid or could form themselves into local mini grids, the possibility of remote controlling and centralized operation could be considered.

Telemetering and remote controlling has been in operation in our countries for sufficient length of time that the experience gained and the expertise developed is available. It would be only necessary to develop clusters of SHP projects to form themselves to be centrally operated by a few skilled and trained personnel, thus eliminating numerous problems associated with the lack of trained personnel who are in most cases unwilling to serve in remote areas. It should also be mentioned here the advantage of eliminating all associated overheads involved with staffing a manned power plant.

c) System cost optimisation of SHP

This is one of the least addressed subjects in the field of research in our region. It has always been the case for someone other than the designer to evaluate the project where cost effectiveness is concerned mainly for funding purposes. The need for closer understanding of the cost vs. the design parameters is a prerequisite for cost optimisation of such a project. Ready reckonners and computer models should be developed and in cases where it is already developed it should be modified wherever possible to correlate the design parameters of the system with the cost and economic parameters.

The expertise available in our countries could be well utilised for the development of such econometric models to run on micro processors or results of such runs to be made available to our designers as ready reckonners.

3. **Areas and Types of Activities where Sri Lanka could take the Lead for Organizing Projects**

Several projects which could be carried out within the country by taking a lead role could be identified as follows:-

a) To act as a focal point for information dissemination;
b) To scrutinize and forward suitable candidates for proper training;
c) To co-ordinate activities of fellowship recipients;
d) Organisation of seminars, meetings and workshops on SHP;
e) Monitoring of hardware development effort;
f) Market penetration studies.

VI. THAILAND

1. **Priority Subjects**

The meetings and workshops on small hydropower organized previously could be considered as satisfactory. However, subjects dealt with in those meetings were oriented towards fundamental knowledge of small hydro development. They are excellent in their own context but their contribution to the cost reduction of the project is questionable.

With this concept in view, priority subjects for future expert group meeting, workshop and training courses are thus proposed as follows:

i) **Expert Group Meeting**

Subject	Feasibility study
Objective	To identify various drawbacks and inappropriate criteria and methodology currently employed in the feasibility study of small-scale hydro and formulate a new internationally recognized standard manual, specifically tailored for the feasibility study of small-scale hydro schemes.

Participants Experts from member countries as well as from international and United Nations Organizations and from technical and financial sectors.

Justification Feasibility study is the decisive factor for the existence of project and it is mandatory. Since small-scale hydro is rather a newly emerging area, the criteria and methodology currently employed by the financial institutions was adopted from the conventional one used for the feasibility study of major hydro. They are inappropriate and consume substantial time and money, which small-scale hydro cannot afford. In addition they are oriented towards financial benefits rather than economic. As a result many projects good for rural development were discarded simply because their overwhelming intangible benefits could not be counted in the evaluation and the projects thus became infeasible. A new criteria and methodology specifically tailored for small-scale hydro have to be innovated.

ii) Workshop

Subject Design and construction of low-cost civil works

Objective To exchange and compile information and experience in the design and construction of low-cost civil works in various countries.

Participants Experts from implementing agencies in small-scale hydro from member countries and also invited experts from outside the region.

Justification The major cost of the small-scale hydro is the civil works and in some cases occupies as much as two-thirds of the project costs. The simplified standard design and construction approach to alleviate the cost of civil work will help to increase the economic viability of the small-scale hydro projects.

iii) Training Courses

a) Subject: Civil Works Design

Objective: To train junior civil engineers in the design of low-cost civil works.

Trainees: Junior civil engineers from the region.

Justification: Civil works is the major investment portion of the small-scale hydro. However, the civil work can be designed and constructed by local engineers at reasonable cost providing that they have the appropriate information and experience. Unlike the mechanical and electrical counterparts, the knowledge of civil design existed in all countries of the region. In addition, their acquaintance with local materials available and site conditions offer merits of their work. In many cases, especially for small hydro in remote areas, these qualifications have evidently proved to be of great advantages to the design of low-cost civil works. This course will broaden the horizon of these engineers and thus strengthen their capabilities in this field.

b) Subject: Small Propeller Turbine Design

Objective: To train mechanical engineers in the design of small propeller turbine for irrigation canal.

Trainees: Mechanical engineers

Justification: In rural areas of many countries in this region, the governments have constructed many small weirs and canals for irrigation. These weirs and canal drops offer excellent small hydro potentials for electricity generation or mechanical power that the farmers in the vicinities can utilize. Yet, these potentials have not been harnessed, its constraint is the costly generating equipment, particularly the turbine. Therefore the know-how of small propeller turbine design, probably in the range of 1 to 5 kilowatts, and exchange of information on locally manufactured low-cost propeller turbine in order to increase the productivity and improve the quality of life of a large sector of population will be greatly beneficial to the rural poor.

2. Priority Subject Areas for Joint/Co-operative Research Projects

In hydro-electric generation it is vital that the frequency has to be constantly maintained no matter how the load varies. Normally, hydraulic or electro-hydraulic governor is used for controlling the speed. This type of governor required sophistication in design, precision in manufacturing and highly trained personnel to adjust and maintain. Therefore, they are supplied by only a handful of manufacturers around the world, and of course, at a very high price. The electronic load controller recently developed and introduced to the market opened the new era of low-cost, but near free maintenance governor.

In our experience as the user and manufacturer of the load controller under the license from U.K. for over five years, the load controller proved its claim. However, its limitation in capacity (not over 100 kW) and in application (consistent amount of water discharge)and the problem of heat dissipation of the dummy load together with its performance that does not allow synchronization with other machines made its application confined to the small, isolated run off the river with high discharge hydro scheme. Nevertheless, its concept and performance are quite impressive. In addition its low-cost makes it challenging to explore into the possibilities of modifying it for flow controlled application. In this new application the electronic part will function as a frequency sensor. The change in frequency as the result of the load variation will transmit the electric command signal to drive the gear motor coupled to the flow control valve which will increase or decrease the flow according to the requirement. Thus the turbine speed will be constantly maintained.

At present, the National Energy Administration is developing this type of governor. The performance of the prototype simulated in the laboratory was encouraging and actual field test will be carried out soon. However, the perfection of its performance requires further research work. In this regard, Thailand proposes the development of this type of governor as the priority subject area for joint and co-operative research projects.

3. Areas and Type of Activities where Thailand could take the Lead for Organizing Decentralized Projects, Subject to Availability of Financial Support

The area of activities that Thailand can propose to take the lead for organizing decentralized projects is on-site training course on the co-operative approach in the management of construction and operation of small hydro for rural villages.

In Thailand, many rural villages in remote areas, have enjoyed better quality of lives through electricity from small decentralized hydro power developed and managed by the villages themselves. In each project the villages will form among themselves a co-operative in joint venture with the Government to construct small hydropower stations in their vicinity. The villages contribute free labour and free local materials. The Government provides the rest including generating equipment as well as technical assistance. The contribution from two sectors will be converted to shares which will be held by all participants. The revenue from the electricity will be shared among the shareholders. With this approach the Government can reduce the investment on rural electrification and allocate the burden on the operation and maintenance on remote decentralized stations. The villagers on the other hand, will benefit from the increase of productivity and enjoy better living conditions through electricity and co-operative benefits.

This approach can be duplicated in every country in the region providing that the technique of management and the will of people to co-operate exists. Thailand proposes to offer on-site training course in this know-how to the countries of the region, subject to availability of supporting funding will be made available from the UN organizations.