Decentralized hydropower training for developing countries

A proposal

NRECA Small Decentralized Hydropower (SDH) Program

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Small Decentralized Hydropower Program
International Programs Division
National Rural Electric Cooperative Association

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This publication is one of a series that fosters the effective use of small decentralized hydro-electric power systems. This series is published by the Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association (NRECA). NRECA operates the SDH Program under the terms of Cooperative Agreement AID/DSAN-CA-0226 with the Office of Energy, Science and Technology Bureau, U.S. Agency for International Development.

Under the agreement, begun in May 1980, NRECA provides a broad range of technical assistance to developing countries. NRECA provides assistance by:

- designing and implementing regional workshops in Africa, Asia, and Latin America
- developing and conducting in-country resource surveys and site assessments
- providing engineering, supervision, and specialized assistance
- developing specialized publications such as state-of-the-art reports, inventories of manufacturers, and assessment methodologies
- conducting special studies on issues pertaining to finance, management, evaluation, and other subjects
- providing training services in such topics as operation and maintenance, resource assessment, equipment fabrication, and institution building
- carrying out specialized services such as tours of U.S. manufacturing plants and small hydro sites and seminars on private sector involvement
- creating specialized products such as productive-use plans for energy from small decentralized hydropower.

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Summary

This is a proposal to provide training to developing country nationals. Approaches include both in-country as well as U.S.-based instruction, classroom style as well as hands-on. The subject is decentralized hydropower.

Why train?

The problem. Technologies in developing countries fail for a number of reasons, principal among them are lack of: in-country technical assistance support; proper planning; adequate operation and maintenance; appropriate design; effective management; and so on. Systems tend to fail for institutional or managerial reasons at least as often as for engineering reasons, if not more frequently.

Technology transfer. One of the basic purposes of development assistance is, through properly designed and funded programs, to eventually develop self-reliance within a country and avoid continued dependence on outside resources. In transferring a technology from one country to another, particularly from an industrial nation to a developing country, it becomes easy to misunderstand, misinterpret, or pay insufficient attention to the cultural, economic, infrastructural, political, and educational differences. Being aware of these differences and understanding how to adapt technologies to meet developing country needs will be the key to successful technology transfer.

Institution building. In order to plan, implement, and manage rural energy programs, a successful institutional arrangement will be necessary. The elements of this arrangement may include a board or commission responsible for rural electrification, a professional staff, and a clearly defined process of operation—financial management, resource assessment and development, system construction, and management—all carried out through both strong decisive leadership and effective interagency cooperation supported by adequate funding and a serious national commitment. A principal ingredient in the formation of these institutions is training—training for initial design of the proper institutional development and operation (i.e. how is it put together and how does it work), as well as subsequent training of professional and technical staff for maintaining these institutional responsibilities. This initial orientation training for institution building is equally as important as the follow-on training of organizational personnel for planning, implementation, and operation and maintenance of rural schemes.

U.S. experience. The U.S. represents a substantial source of knowledge and equipment for assisting developing countries through technology transfer and institution-building. The private sector offers equipment, manufacturing know-how, site development experience, limited financing, and expertise in training. The public sector provides intergovernmental arrangements to facilitate this assistance, funding, development program planning, and implementation. Among the non-profit private sector organizations is the National Rural Electric Cooperative Association (NRECA) with over 20 years of experience in technology transfer, institution building, and training in rural energy systems.

Why NRECA?

In the U.S. For over 25 years, the NRECA Management Services (MS) Department has provided effective training for its member systems managers, directors, and supervisors. MS training currently consists of over 60 courses in problem solving, decision-making, accounting, planning, and effective management.

Overseas. Since 1961, the NRECA International Programs Division (IPD) has carried out more than 300 assignments to assist developing countries in planning and implementing rural electrification and renewable energy programs. Over 400 representatives of 34 countries have received organizational and management training in the U.S., and hundreds more overseas, as a result of the particular assistance provided to a country.

SDH Program (see title page overleaf) experience with 3 regional workshops in Latin America, Asia, and West Africa, with an additional workshop planned for East Africa, will have served over 400 attendees with 25-30 resource people, including responsibility for substantive program development, background materials, paper presentations, discussion leaders, panelists, field exercise design, coordination of all logistics, expenses, facilities, transportation, and working with cosponsoring institutions. All of this is highly relevant to providing in-country training.

Resources. The MS Training Division employs 10 full-time professional trainers. The IPD has developed training programs, with assistance of specialists, designed to expose problems associated with rural electric system operation, organization, and management. Many of the 1,043 U.S. member systems have provided facilities for training developing country visitors for hands-on experience. As a recent indication of the continuing international involvement of member systems, NRECA will be presenting service awards to 15 people who recently served in 12 countries and training awards to 13 member systems which have recently hosted visitors from Egypt, Zaire, Pakistan, and

Bangladesh. In addition to the member systems' skilled engineers, managers, and planners, the SDH Program staff can draw upon the resources of 18 systems currently operating small hydropower plants, 3 more under development, and approximately 100 plants proposed. The most important resources are those developed by NRECA as the AID agent for decentralized hydropower technical assistance to developing countries—a world-wide network of hundreds of professional contacts; a talent bank of U.S.-based scientists, including over 100 engineers; a familiarity with staff and equipment of at least 8 U.S. turbine manufacturers; personal experiences in all phases of decentralized hydropower development in developing countries; an in-depth knowledge of the history and current state of small hydropower development in over 40 developing contries; and an understanding, through in-country experiences, of the need for institution building through effective training.

Approach

Basic services. Training will be provided both in-country and in the U.S., depending on host country needs. Although a full range of services can be applied in either location, it is anticipated that in-country training will focus on specific projects and sites. The level of training may be quite technical, aimed at junior and mid-level engineers, whereas U.S.-based training may be broader, more comprehensive, and aimed at senior engineers and program managers. The advantages of in-country training are that more individuals per country can be served, the costs are fewer, the environment is familiar to the trainee, there is a higher likelihood of instruction and discussion in native language, and there is a greater availability of sites to be developed (including sites already developed which may include examples of errors in design, construction, or operation that can be good teaching tools). Moreover, there is the proximity of potential institutions for involvement in eventual program planning and management. The disadvantages include difficulties in finding resource persons with language skills, availability of teaching staff for a month or more overseas, and suitable facilities for providing instruction. The advantages for U.S.-based training are that resource people can instruct in English, the facilities are "closer to home" and perceived as being more controllable, less time is committed by each resource person, and more facilities (for instruction and operating sites) of different kinds are likely to be available and easily accessible. The disadvantages of U.S.-based training are that the costs are substantially higher, trainees are more likely to be restricted to those who speak English, and there may be little in the U.S. culture, infrastructure, and approach to development that the trainee can absorb, let alone attempt to duplicate in his home country. In summary,

U.S.-based training is more convenient for U.S. resources, but at a higher cost, while in-country training is more familiar to the trainee, but inconvenient for U.S. resource people.

Other services. Also available are options tailored to suit specific needs, such as internships with a U.S. turbine manufacturer, small hydro developer, or possibly other private or public institutions involved in hydropower development (i.e. engineering firms, TVA, BuRec); or study tours of U.S. manufacturers and small hydropower sites (developed and under construction).

Response. Because of its specialized resources and unique experience, NRECA is able to respond quickly to requests for training, regardless of location. This response mechanism includes, on the one hand, rapid but thorough logistic planning, coordination, and implementation; and, on the other hand, courses carefully designed in terms of content, format, resource specialists selected, timing, and cost.

Evaluation. NRECA proposes to establish a Training Advisory Committee (TAC) to review and evaluate the training services provided to assure the effective commitment of limited resources. TAC members would be drawn from USAID, NRECA, the University of Minnesota, resources within the U.S. small hydropower private sector, international training experts, and others as required.

