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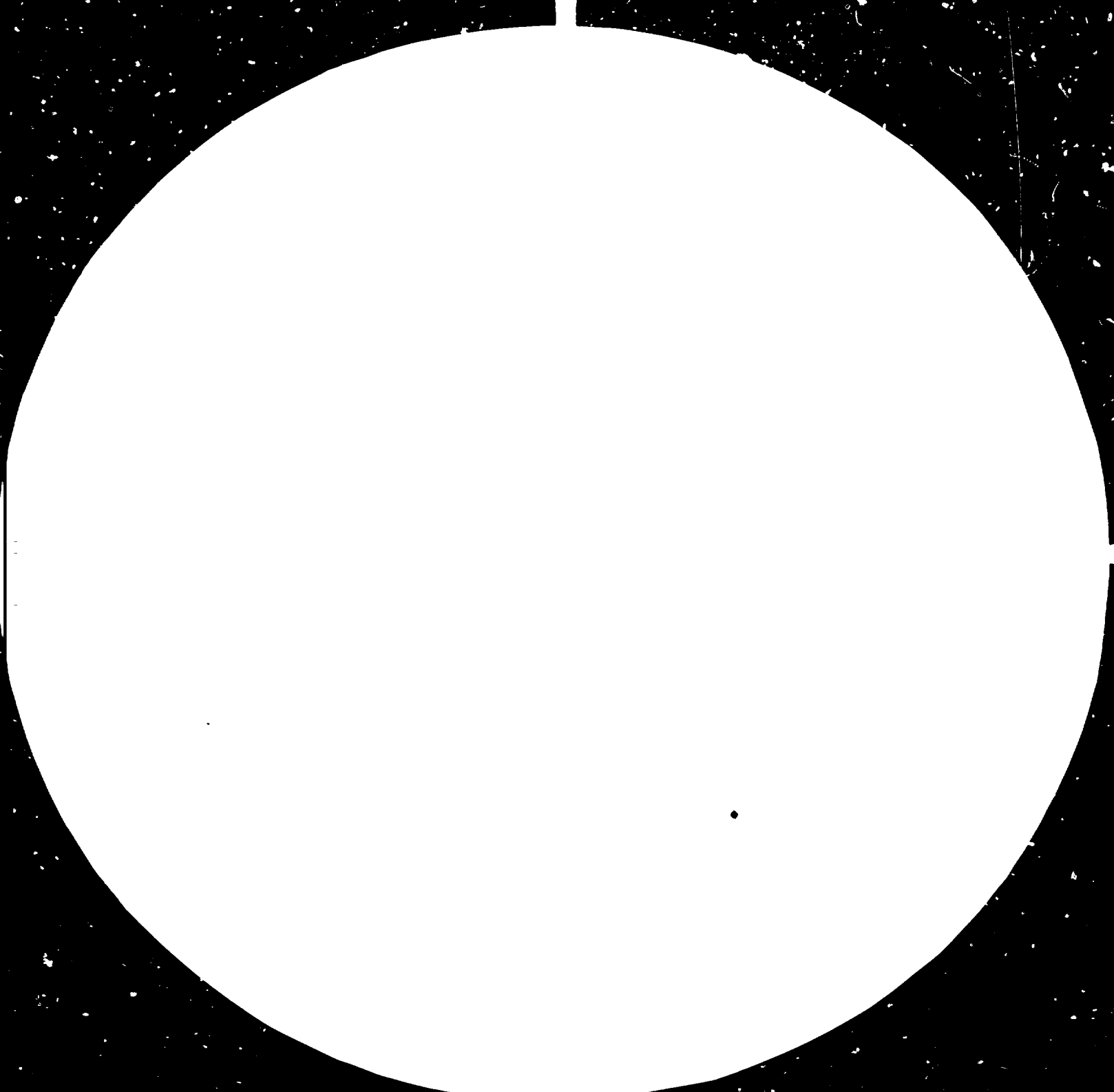