What we're offering

In general, this proposal is designed to offer training that can be utilized in both the in-country or U.S.-based context.

Course units. A broad range of "units" of 1 to 3 days in duration are available which in the aggregate provide for a 6-week overview of decentralized hydropower development. Single units or groups of units with a particular theme, (i.e. hydrology, equipment, or economics) can be offered, as presented here or in a more expanded form, for in-depth coverage to serve a more specialized training request. Course unit topics for the 6-week overview are:

- site assessment
- hydrologic analysis
- energy and power computations
- turbine selection
- manufacture and fabrication of turbines
- electro-mechanical equipment
- electrical distribution planning
- bid specifications for turbogenerating equipment

- civil works designs and considerations
- cost analysis
- demand forecasting and end-use planning
- financial analysis
- socio-economic analysis
- administrative planning and implementation
- organizational development and management considerations.

Field exercises. For both the Overview Course and in-country training, field exercises are emphasized, consisting of one-half day to several days in duration of on-site instruction, demonstrating data collection and project analysis procedures, construction techniques, and system operation and maintenance. Field exercises are scattered throughout the Overview Course to reinforce principles learned in the classroom.

Specialized training. Among other types of specialized training, U.S. study tours of several weeks in duration will be offered from time to time to visit small hydro manufacturing facilities and projects, both under development and in operation. Internships of several weeks' to several months' duration will be offered in which developing country personnel can spend time working with U.S. small hydro manufacturers and with U.S. private development firms on actual projects to gain practical, on-the-job experience in various aspects of machinery fabrication, assembly and maintenance, and project development.

Format. For the Overview Course, lectures, discussions, and classroom and field exercises will be provided. In-country training and other specialized training will be arranged on a case-by-case basis, according to the specific need.

End results. For the Overview Course, program managers will understand the process of decentralized hydropower development, how it fits into national energy planning, and will realize the important role of institutional arrangements. For more specialized, in-depth training, the trainee will learn how to carry out a particular set of tasks (i.e. operation and maintenance) to adequately perform a series of analyses (i.e. financial, economical, or social); or learn how to train other trainers. The training objectives of study tours, internships, and other specialized training will be determined on a case-by-case basis.

Resources

People. The SDH Program's talent bank contains a listing of over 100 engineers and many scientists and development specialists. Many of these people have already

worked with the SDH Program, others have had training experience in one form or another. SDH Program staff have access to other in-house resources such as other IPD staff themselves, the IPD inventory of rural electrification specialists built up over the last 20 years, and the MS training specialists. Outside of NRECA are the already-mentioned 1,043 member systems' staff and managers (over 55,000) many of whom, over the years, have worked with the international program. In addition, NRECA can draw upon specialists from universities, government agencies, engineering firms, and manufacturers who have participated in NRECA program activities in the past.

Places. Locations for training are varied depending on the need. For in-country classroom training, hotels, colleges or universities, research or educational institutes, and special government facilities (possibly designed for training) are all usually within an urban location. Field work tests will be conducted at laboratories and at developed and undeveloped sites close to the training locations selected. NRECA is familiar with many of these in-country training locations having visited a number of them and actually used a few. For U.S.-based classroom training, the choices are almost infinite; however, the required support services often dictate the use of a university or other type facility (often government) with experience in international training. For field work, there are, again, actual developed sites or sites under construction, laboratories, and others. Many NRECA member systems operate or are developing hydropower sites. The University of Minnesota provides both classroom and support capability as well as laboratory and operating site capability. For this reason, the University seems best suited for an overview training course. They are also well suited for specialized training in hydraulic design and equipment testing. Other locations tend to have other strengths suitable for specialized training—for example, Colorado State University for hydrology, and the University of Missouri at Rolla for engineering management and electrical distribution design and construction. Government facilities have also been used for international training relevant to small hydropower development—the Corps of Engineers' Hydrologic Engineering Center and the Tennessee Valley Authority. Manufacturers' shops and laboratories and private developers' sites (new and retrofit) would also serve as suitable training facilities. Many NRECA member systems possess training facilities for both classroom and field instruction. All of these and other locations are well-known to the SDH staff.

Materials. NRECA possesses a wide range of suitable material for training, from the extensive libraries of NRECA, IPD, and the specialized SDH Program library which contain manuals, methodologies, reports, documents, and other publications useful for instruction. Other materials will be developed in-house specifically for course units as

illustrations, examples, and field exercises. Many existing SDH Program publications, all of which are original documents, are directly relevant to training—the methodologies for hydrologic survey, for environmental assessment, for country wide survey, and for prefeasibility studies; the manufacturers' directory; the micro-hydropower sourcebook including the case studies for Pakistan and Nepal; and others.

What will it cost?

There are no funds currently in the SDH budget to cover training costs. NRECA can provide training in 3 to 5 developing countries for approximately $250,000. NRECA can conduct a 6 week Overview Course at the University of Minnesota for 40 participants that will cost approximately $200,000. Costs for the TAC, development of training materials, and publication of the training workbook will cost approximately $50,000. The total estimated cost is $500,000 for one year.

NRECA believes that:

- there is a widely agreed upon need for this training
- there is a genuine interest in such training from AID Missions and host countries
- the recommendations of the Energy Office (ST/EY) evaluation committee report on the SDH Program for training should be implemented
- the SDH Program staff is uniquely qualified to develop, manage, and implement training services.

The critical need for training

Global shortages of energy have focused international attention on renewable energy technologies. This is particularly true in the oil-importing developing countries, many of which face virtual bankruptcy because of the severe debt-servicing problems in paying for petroleum imports. To help stem rapid foreign exchange depletion, many developing countries are attempting to tap decentralized hydropower potential, since it is a relatively proven, low-cost technology which is readily adaptable to remote rural areas where there is little likelihood of grid supplied power for many years to come.

Since some two-thirds of the world's remaining hydropower potential is found in the developing world, the straight-forward nature of the technology promises to make a significant contribution to these countries' energy needs. The real challenge involves training and institution-building aspects of program development to allow effective management of isolated decentralized hydropower systems. The integration of the basic planning, engineering, construction, management, and operation and maintenance of these systems, with the provision of timely and appropriate technical assistance, must be well-planned and carefully developed. Training programs are an essential ingredient of this integrated approach to decentralized hydropower project development and cannot be treated as an isolated, distinct element of the overall program, to be effective.

To provide an adequate response to these needs, the training component of a given project or program effort must be managed by a resource base that is fully familiar with the project or program context in which the training is offered. The National Rural Electric Cooperative Association's (NRECA) Small Decentralized Hydropower (SDH) Program, recognizing the urgent need for training as part of its overall technical assistance program for developing countries, proposes to fill this important role.

NRECA's response to meet training needs

To help keep pace with the growing demand to expand indigenous energy supply, developing countries must devote greater attention to the training requirements of decentralized hydropower programs, especially in those countries which have depended so heavily on imported technical expertise. To be viable, projects must limit the expense of engineering studies and design work to a reasonable percentage of the capital cost. With

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smaller projects in particular, the costs associated with the use of highly-priced engineering consultants are prohibitively high. Therefore, more of the effort must be provided at the local level to help assure that the projects are cost-effective.

Training is often the missing link in the development of viable rural energy programs in developing countries. But defining the proper scope, timing, and execution of a training program is a challenging task. Conditions in each country and, consequently, the training needs vary greatly, depending on the existing technical and managerial expertise within the country.

The litmus test of short-term training programs is their effectiveness at the project and program levels in defining training needs and providing an adequate response to those needs. Too often the objectives of training efforts are not clearly defined in relation to the specific need. As a result, the training is frequently ineffective. It is essential, therefore, that:

- the training program be closely linked to the desired result
- the results be based on the specific project or program requirements
- the timing and substance of the training that is offered be appropriate
- preparatory assistance and follow-up training be considered in each case to ensure that the training is ultimately useful
- above all, hands-on experience, coupled with specially designed class, laboratory, and field exercises, should have a prominent role in any training program that is offered and should be directly related to the kinds of project or program activities that the trainee is likely to encounter.

Very specialized training needs exist. They vary noticeably from country to country and even project to project and depend considerably upon the level of sophistication of a country's technical expertise. Over the past year, the SDH Program has received several requests for training assistance in diverse fields from many AID countries including Morocco, Rwanda, Liberia, and Thailand. The in-country training program described in this training proposal is much more specialized than that which the SDH Program proposes to offer in the U.S. and is designed to permit the SDH Program staff maximum flexibility in responding quickly to a developing country's request such as those it has received for specific on-site, in-country training assistance. The approach taken for this training is described in In-Country Training Program (Tab 3).

The strategy for implementing this multi-faceted approach involves a two-pronged training program with (1) the Overview Course covering all 15 course units offered at the University of Minnesota and with (2) specially tailored mini-courses for in-country

training, based on specific training requests from AID Missions and/or the host country governments.

This approach results from a request from the U.S. Agency for International Development (AID) ST/EY for such a proposal and from the SDH Program staff perception that training needs will vary from case to case. These include a general need for a well-developed training program that provides an overview of all aspects of decentralized hydropower planning and development and an on-going need for more tailored, country-specific training effort. The Overview Course consists of 15 separate course units covering the full range of technical, economic, and institutional aspects of decentralized hydro project development. They are designed to expose participants to the latest developments in the field of decentralized hydropower (in the range up to about 15 MW) and to help ensure that there is no gap between project planning and project performance due to poor implementation. The course units may be offered as a unified whole, covering several weeks of intensive training, or, in response to specific requests, as limited training packages of one or more units to serve specialized needs.

The training to be offered in the U.S. at the University of Minnesota is designed to meet the preliminary general training needs of the manager of a typical decentralized hydropower program in a developing country. Decentralized hydropower plants tend to be dispersed throughout a country and located in rural areas. This makes them particularly difficult to plan, build, operate and maintain, and manage from a central governing body. This training approach is comprehensive, emphasizing the interelationship of all aspects of decentralized hydropower development, from the initial planning stage, through the day-to-day operation and maintenance of the system. It forces the manager to view his program, including the technical, economic, managerial, and organizational features, from a broad perspective, and not as a series of diverse disjointed components.

A prime objective of this proposal is to train key developing country personnel to become trainers themselves. The term "manager" includes any person with general responsibility for a program or project whose duty it is to see that the right people are in the appropriate positions with the proper talents, skills, and information. The Overview Course should instill a sufficiently broad sense of the components of a decentralized hydropower program so that this person is capable of managing people as well as tasks.

The proposed training course at the University of Minnesota, by its very nature, is a general course and does not attempt to respond to specialized needs, such as accounting and finance systems, or turbine design and manufacture. Instead, it is a broad

overview. This training course is described in detail in U.S.-Based Training Program (Tab 4).

NRECA—some background

NRECA, in its capacity as the AID contractor for the SDH Program, is uniquely qualified to act as the management agent for these training programs and to provide the vital link between the necessary training and overall project development. The SDH Program staff includes engineers with both developing country and training experience and is uniquely familiar with decentralized hydropower project developments worldwide based on:

- its work for the ST/EY in providing technical assistance to 18 developing countries to date
- the valuable training experience it has gained in planning and coordinating the three international decentralized hydropower workshops it has cosponsored in Quito, Bangkok, and Abidjan
- the useful contacts it has made in developing teams to provide technical assistance to the Missions, as well as from its information dissemination efforts such as the workshops and seminars it has sponsored
- the documentation of decentralized hydropower developments worldwide which have been collected in the SDH Program library, recorded in the many publications and in hundreds of slides of projects in developing countries.

Each of these efforts makes the SDH Program staff an invaluable resource in developing and conducting these training programs and makes it uniquely capable of offering an eclectic perspective on site development and design details and the social, economic, and managerial implications of alternative approaches.

As a leader in bringing electricity to remote rural areas, NRECA has accumulated a wealth of knowledge, experience, and trained personnel to assist developing countries in the technical, economic, financial, and management aspects of rural energy system development. In many cases, this assistance has included the establishment of viable, professionally-managed local institutions responsible for providing reliable electric energy in rural areas. Training has been an integral part of that effort.

For more than 25 years, NRECA's Management Services (MS) Department has provided effective appropriate training for its member systems' managers, directors, and supervisors. Today, the MS training consists of over 60 courses in problem-solving, decision-making, accounting, planning, and effective management structure of one day to several weeks' duration. The MS Training Division employs ten full-time professional

trainers, several of whom worked with NRECA member systems previously, as well as consultants for developing course content, evaluating course effectiveness, and in-class training. The SDH Program staff has tapped this in-house expertise in developing these training programs and will continue to make full use of the MS staff to refine the training it offers as well as to assist directly in both training programs.

Since its inception in 1961, NRECA's International Programs Division (IPD) has carried out more than 300 assignments in assisting developing countries in planning and implementing rural electrification and renewable energy development programs. As an integral part of this rural energy development assistance, IPD has developed dynamic training programs designed to expose key developing country personnel to problems associated with rural electric system operation, organization, and management. IPD Training Experts (Appendix A, Tab 5) lists the specialists who have assisted with IPD's training programs over the years.

IPD has accumulated vast international experience and expertise in assessing and responding to developing countries' needs, including training requirements. Long before "cross-cultural communication problems" were an issue in international training, IPD was sensitive to the basic human needs and fears of trainees from far-off developing countries arriving in the U.S. for the first time. The initial phase of the IPD training program was (and remains) geared toward helping these visitors from developing countries adjust to the resultant culture shock. Many of the NRECA member systems have graciously served as hosts over the years for visitors from developing countries who are interested in taking a closer look at U.S. rural electric systems and who want some extended hands-on training.

The NRECA 1043 member rural electric systems are a rich resource from which the SDH Program can draw skilled engineers, managers, and planners, many with experience in developing countries. The SDH Program staff can draw upon this valuable resource to assist in developing course content and for in-class teaching as well. Moreover, 18 of NRECA's member systems currently have operating decentralized hydropower plants, 3 more are under development, and approximately 100 decentralized hydropower plants are proposed. Many of the operating plants owned by NRECA's member systems, which are listed in NRECA Member Systems with Small Hydropower Plants (Appendix B-Tab 6), are located in the western part of the U.S. A few are in the North Central U.S. This proposal is designed to take full advantage of these plants as sites for hands-on training, recognizing that there may be instances where trainees from developing countries require more extensive hands-on training than is proposed for this

training program, will call upon NRECA's member systems and U.S. equipment manufacturers to assist in this effort.

Course units

The in-country and U.S.-based elements of this proposal are complementary programs and will draw from the same set of course units, resource materials, and faculty. Each of the 15 course units concentrates on a general topic area such as site assessment, manufacture and fabrication of turbines, or demand forecasting and end-use planning, and focuses on the various elements of those topic areas. For example, Course Unit 1—Introduction to Site Assessment reviews the kinds of data needed for a site assessment, how to organize a search of existing data, how to estimate data if unavailable, and how to assess environmental and socio-economic impacts.

The course units are outlined in Course Unit Listing and Descriptions (Appendix C-Tab 7). These course units are based on the wide experience gained by the SDH Program staff, both prior to as well as during the first 2 1/2 years of the Program's operation, and focus on the kinds of information and techniques that are most needed in developing countries. The 15 course units cover the fundamental elements of decentralized hydropower development and are designed to train personnel in the basic skills needed to assess and utilize the decentralized hydro potential in a developing country most effectively. However, from time to time it may be necessary to refine or expand these course units to keep current with the development of new techniques or equipment or because a particular country needs more in-depth training on particular elements of a course unit.