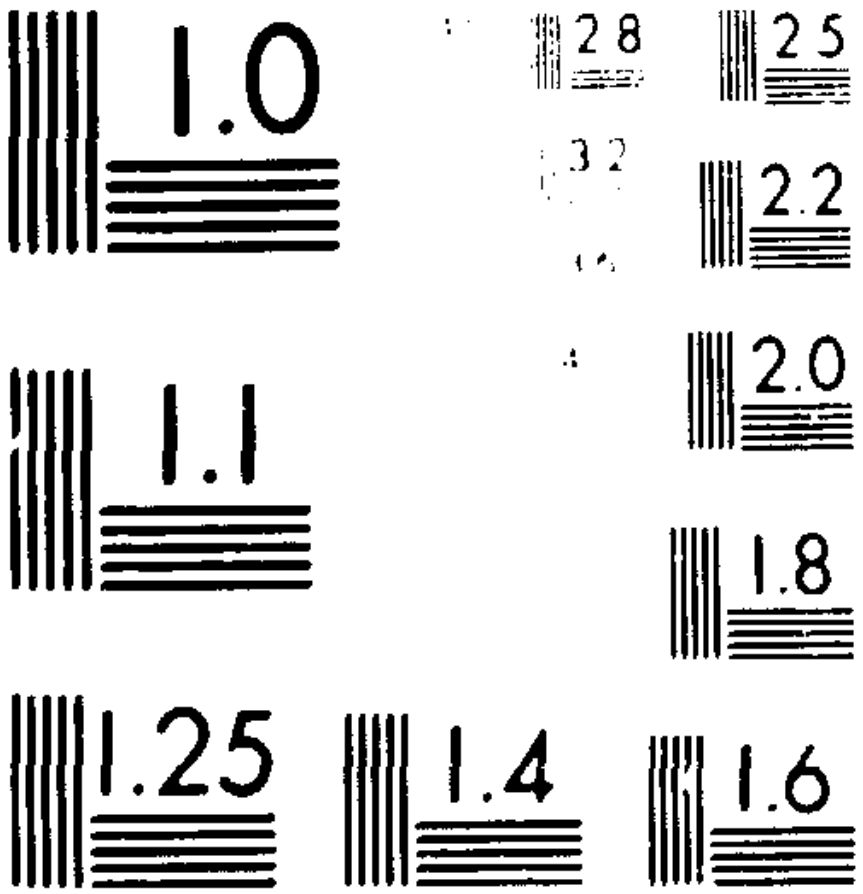
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UNIDO ISSUE PAPER*

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INTRODUCTION

This UNIDO issue paper is intended to be an expanded agenda for the Second Seminar-Workshop on the Development and Application of Technology for Mini-Hydro Power Generation (MHG). The first Seminar-Workshop on this subject was held a year ago in Kathmandu, Nepal, and led to the "Kathmandu Declaration" *) in which the participants pledged to strengthen international co-operation in the field of MHG. The Kathmandu meeting had focussed on technical, economic and institutional aspects of MHG, using inter alia a few case studies prepared by participants from both developed and developing countries. This second MHG Seminar Workshop is intended to build on the results of the first meeting.

The issues to be covered, in the light of UNIDO's preparatory work, can be divided into three separate themes:

a) Systems approach, largely concerned with policy issues;
b) Local manufacture and construction, dealing with the specific technical and economic aspects of MHG in developing countries; and
c) Ways and means of financing MHG installations.

UNIDO's interest lies in the industrial aspects of MHG, which fit into two main conceptual frameworks: one is the industrial requirements for the manufacture, operation and maintenance of MHG installations while the other is the industrial development implications of making MHG units available, particularly as it makes small and medium scale industries and maintenance shops possible in remote and isolated areas. It is not possible, however, to provide assistance and guidance in the establishment of MHG programmes without being aware of dimensions other than those two, such as the potential impact of MHG or irrigation or on the social welfare of the population or still the financing problems involved. These non-industrial aspects may warrant, in some cases, co-operation with other UN agencies such as, but not limited to, FAO, DTCD or the World Bank.