Both the in-country and U.S.-based training, aside from the benefits derived from an increased awareness and understanding on the part of the participant, will have the added attractions of:

- stimulating wider interest in decentralized hydropower as a viable renewable energy technology, both within the participating developing countries themselves and the AID Missions
- fostering a closer working relationship between the Missions and the host country governments by working together to select candidates and to assist in the follow-up evaluations
- providing a logical link for any follow-on requests for technical assistance, training, or information about the latest decentralized hydropower developments applicable to that country.

Training advisory committee

A great deal of money is invested in training programs for developing countries worldwide. However, the return on that investment is often limited by the failure of many training services to fully address the technical and cultural environment in which the training is applied. Training programs designed for developing countries too often ignore the technical, economic, financial, and institutional realities of the Third World. These programs typically are drawn from existing curricula of Univesities and other technical institutions designed to educate engineers working in the context of the industrialized countries, which is vastly different from that found in many developing countries. This proposal seeks to depart from this conventional pattern of designing training courses.

The training programs outlined in this proposal have been developed with contributions from a wide range of engineers, economists, and training specialists, who have considerable working knowledge of decentralized hydropower programs in developing countries. A concerted effort has been made to take into account the anticipated training needs in decentralized hydropower and to assure that the services offered are well-defined and appropriate. Since funds to carry out these training programs are not unlimited, it is even more essential that the results of these training services be highly effective. To further assure that this goal is achieved, a Training Advisory Committee (TAC) has been included in this proposal to:

- help anticipate changing training needs
- help develop marketing tools to publicize these training programs and to solicit interest among other development institutions in financing long-term training programs
- help establish criteria by which staff for the SDH Program and the ST/EY can judge the many training requests received to help determine which countries have the most pressing training needs and to help set priorities among them
- provide guidance as needed on how to most successfully respond to a country's request for training (U.S.-based or in-country)
- review training course schedules, lecture notes, and other course materials (class, laboratory, and field study exercises)
- periodically evaluate and refine the SDH training program, including the development of responses to, and training services for, the varied training needs.

In short, the TAC will be the policy and review committee for the ST/EY to provide added assurance that the limited resources for training are used most effectively.

The TAC would be comprised of:

- two SDH staff members (a training specialist and an engineer)
- at least one person representing the ST/EY/AID
- one person from St. Anthony Falls Hydraulic Laboratory (SAFHL) of the University of Minnesota
- at least two training specialists, preferably with international training experience, familiar with AID training programs, and with experience in developing training courses in energy-related areas
- at least one representative from the decentralized hydropower private sector (manufacturer, engineering consulting firm, developer, or NRECA member system)
- one or two engineers with considerable experience in designing decentralized hydropower plants in developing countries.

Listed in Training Advisory Committee Candidates (Appendix D-Tab 8) are suggestions for candidates for each of these positions. It is proposed that, once the ST/EY has made a decision about the kinds of training to fund, the TAC members be selected and convene prior to the implementation of any training services. In spite of the time and effort that have already been put into this proposal, much remains to be done. To have sufficient lead time to conduct the training course at the University of Minnesota including advertising the course through the Missions, selecting candidates and trainers, and developing good lecture notes, class, laboratory, and field exercises, it is hoped that the ST/EY will decide quickly that it will fund this course. Schedule for the Training Program (Appendix E-Tab 9) provides a schedule, based on a November 1 funding approval date, for further developing this program and gives target deadlines and meeting dates for the TAC. NRECA believes that the TAC should meet three times each year in November, January, and May.

Resource people

The value of any training program must be judged, at least in part, by the quality of the trainers. For each of the 15 course units it has developed, several resource people have been located who are able to share their extensive expertise in decentralized hydropower development in developing countries and to assist with these training programs either here in the U.S. or in-country. Most of these resource people have

provided technical expertise to developing countries in hydropower or rural electrification as consultants to the SDH Program, through private sector enterprises, or through other development organizations. Many have considerable experience in training. These trainers include:

- members of the SDH Program staff
- other NRECA personnel including trainers from its Management Services and International Programs Division and selected managers and engineers from its member rural electric systems, many of them whom have considerable in-country experience
- staff of the SAFHL, the staffs of the various engineering departments, the Agricultural Economics Department, and the International Students Office of the University of Minnesota
- staff of other academic institutions such as the University of Missouri-Rolla's Department of Engineering Management and Colorado State University's engineering departments
- decentralized hydropower specialists including civil, mechanical, electrical, and chemical engineers, hydrologists, economists, institutional advisors, and developers from the private sector
- U.S. equipment manufacturers such as Allis-Chalmers, The James Leffel and Company, and General Electric, and several of the smaller U.S. manufacturers of hydropower equipment
- multilateral and private lending institutions including the World Bank and the United Nations
- other sources of decentralized hydropower expertise such as the U.S. Corps of Engineers, TVA, and U.S. Bureau of Reclamation.

For the Overview Course, resource people will be selected to teach those elements of a course unit with which they are most familiar. Therefore, for some course units, there may be several people tapped to teach particular elements either individually or as part of a team. Resource People (Appendix F-Tab 10) lists the resource people alphabetically and provides a brief biographical sketch of each, except for the SDH Progam staff and the SAFHL staff, whose resumes are included in Appendixes G-Tab 11 and H-Tab 12, respectively. In addition, Allocation of Resource People by Course Unit (Appendix I-Tab 13) shows graphically which course units each resource person is qualified to teach for either of the training programs.

Resource materials

Appropriate resource materials will be selected by the SDH staff with assistance from the TAC, the coordinating staff of the SAFHL, and other trainers. These materials will include references to supplement original lecture notes developed for this program. Course materials will include:

- SDH Program publications (completed portions of the Micro-Hydro Sourcebook; Quito, Bangkok, and Abidjan workshop proceedings; environmental and hydrologic methodologies; special studies on management evaluation criteria, productive uses, and economics; and audio-visual materials including decentralized hydropower films and selected slides from sites the SDH Program staff has visited or assisted in developing)
- Rural Electrification Administration bulletins and end-use promotional materials
- manuals prepared by U.S. consulting engineering firms and developers
- decentralized hydropower publications used for academic courses
- publications the SDH staff have acquired on various aspects of small and micro-hydropower in developing countries
- training materials prepared for other NRECA management and rural electrification courses
- manufacturers' brochures, slides, films, and other training materials
- original lecture notes prepared for each course unit
- maps
- instruments for survey and measurement
- specially designed class, field, and, where appropriate, laboratory exercises.

A more complete listing of the resource materials for each course unit can be found in Resource Materials (Appendix J-Tab 14).

Classroom, laboratory, and field exercises

To be meaningful, training programs should not be limited to a series of classroom lectures. In technical instruction, knowledge gained from doing things is generally more valuable than abstract principles learned in listening to lecture after lecture. The classroom lecture approach may be particularly ineffective for training developing country nationals. Many may have been out of college and removed from the academic atmosphere for many years and may be away from their home country for the first time. Therefore, they may find it difficult to adjust to a classroom context. Some may find it difficult to interrupt a lecture session when they do not understand something;

some may even be reluctant to participate in a class discussion at all. Cross-cultural communication problems, between the resource people and even between the participants themselves, may further complicate the learning process. Even when these problems are overcome, however, the participant may still have difficulty relating the learning to his own needs and the context of his role in his country's decentralized hydropower program.

To help overcome these problems, the courses offered in this proposal are specially designed to include:

- hands-on training using the facililties at the St. Anthony Falls Hydraulic Laboratory and equipment in several nearby operating decentralized hydropower facilities (for the U.S.-based training program)
- field trips to nearby facilities (in-country and U.S.-based)
- small discussion groups led by qualified resource people (in-country and U.S.-based)
- one-on-one assistance from resource people and, in the case of the U.S.-based training, student assistants from the University of Minnesota's graduate engineering programs, particularly for tutoring those experiencing difficulty in understanding certain elements of the course units (in-country and U.S.-based)
- class, laboratory, and field exercises (in-country and U.S.-based).

Each course unit will include as many of these aids as necessary to:

- draw the participant out and encourage him to invest something of himself in the training program
- highlight aspects of each course unit that are of particular importance to the establishment of successful decentralized hydropower programs in developing countries
- require the participant to build on and draw from what he has learned from the preceding course units.

For the U.S.-based training course, the class, laboratory, and field exercises will be based on a case study. Site characteristics, hydrologic and cost data, and other pertinent information will be provided at the beginning of the course. If possible, this data will match the characteristics of a hydropower site the participants will visit during the six-week course. If this is not possible, realistic data of a typical hydro project will be developed to serve the widest possible set of circumstances in a developing country context. The same case study will be used for all the exercises. In some cases, the participant may have to derive his own figures (i.e. gross head based on measurements taken in the field).

For the in-country program, a similar approach will be taken for exercises developed for each course unit taught. Data for these exercises ideally will be supplied by both the host country government and the AID Mission where possible, based on an actual site(s) within the country, preferably near the training site. The exercises for each course unit are described in more detail in Classroom, Laboratory, and Field Exercises (Appendix K-Tab 15).

Developing these exercises and field trips will represent a considerable task; but if these training programs are to be truly effective, the SDH Program staff believes they will be necessary.

Because of the dearth of appropriate and up-to-date decentralized hydropower reference material for training purposes, it is proposed that selected lecture notes, original material prepared for the training program, and classroom, laboratory, and field exercises be edited and published in book form by the SDH Program staff to serve as a formal training manual. Much of the material for such a manual has already been collected by the SDH Program staff.

U.S. private sector participation

The SDH Program staff believes that the U.S. private sector (equipment manufacturers, developers, engineering consulting firms, and NRECA's member rural electric systems throughout the U.S.) is a resource that can greatly enrich the quality and effectiveness of these training programs. By sharing their technical expertise and their experience in developing decentralized hydropower plants in-country, members of the private sector can impart to the trainees practical developmental and appropriate managerial techniques. This assistance can take many forms, including:

- participating in the development of the training programs
- serving as instructors for training course units
- acting as sponsors and hosts to trainees interested in extensive "hands-on" training through an "internship program" in any of a number of topic areas such as manufacture of turbines, design of decentralized hydropower plants, or rural energy system management
- acting as guides for extended tours of manufacturing plants and operating decentralized hydropower sites, sites under development, and sites using U.S.-manufactured equipment
- providing on-site technical assistance at sites under development within the developing countries

- contributing financially to these training efforts, directly or indirectly, by providing materials and speakers.

During its recent Seminar on Private Sector Participation in Decentralized Hydropower Programs in Developing Countries, held in Washington July 27-28, 1982, participants representing the key segments of the private sector indicated their willingness to cooperate with planned SDH Program training endeavors. The SDH Program staff feels strongly that this assistance will measureably strengthen any training program it undertakes and proposes to draw heavily on this resource for both its U.S.-based and in-country training services.

Marketing training programs

There is an element of training to much of the work that NRECA has undertaken. Generally, host country counterparts accompany team members the SDH Program has sent into the field to provide technical assistance to a particular country, thereby gaining on-the-job training in both conducting a site assessment and learning how to develop a more feasible organizational structure. Moreover, the three regional decentralized hydropower workshops NRECA has planned and managed have been useful training tools as well.

The SDH Program plans to assist the ST/EY in publicizing these programs by:

- sending a circular cable to each of the AID Missions through the ST/EY
- notifying the regional bureaus and other offices within AID
- notifying other development agencies, such as the World Bank, Peace Corps, and United Nations, which may have individuals they want to have trained
- notifying other organizations with interests in training, such as Appropriate Technology International and Intermediate Technology Development Group
- developing an attractive brochure to send to selected individuals, organizations, and engineering trade journals
- including these programs in the NRECA/IPD training catalogue, currently under development, outlining all the training programs available through IPD (this catalogue will be mailed out or carried by teams or individuals from NRECA traveling to developing countries, and shared with host country governments)
- perhaps most importantly, every effort will be made to make training, as part of institution-building, a part of each scope-of-work for any future country work the SDH Program staff undertakes.

The response may be substantial. But, assuming that priorities need to be set, certain factors may make the decision about which countries should participate easier to weigh:

- which countries are truly interested, and how much of a role are the Missions and host country governments willing to take in developing a scope-of-work for the training, selecting candidates, helping organize in-country training, acting as liaison for training program(s), evaluating training efforts, financing candidates, and so on?
- which countries have the most appropriate need, and do they have the right training environment? (i.e. decentralized hydropower resource potential, a national commitment of decentralized hydro program, and substantial bilateral or multilateral funding)
- which countries have the greatest need or have needs which are the most easily assessed and met?
- are there certain countries or areas of particular strategic importance which would influence AID's selection?
- should there be some geographic balance to funding participants and training programs in developing countries to help foster the development of regional training centers?

A careful balance must be maintained among these factors. The SDH Program staff will work closely with the ST/EY staff, regional AID bureaus, and the TAC to establish these training priorities.

Training Costs

Training, particularly effective training, is an expensive and time-consuming activity. However, there are no funds in the current SDH Program budget for training. It is estimated that conducting the Overview Course at the University of Minnesota for 40 participants will cost approximately $200,000. In-country training could be carried out in the range of $50-65,000 per request. Additional costs for the TAC, development of training materials, and publication of the training workbook may add an additional $50,000.

Assuming one session at the University of Minnesota and 3 to 5 in-country assignments, funding requirements for one year is estimated to be $500,000. The Tentative Budget for the Training Program (Appendix L-Tab 16) shows the preliminary estimated breakdown for each of these items.

Although this is a sizeable sum, the SDH Program staff believes it will be money wisely spent and is justified since:

- there is a genuine interest in such training based on requests from AID Missions and host country governments
- the ST/EY evaluation committee, in its report on the SDH Program, repeatedly recommended that the SDH Program add training to its services
- the SDH Program staff is uniquely qualified to develop, manage, and implement such training programs.

From time to time, there may be a need for much more extended, and therefore, more costly training in a particular country. Recognizing this, the SDH Program staff will seek out other funding sources for these training programs to supplement the budget the ST/EY provides for this effort.

The SDH Program staff has developed what it believes is a sound training proposal with the flexibility to respond to diverse needs, that it can judiciously administer the programs as AID's contractor for decentralized hydropower, and that it has the knowledge and expertise to develop them, with assistance from experts in the public and private sectors, into programs that effectively assist developing countries in attaining their goal of energy self-sufficiency.

Introduction

The SDH Program staff believes that the most effective means of training developing country nationals can be with in-country, site-specific training specially tailored to the known needs of the trainees. The U.S.-based training course, on the other hand, meets an immediate, widespread need among managers of decentralized hydropower programs for a broad overview of all aspects of decentralized hydropower developments.

By itself, this general overview does not provide sufficient flexibility to allow timely and responsive training in cases where specific requests are made. A country with a fledgling program may need extensive training in the technical and planning aspects of decentralized hydropower development. A program that has been under development for a couple of years and is about to begin designing small projects may find it needs specialized training in turbine selection for its engineers or training in the economic aspects for its managers, planners, and project engineers. A country with a much more advanced program may require training in turbine design and testing with a view to local fabrication of equipment.

Whatever the need is, the SDH Program staff believes that the 15 basic course units it has developed for use in both training programs can be expanded or modified to meet any of these specialized needs.