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*) See Annex I

A number of issues have been put in the agenda of two of the three groups and sometimes on all three. This is because "local manufacture", to take only one example, presents some policy aspects, some technical and economic aspects, and impacts on the financing of a project. This agenda is simply a guide as a starting point for discussion and the emphasis to be placed on those issues and other ones will be up to the working groups. This issue paper is subdivided according to the main themes and working groups called for in the schedule and agenda of the Seminar-Workshop. One also expects that the final report will largely follow the same skeleton.

Plenary sessions will allow every participant to get the benefit of the work of all others, thereby fulfilling the stated objective of "promoting the transfer of technology, the exchange of information, knowledge and experience in the planning, construction and application of MHG units in the developing countries, with particular reference to the comparison of the system of planning and project implementation in the People's Republic of China and in the Republic of the Philippines".

The participants will also have an opportunity to be brought up to date on a number of past, present and future activities. A final report will be prepared, which will include the recommendations of the participants for follow-up activities at the national, regional and inter-regional levels, including technical co-operation among developing countries and technical assistance by UNIDO and other UN or non-UN organizations as well as bilateral assistance programmes.

## I. Systems Approach to the Establishment of MHG Projects.

MHG projects, like other industrial projects, are part of a multi-dimensional system in which scarce resources must be allocated and organized in the best possible way. The theme of system's approach is of primary concern to the policy and decision makers who must accomplish the following tasks:

a) Fix the objectives and priorities;
b) Identify the present capabilities and capacities of the country;
c) Devise and implement a plan of action within a precise time schedule.

Those three tasks are interdependent: some constraints, particularly the lack of industrial infrastructure, may force a lowering of the objectives; and the plan of action must be realistic and agreed upon by all parties involved.

### A. Setting the objectives and the priorities:

An MHG programme is part of an industrialization programme. It can be described as the formation of capital goods and as an investment, since the existence of MHG units can foster further industrialization. Two important objectives to be considered are:

a) The encouragement of specific electricity users:

For instance, one may want to favor the development of rural and remote areas with objectives such as the promotion of:

- Cottage industry, small scale industry
- Manufacture, maintenance and improvement of agricultural machinery
- Social services such as education, health, communication .....

One may also aim at more general objectives such as discouraging rural-urban migration improving the quality of rural life and creating new jobs in the country.

b) The utilization and improvement of the country's capacity to produce and install this type of equipment in terms of both human skills and industrial infrastructure.

Practically, the objectives will be summarized in terms of:

- Number, size (kw) and location of MHG units to be installed within a given time frame.
- Degree of sophistication and local participation in the designing and manufacturing activities.
- Specific users to be determined and encouraged.

B. Identification of present capacities and capabilities:

1. Technological possibilities: they depend on the following conditions:

a) Skilled personnel available for the project

b) Manufacturing and construction capabilities of the country.

One useful task to be performed mostly by experienced technical people is to draw project flow-charts showing how material inputs are transformed into intermediary products in a succession of steps ending with final assembly and construction. Each step can be characterized not only by its material input and output, but also by the level of skill and the physical equipment required.

Different flow-charts or "technological routes" lead to MHG plants having various degrees of sophistication, cost and efficiency. For instance, a country equipped with casting and forging facilities can produce more sophisticated equipment than a country deprived of such amenities. One may then see whether the pre-conditions for the realization of a particular type of project are met in any practical location or if remedial solutions are required.

2. Coherence with other programmes:

a) MHG is one of the sometimes conflicting uses of the country's water resources. The following uses may be ascribed different orders of priorities with implications on MHG programmes:

- electricity generation
- irrigation
- navigation
- fishing
- environmental protection
- recreation

At least one of the participating countries (China) is known to have chosen one particular order of priorities in this respect.

b) More generally, MHG programmes must be in harmony with concurrent programmes such as:

i) National energy and alternative rural electrification policies and plans (e.g. conditions of connection to the grid)
ii) Capital formation plans
iii) Environmental protection.