This training approach has the obvious advantages of:

- maximum flexibility in course content. No matter how narrow or broad the focus, the SDH Program can field an appropriate training team and equip them with the necessary resource materials and exercises.
- maximum flexibility in timing and duration. The U.S.-based course, because of logistics, must be planned several months in advance. In-country training can be conducted at any time convenient to the AID Mission and host country government. Generally speaking, availability of resource people, unless the training is for more than a few weeks, will be less of a problem since the SDH Program has a large pool of trainers from which to draw. Training programs can be developed for a few days to several weeks in duration. More extended training periods are possible if additional funding - perhaps from sources other than ST/EY - is available.

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- the training needs are clearly defined. At the outset this is done in a "scope-of-work"-like agreement, thereby helping to assure that the selected course units can be tailored for those needs
- more than one kind of training. These services can be provided concurrently
- different levels of training needs for different groups. These can be handled with little difficulty. As an example, for management training, a 4-week course can be arranged with the lowest level management group attending all 4 weeks, and with mid-management and top management attending for shorter periods of time during the course, as appropriate to the level of instruction.

Response mechanism

As mentioned previously, the SDH Program has received several unsolicited requests for training and anticipates receiving many more. A mechanism must be established to handle these requests. The SDH Program staff suggests that the most appropriate response mechanism to handle these requests is similar to that used in handling requests for other technical assistance from the SDH Program:

- a need is perceived
- a request is made
- a decision is made whether to furnish a team
- a scope-of-work is developed
- team members are selected
- the team performs its duties
- the team writes and submits a report on its return.

In the case of the in-country training program, the "need" for training may be:

- perceived by the host country government
- noted by the local AID Mission or other development organizations such as the Peace Corps, World Bank, or United Nations
- seen by an SDH Program team working in the country
- apparent because there has been some new technological innovation or some cost-saving technique developed that should benefit all programs, regardless of their stage of development.

In turn, the request for training assistance may result from any of the SDH Program's publicity efforts, including:

- the circular cable sent through ST/EY
- the NRECA/IPD training catalogue presently under development.
- the proposed training program brochure

- advertising the training programs through the SDH Program regional workshops or seminars.

Training schedule

However the need is felt and the request is made, the process will be the same as with the general schedule, based on the November 1 funding approval date, for handling the requests. The TAC will meet three times during the year in November, January, and May to consider the requests and dispense with other training business. The following is a step-by-step description of how in-country requests will be handled.

Each November, the TAC will meet to establish selection criteria with which to evaluate training requests. These criteria will be based generally on a country's available hydropower resources, the availability of financing within the country for developing these resources, and the training need (i.e. how urgent it is, how easy it is to respond to the need, what length of time is necessary to provide adequate training in the specified areas). The need also may vary from year to year based on AID's overall energy planning and development assistance policies.

The request will also be considered in light of other training that has been provided, with priority given, in most cases, to providing training in a particular topic area already supplied to at least one other country since the cost of developing such programs is reduced by re-offering it on a "standardized" basis. The cost is reduced substantially if the course is already essentially developed, although modifications are easily made to respond to specific conditions or requirements.

In late November, formal announcement of SDH training services will be made through any of the means listed above. However, throughout the year, the SDH Program teams providing technical assistance to developing countries will be responsible for assessing the training needs of the ministry and/or government agencies responsible for developing cost effective decentralized hydropower plants. This information will be invaluable in developing and refining the training programs we provide. NRECA will also be responsible for developing and distributing application packets, including brochure describing program, application forms, technical background questionnaires, to the AID Missions and other interested parties and providing information about kinds of training assistance available, levels of funding, and about other aspects of training offered.

The deadline for all preliminary training requests is mid-December. As initial requests are received, the SDH Program will be responsible for assuring that ST/EY, the TAC, and the appropriate Regional Bureau are kept abreast of the latest training requests.

In late December, the SDH Program will tentatively rank the requests it has received based on the selection criteria the TAC has developed. The ranking process is necessary since requests are likely to exceed available funding. AID Missions will then be contacted to begin developing a scope-of-work for training services requested. It will provide the information it has gathered to the appropriate parties (ST/EY/TAC/Regional Bureaus). It may be necessary, in developing the scope-of-work, to have a training specialist visit the country requesting training, particularly for those countries in which the SDH Program has done no work, to assess the needs, objectives, and level of effort required. Optimally, this will be accomplished by a member of one of the SDH Program technical assistance teams operating in the field in a nearby country. The initial scope-of-work will undergo a refining process as the training needs are probed further.

All formal requests for training assistance, using material provided in the application packets, should be received no later than mid-January.

In late January, the TAC will meet to make the final selection among the training requests received, develop a schedule for providing the training to the selected countries, determine the level of funding for this training, further refine the scopes-of-work based on the 15 Overview Course units and make suggestions about suitable resource people and materials for each.

The SDH Program staff will immediately notify each of the countries requesting training assistance of the final decision. Once notified, the SDH Program will be responsible for finalizing the scopes-of-work, recruiting and fielding training teams, assisting them with locating and developing training materials and class, field, and, where applicable, laboratory exercises, and making the logistical arrangements for the teams. The SDH Program will also be responsible for developing evaluation tools for the training program participants, the training team members, and the AID Mission staff to better judge the adequacy of the training assistance provided. This information will be used by the SDH Program and the TAC to further refine the training programs when the TAC meets the following November.

Schedule for The Training Program (Appendix E-Tab 9) shows a more complete schedule for the training services. Outlined below are two examples of how this procedure would operate, based on an actual and an anticipated request for training by the SDH Program.

Morocco

Morocco has a relatively new small hydro program. Established in 1978, the Office National de l'Electricite (ONE), under Morocco's Ministry of Energy and Mines, proposes

to develop 15 small decentralized hydropower schemes by 1985. Of these, AID is funding 3 which are currently in the preliminary design stage.

Although existing small hydro plants in Morocco compete well with diesel plants (17¢ per kWh compared to some diesel plants which operate at as much as $1.00 per kWh), they are proving to be an administrative problem to ONE. These remote, off-grid plants are far removed from the central management offices. Therefore, responsibility for their operation and maintenance falls under the purview of the field offices of the Interior Ministry. However, its employees have no expertise in maintaining these plants and require assistance from ONE, headquartered in Casablanca, in trouble-shooting any problems that arise. ONE, on the other hand, which is responsible for managing much larger plants (those over 300 kW), has limited staff resources of its own and, consequently, tends to ignore these much smaller isolated schemes. As a result, Morocco's small hydropower plants, particularly the very small, isolated schemes, do not operate effectively.

In April, Gary Bricker of the Technical Projects Office at the AID Mission in Rabat, Morocco, requested NRECA's assistance in providing training to the junior-level technical staff in ONE and the Interior Ministry. It was his assessment that, rather than technical training, the real need is for training in administration and finance for both ONE and the Interior Ministry.

The SDH Program staff believes that a training program can be developed to assist Morocco in more effectively planning and administering its remote small hydropower systems. However, more information is needed before a training program can be developed to respond to these needs. Fundamental issues must first be addressed:

- in the area of administration, does Morocco need a specific management model (decentralized to administer the small hydropower plants in the more remote rural areas) or more general training in operation, maintenance, and management of isolated rural energy systems?
- in the area of finance, is the problem more with financial planning and revenue projection or with day-to-day accounting techniques and bookkeeping and billing procedures?
- what does the host government and the AID Mission hope to achieve with this training?

Other logistical questions must be answered as well:

- how many people need to be trained?
- what is their level of expertise and what are their current responsibilities?
- what training have they had (i.e. are they engineers)?

- where will the training be conducted?
- what is the best timing for this training for all parties concerned and what length of time is needed to adequately train them?
- although Bricker indicated that the Mission would pay for the training, does that include all training costs or only part of them?
- is there a training specialist working for any of the parties involved who could assist with any of the training components, and could not only assist with, but also learn from, the training to better equip him to provide training assistance, assess training needs, or develop training programs in the future?

If ST/EY and NRECA determine that this training would be particularly useful, a scope-of-work will be developed. Much of the information required can be gathered through correspondence or by cable. However, it would be invaluable to have someone, particularly an SDH Program staff member, work in-country with the AID Mission personnel and ONE and Interior Ministry officials to:

- better analyze, first-hand, Morocco's training needs
- set training goals, wherever possible for each of the trainees
- develop a preliminary scope-of-work outlining kinds of training and kinds of trainers needed, level of effort for each, those to be trained, details of the logistical arrangements, and make other such determinations, on the spot.

Rather than sending someone to Morocco for just this purpose, however, NRECA proposes a stop-over in Rabat be scheduled as part of another trip by one of its staff. For example, Allen Inversin will travel in October and November to Burundi to provide technical assistance to that country. Inversin, having assisted the AID Mission in Rabat previously, is familiar with the parties involved and the small hydropower program in Morocco, knows the country, and, based on this familiarity, can more readily assess the training needs and how to respond to them.

Based on the information gathered, the SDH Program staff, in collaboration with the TAC, will consider the request, and, if the request is deemed worthy of the time and cost:

- the scope-of-work will be refined
- appropriate course units (very likely Course Unit 14—Introduction to Administrative Planning and Implementation and perhaps Course Unit 15—Organizational Development and Management Considerations) will be selected
- trainers will be selected to provide the training in these areas in French, if necessary, from the SDH Program's ever-expanding cadre of skilled training experts

- appropriate course materials will be selected based on the final scope-of-work, and others will be gathered and/or developed
- class and, if appropriate, field exercises will be tailored for the training course
- the team will meet with the SDH Program staff prior to their departure and will spend the necessary time (depending on the length of training needed) preparing for their trip
- upon arrival in the host country, the team will meet with the AID Mission personnel, ONE and Interior Ministry officials assisting in developing the training program, including any on-site training expert, to finalize the training agenda
- after the training has been conducted, with at least partial attendance by Mission personnel/ONE/Interior Ministry officials, the training team will meet again with the Mission and host country officials to evaluate the training provided

This evaluation process will continue after the team has returned to the U.S. The team will prepare a report outlining the strengths and weaknesses of the training program as they perceived them to better tailor future training programs NRECA provides. NRECA believes that this process of developing a training scope-of-work, refining it, and then refining further, is a reiterative process that will be essential to developing truly effective and responsive training programs.

Pakistan

In Pakistan, the Water and Power Development Authority (WAPDA) provides electrical power throughout a large area of the country with the national grid system. But because of the rugged terrain and the scattered, isolated nature of the population to be served in the northern part of the country, penetration of the national grid into that area is difficult. In addition to the cost of extending the grid into the area, there is a national shortage of generating capacity. However, 56% of Pakistan's hydropower capacity is located in the area, mostly from the Tarbela site located at the southern edge of the mountains. 100 MW of small hydro potential, enough to meet the energy needs of the area, has been estimated for the more populated portion of the northern region. Only a very small portion of this potential has been developed to date.

In 1974, in an attempt to assist the development of this potential, the federal government ordered 100 standardized turbogenerating units. WAPDA developed mini-hydropower sites in the northern portion of the country using some of these units but these were costly undertakings and required a number of years to implement. The

remainder of these units were turned over to various agencies in the northern portions of the country so that they might undertake future developments. In the North West Frontier Province (NWFP), the Irrigation and Public Health Engineering Department is one of the organizations which received a number of these units. They are presently installing their first plant (2 x 100kW) near Kalam in the upper Swat Valley to serve some 8,000 people.

In the early 1970's, the Appropriate Technology Development Organization (ATDO), under Pakistan's Ministry of Science and Technology, began to develop a much more cost-effective approach to installing micro-hydro schemes. Using locally available materials, simple designs, locally fabricated equipment, and labor provided by villagers, the ATDO has, over the past 5 years, developed approximately 40 sites with capacities of 5-20 kW each in the NWFP. However, very limited staff and resources are available to continue implementing these micro-hydro schemes. With the successful work to date with the design and implementation of these schemes, the ATDO is eager to have other agencies carry on the work so that they can continue with their mandate (i.e. research and development work).

In the NWPF, the Irrigation and Public Health Engineering Department is expanding the scope of their work, in both mini- and micro-hydro, and have recently set up a Power Wing to undertake this work. WAPDA has recently detailed two engineers, for at least three years, to the Power Wing to assist with the running of that program. But several obstacles hinder progress in this area. These include the lack of:

- trained personnel
- economically viable designs
- effective, tested implementation strategies for developing this potential.

The AID Mission has committed about $2 million to assist Pakistan over a five-year period in overcoming these and other problems and to effectively harness this resource. The project paper, with which the SDH Program assisted, outlines the proposed assistance that will be required in addressing these problems. It has targeted two organizations within the NWFP to develop this hydropower potential. ATDO will continue to focus on small hydro research and development and the provincial Irrigation Department will focus on implementing both micro- and mini-hydropower schemes. Each of these elements requires training assistance in one form or another.

Although there has been no formal request for training assistance, NRECA believes that it can effectively respond to the training needs sketched by the project paper. Indeed, the SDH Program staff is in an ideal position to assist Pakistan in these areas since Allen Inversin of the SDH staff has been in Pakistan twice (during site visits

last year and during this recent work on the project paper) and is familiar, therefore, with the "players," the organizations, and the strengths and weaknesses of the various approaches to hydro development in Pakistan. Because of his work on the project paper, Allen Inversin has already helped delineate and assess training needs in the two organizations which the project paper team proposes that AID fund.

The SDH Program is thus well-equipped to respond quickly and effectively to a possible formal request from Pakistan for training. As an initial step, it would notify the TAC and proceed to develop a proposal, to include:

- enrollment in the Overview Course (see U.S.-based training program, Tab 4) by the two engineers from the newly formed Power Wing of the Irrigation Department who will be responsible for developing the micro- and mini-hydropower program and designing and implementing 20 schemes within the five-year project period
- organize and manage a tour of hydropower facilities for these two engineers in Nepal (Butwal Engineering Works and the Development and Consulting Services, which have employed a private sector approach to small hydropower development, and the Small Hydel Development Board, a government agency responsible for small hydro development), Philippines (National Electrification Administration, which has a very large program using a country-wide approach and is looking at local manufacture), and Thailand (which has installed a number of small hydro schemes, including some that are utilizing locally fabricated turbines)
- develop a tour, perhaps following the Overview Course, of U.S. small hydro equipment manufacturers to learn more about what equipment is available which might suit their needs
- provide in-country training in turbine selection, manufacture, and fabrication to the engineer at ATDO's proposed Small Hydro Research and Development Centre. He will be responsible for selecting a workshop and developing that workshop to manufacture turbines and related equipment. Training will expose this engineer to skills, techniques, equipment, and materials needed to "set up shop". Training in turbine manufacture might also include an internship program of perhaps several months' duration (as described in Tab 4) with a U.S. small hydro equipment manufacturer
- develop an in-country training program for other Irrigation Department and Power Wing engineers in the areas of:

  institutional arrangements

turbines design, selection, and manufacture

electrical system design and distribution

management aspects

operation and maintenance

preparing bid specifications.

Once the initial scope-of-work was developed, the general "response mechanism" outlined above would take place:

- send tentative scope-of-work for appropriate parties (ST/EY, TAC, Regional Bureau, AID Mission, host government)
- continue refining scope-of-work based on contacts with above parties
- rank Pakistan's request for training along with others received
- make final decision about whether to train in Pakistan; if request is approved, develop schedule for training, select appropriate course units, and recommend resource people
- tailor class and field exercises to Pakistan's needs
- make logistical arrangements for team and trainees
- develop evaluation tools for the different facets of training provided
- evaluate training based on input from trainers, trainees, TAC, and Missions.

Pakistan will be embarking on an ambitious plan and will need training in a number of areas. NRECA believes it can effectively assist Pakistan with much of its training needs.