3. Funds availability: while the financial issues are examined in more depth in Chapter III, the policy and decision makers can influence the availability of funds for MHG through various incentive programmes (Government subsidies, tax incentives, preferential loan terms, etc.). They must also decide where they wish the funds to come from, given the financing capacity of the community at the local, regional and national level.

4. Authority, awareness and willingness of the parties involved: there may be structural problems to be resolved, such as:

a) Legal problems concerning the status of electricity generating bodies, or
b) Traditional resistance to change that must be overcome by a proper information compaign and an appropriate set of incentives.

C. Action Planning:

The formulation of an action plan should cover the following issues:

1. Organizational structure and decision making process, which includes such specific items as:

a) Planning method, tools and process (for illustration, please see an example of Workplan-Progress Chart in Annex II).
b) Centralization versus decentralization (with particular references to experiences in China and the Philippines).

c) Communication process: dialogue between users and promoters, suppliers and designers, policy makers and engineers, as well as exchanges of information from one MHG project to the next and between suppliers and users of technology.

d) Standardization authority.

2. Project evaluation and realization sequence: timing of the various steps including:

a) Pre-feasibility studies (hydrological survey, demand projections, site selections);

b) Feasibility studies (cost/benefit projections under various choices of technology and equipment) and choice of technology;

c) Financing;

d) Training;

e) Engineering and procurement (choice of equipment and suppliers);

f) Manufacturing and construction;

g) Distribution of energy to users;

3. Infrastructural development and project integration: the project integration is an iterative process by which specific actions are taken in order to loosen all the constraints so that the objectives can be reached. Alternatively, the objectives are revised to take unsurmountable obstacles into account. Important issues are:

a) The degree of local involvement: treated in more detail in Chapter II, it includes the decision to utilize, upgrade or create certain portions of the country's industrial infrastructure.

b) The organization of training activities at all levels from labor to supervising and management for all the tasks involved, whether technical or managerial in nature. A comprehensive programme may include medium and long term actions such as appropriate curriculum in vocational and technical educational establishments and scholarship programmes for special purpose courses in the country or abroad, etc., and short term actions

such as intensive courses and study tours aimed at providing specially recruited people with the skills needed for the tasks they will have to perform. Skills required for a successful MHG programme fall into three categories:

i) Planning, designing and realization of the physical plant, including the manufacture of the various components.

ii) Operation, maintenance and customer service of the installed generating set.

iii) Industrial uses of the newly created energy source.

UNIDO may assist developing countries with the establishment of such programmes upon request.

c) The coordination of the tasks to be performed at the local regional and national level.

d) The logistic requirements (transport of materials and parts, temporary manpower and equipment procurement, communications, etc.).

e) The recording and dissemination of accumulated experience by means of demonstration programmes, formal exchanges of information, pilot projects, etc.

## II. Local Manufacture of MHG Equipment and Civil Engineering

Local fabrication and construction involve technical and economic issues which have been resolved in various ways by those countries already engaged in MHG programmes. A review of the state of art in those countries, together with the exploration of new ideas, should provide the participants with a better insight on the choices offered to them concerning the degree of local involvement in MHG programmes.

### A. Manufacturing and Construction Flow-Charts:

One can visualize the technological routes that have yielded MHG installations in both developed and developing countries by decomposing the complex manufacturing and construction process into elementary steps such as casting of turbine blades, forging of generator shaft, etc., as the case might be. Some of those steps occur sequentially, some can be accomplished independently. Each one requires

- some material inputs (raw materials or intermediary goods)
- some manpower (labor and supervision with varying degrees of skills)
- some physical facilities(such as an increasing order of complexity, sheet metal fabrication, heat treatment, forging, casting, etc.).

Some of these steps may be accomplished in the country, some abroad. By knowing how things can work, one will be better able to assess the country's potential for local manufacture and construction, as further explained below. This approach provides a methodology for the analysis of post achievements and for the projection of future realizations.

### B. Technology Adaptation and Coordination:

1. Assessment of the country's technological and technical capabilities: the actual manufacturing and construction flow-charts mentioned in A (above) permit to compare the requirements of a particular design with the actual possibilities of the country: one can then identify obstacles and evaluate their importance.

2. Technology adaptation: the obstacles previously identified can be surmounted in a number of ways, amongst which:

a) choice of a simpler design

b) reliance on distant or foreign supplies of goods and services

c) upgrading of local manufacturing and construction potential.

Developing countries may want to use all of these solutions at the same time. There may also be an evolution over time. For instance, the first units can be assembled from foreign-made parts with plans for future backward integration.

3. Cost considerations: the choice of technology is not dictated only by the physical manufacturing and construction possibilities, but also by single economic considerations that can be summarized in one important figure: the cost of producing one kWh over the life of the project. Issues of importance to the cost-engineer include:

a) Trade-offs between cost and sophistication on one hand, and efficiency on the other.

b) Simplifications of design, manufacture and operation by such techniques as the multiplication of standard components and the elimination of unnecessary features.

c) Adaptation and rehabilitation of existing structures and equipment (irrigation dams, water wheels, etc.).

4. Coordination at the local, regional and national level, including such issues as:

a) Advantages and disadvantages of a national focal point (such as a National Electricity Board).

b) Standardization and compatibility with existing equipment.

c) Distribution of the tasks (e.g. central facility for electric motors, local authority for civil engineering work, etc.).

d) Horizontal and vertical information network.

e) Role and importance of "development and demonstration centers".

5. Human Resources Development: This includes the identification of training needs and priorities, and the determination of the level of industrial personnel to be trained in two areas:

a) MHG design and realization, including the realization of the various components;

b) MHG operation and maintenance.

Training programmes should aim at both technical and managerial personnel. Training can take a variety of forms, amongst which:

- Regular curriculum in local universities and vocational schools;
- Special courses in the country aimed at staffing specific projects;
- Scholarships in training centers abroad.

6. Special Problems:

a) Civil engineering work: simplicity and safety against catastrophique failure.

b) Electrical equipment: simplicity and safety against electrocution.

c) Handling of wide voltage fluctuations due to small, captive user's network.

## III. Ways and Means of Financing MHG Installations

Even though financial management is often largely left to specialists, both decision makers and technical people should have a feel for the issues involved, so that they can meaningfully interact with the finance specialists. These may work out the fine points, but they need guidance from the policy-makers so that their financial strategy is in harmony with such non-financial goals as socio-economic development and others, as the case might be.

### A. Project Evaluation:

Before a decision is made on a particular project, a consistent methodology is necessary for the financial evaluation of all the alternatives as part of the overall evaluation, and the following issues should be agreed upon:

1. Project Bounderies: all the components of the project must be taken into account for a fair comparison of alternatives. Also, one may want to consider the distribution network and even some of the industrial applications as part of the same package (for instance, MHG plus welding shop) in order to avoid the waste of time and money associated with what can be viewed as a lack of coordination.

2. Quantitative evaluation method and numerical value of the corresponding parameters (required rate of return, maximum acceptable payback period, cost of the kwh, etc.)

3. Secondary benefits: MHG may decrease the need for some state subsidies or increase the tax revenues if the income of the population increases.

4. Foreign exchange implications and effect on the balance of payments:

   a) Negative: purchases of equipment and services, dependance on future spare parts and services from abroad.
   b) Neutral: if additional foreign aid is available for MHG with no prejudice to other projects.
   c) Positive: lower oil import bill, increased GDP and import substitution.

5. Rate structure and demand projections: these two issues are intimately related, since the particular rate structure will influence the various components of the demand. The two together give the projected revenue from the customers. Some sub-issues are the following:

i) How to ensure maximum utilization of the generating capacity in a way that is compatible with the goals of the project (see Chapter I/A)

ii) How to encourage energy savings (discourage the use of over-sized receptors and encourage switching off lights and other receptors when they are not needed)

iii) How to avoid excessive peak demand

iv) Advisability of government subsidies and other user's incentives.

6. Fiscal rules and incentives: each country must decide for itself on such issues as

- Depreciation rules
- Investment tax credit
- Applicability of special status (non-profit, state enterprise, small business, public utility .....)

keeping in mind that the attractiveness of MHG may depend on those rules and incentives.

7. Cost of technology transfer: this issue needs a very critical assessment in all cases. Since MHG is a mature technology, licensing fees and royalties are not very likely to be warranted. The experience of the participants involved in MHG programmes will provide invaluable insight for all.

B. Sources of Capital:

The precise ways of raising capital vary considerably from country to country, but one may want to examine the following issues:

1. Financing capacity from savings at the community or local level vs. at the national level.
2. Future access to capital for similar projects or for expansion.
3. Possibility of joint ventures (e.g. public - private).

4. Availability of specific or general purpose foreign aid.
5. Debt versus equity, financial risk. Cost of capital.
6. Government guarantees.

C. Financial Management:

MHG involves the need for some financial management from the pre-feasibility study to the routine operation and maintenance of the completed facility. Issues worth considering are:

1. Personnel and skills required at the various stages of the project's life.
2. Local availability of such personnel and skills.
3. Training needs and type of assistance required.

## IV. Technical Co-operation

A number of ongoing and proposed UNIDO activities will be discussed in plenary session, amongst which the following:

1. Review of the draft "Mini-Hydro Power Station: Manual for Decision Makers".
2. Compilation of the MHG bibliography.
3. Discussion on MHG systems and equipment standardization.
4. Possible establishment of a regional/interregional Development and Training Centre in China.
5. Other training programmes.
6. UNIDO Technical Assistance Programmes upon request.
7. Technical Co-operation amongst developing countries.

While this Seminar-Workshop will permit the accomplishment of a significant amount of work, final conclusions on all matters cannot be expected. The last but not the least task of the participants will be to lay the foundation for productive follow-up activities.

ANNEX I

# Kathmandu Declaration*
## (Resolution for International Co-operation of the Seminar-Workshop)

Proposed by representatives of Nepal, People's Republic of China, Colombia, Norway, Sweden and Tanzania.

The Seminar-Workshop on the Exchange of Experiences and Technology Transfer on Mini Hydro Electric Generation Units organized by UNIDO/ESCAP-RCTT in co-operation with the NCST and the RECAST of Nepal from 10-14 September 1979 in Kathmandu has demonstrated the interest in and the importance of this subject.

Exchange of information, knowledge and experience is felt to be of basic importance for promotion of this technology, not only between developed and developing countries, but also among the developing countries themselves.

In this respect, parties carrying out activities in this field: governments and official and private institutions, as well as UN agencies and other international and bilateral organizations are invited to increase their supporting efforts to accelerate the electrification of rural areas by means of small scale power production including micro and mini hydro generation within the framework of rural development plans.

The participants of the Seminar-Workshop therefore decide to underline the need for the strengthening of international co-operation in a systematic, efficient and effective manner, and want this to be referred to as THE KATHMANDU DECLARATION.

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* Source: ID/WG.305?22, 13 November 1979: Seminar Workshop on the Exchange of Experience and Technology Transfer on Mini-Hydro Electric Generation Units, Kathmandu, Nepal: Draft Report on the UNIDO/ESCAP-RCTT Joint Meeting.

EXHIBIT I

# WORKPLAN - PROGRESS CHART
## EXAMPLE FOR A 500 KW HYDRO-ELECTRIC POWER PLANT