Expedited response

The SDH Program is not "locked into" the response mechanism described previously in this proposal. Instead, this expedited response process permits the SDH Program staff maximum flexibility in responding to training requests in a matter of weeks.

Although the SDH Program staff expects that most of its requests for training can be accomodated by the training schedule outlined above, it recognizes that there will be special cases in which a quick turn-around response is required, particularly for in-country training, until the Program and its procedure can be formalized. The SDH Program is prepared to handle such requests as rapidly as necessary. NRECA's Expedited Response Process for In-Country Training (Appendix M, Tab 17) shows schematically how such a response will be handled.

Generally, the process will include the following steps:

- a request for immediate training is received (week one)

- the SDH Program works with ST/EY, the appropriate Regional Bureau, the Mission, and host country government to develop an effective training program based on the initial training request; selects from the 15 units described for the Overview Course those units which most closely address the country's needs and tailors them to match those specific needs; and sends draft program to TAC for review and to Mission and host government (week two)
- continuing to work closely with AID and the host government, the SDH Program staff develops selection criteria (i.e. requirement of technical background, engineering degree or requirement for several years of management experience) for trainees based on the program it has designed; requirements are forwarded to TAC and to Mission/host government (week two)
- resource people are selected, drawing from SDH Program talent bank of specialists, academicians, and others from the private sector, where appropriate, with training experience in the topics to be covered in the training program; lists of resource people are sent to TAC, one Mission, and ST/EY for review (week three)
- consistent with both the program outlined and the requirements for trainees, the host country government submits candidate trainees to the local Mission, which forwards names to SDH Program through ST/EY; SDH Program staff notifies TAC of candidates interested in training program (week three)
- SDH Program makes logistical arrangements (i.e. travel and per diem arrangements) for in-country training (week four)
- the SDH Program staff, with input from other parties including AID, designs training exercises for the classroom, field, and laboratory, gathers pertinent training and reference materials, works with resource people to develop original lecture materials and notes (week four)
- the TAC members review the resource materials and training candidates and makes final determinations on each (week four)
- the Mission and host country government coordinate with SDH Program staff to secure feasible in-country training location and conference facilities (week four)

Once training has been conducted, resource people write an evaluation report outlining strengths and weaknesses of the services provided, and the TAC, along with the trainees, Mission personnel, and host country government personnel, evaluates the training program to help refine the SDH Program's response to future training requests.

Summary

To meet the urgent need for training of those in developing countries responsible for managing their nation's decentralized hydropower programs, NRECA's SDH Program proposes the intensive, six-week, multi-disciplinary training program outlined below to be conducted at the University of Minnesota. A more detailed description of this training program follows.

Goal:	to better equip managers of decentralized hydropower programs, particularly those with fledgling programs, to run them effectively
Trainees:	especially designed for managers of decentralized hydropower programs in developing countries, but useful to individual project managers, planners, and project engineers as well
Curriculum:	six-week, intensive, multi-disciplinary program on all aspects of decentralized hydropower development featuring hands-on training and tours of nearby hydropower plants and sites, and utilizing case studies and specially designed exercises
Resource people:	SDH Program staff, University of Minnesota faculty, as well as faculty from other academic institutions, specialists in the field of hydropower incuding those associated with NRECA's member systems, and equipment manufacturers and others from the private sector
Resource materials:	original lecture notes and problem session materials prepared for the training program, SDH Program and other publications
Costs:	approximately $1,000 per student, per week
Timing:	six-weeks in late July through early September prior to the beginning of the 1983 academic year
Location:	University of Minnesota, Minneapolis, Minnesota

Trainees

This training service is designed to meet the needs of managers of decentralized hydropower programs in developing countries. Very likely, though charged with the responsibility for establishing a viable decentralized hydropower program in his country, a candidate is relatively new to hydropower. He may be trained as an engineer and will probably have considerable experience in the electric power sector, having likely come from the national Ministry of Power or Energy or from a local electric utility. He needs to have a good grasp on a whole range of issues.

His responsibilities are diverse. He may:

- be responsible for developing and managing a new program and must hire the appropriate people at all levels and manage them
- have to develop and manage a workable budget
- have a good general idea of all the likely problem areas
- need to be familiar with the talents, skills, and considerations for each position within his program
- not be involved in the design of turbines, but may well have to write bid specifications and will need to be familiar with the factors needed for proper selection and setting of the turbine
- not design the civil components, but he may need to know cost elements for basic designs of all elements of civil works and the mechanical and electrical equipment.

In short, he needs to know the basics for every element of assessing, planning, designing, operating and maintaining, and managing decentralized hydropower projects. This training program takes into account the dangers of becoming bogged down in the day-to-day, nitty-gritty details of program development to the exclusion of the overall picture. Although this course is designed with the manager of a developing country decentralized hydropower program in mind, others, including individual project managers, planners, and project engineers, will also benefit.

Generally speaking, this training program has certain advantages:

- it can be managed easily from the U.S.
- a relatively large number of people can be trained at one central location
- once the program has been fully developed, it can be repeated with relatively little fine-tuning after each session based on the evaluations of the program attendees, the trainers, the AID Mission, and the host governments.

Participants will be nominated for this training by the appropriate host country government ministry or agency with purview over decentralized hydropower programs in

that country. The AID Mission will be responsible for assuring that each nominee:

- has the appropriate technical background in engineering and economics
- has a good working facility for English (participants, for example, should be able to achieve a score of 550 on the Test of English as a Foreign Language)
- is responsible for managing his country's decentralized hydropower program, or is in a position to benefit otherwise from this training
- can reasonably be expected to return to his home country to use what he has learned.

Once these prospective participants have been nominated, staff from the SDH Programs, ST/EY, and the TAC, will make the final selection. The SDH Program hopes to train 30-40 participants in 1983.

Curriculum

NRECA proposes a six-week Overview Course consisting of a two-day orientation period, which is followed by an introduction and overview of the full range of topics to be dealt with during the course. This is then followed by a series of 15 intense units covering the fundamental elements of planning and implementing a small hydro project. The two-day orientation period, to be conducted with assistance from experts in cross-cultural communications, will be designed to help acquaint the participant with his new surroundings (not only the University, but Minneapolis as well), and to help prepare him to participate actively in the training course. It will include:

- tours of the University and its facilities and a quick tour of Minneapolis-St. Paul
- introduction to the coordinating staff for the program
- information on cultural and extra-curricular activities, restaurants, banking, hospital, and other emergency facilities
- time for each delegation from each of the countries represented to make brief presentations on their decentralized hydropower programs and their strengths and weaknesses.

The introduction and overview are essential to familiarize managers with the factors crucial to successful implementation of a decentralized hydropower scheme. This section will summarize how the course will be conducted and what will be expected of the participants. It will also highlight particularly troublesome problems common to many decentralized hydropower programs in the developing world. The 15 course units will include lectures with notes provided, discussion and problem-solving sessions for each topic, and hands-on training using the University's facilities and nearby small hydro

sites. Resource people and student assistants from the University's graduate engineering programs will work closely with the participants, providing additional assistance during and after class hours to those who find particular segments of the course especially difficult to grasp. U.S. manufacturers of small hydro equipment will make presentations on their available equipment, their experiences with decentralized hydropower plants utilizing their equipment, and the services they provide. The course will end with a two-day review and evaluation of the course.

Tentative Weekly Schedules for U.S.-Based Training Program (Appendix N-Tab 18) provide a day-by-day outline of each day's activities. These schedules are tentative, but show graphically how the course will be taught, the relative importance ascribed to each course unit and its elements, and how exercises and field trips are included as part of the six-week course. Because of the problems of cross-cultural communications, more time is provided for each of the course units than would be normally expected which will allow for more repetition and class discussion, as well as time for course exercises.

Classes run from 8:30 a.m. to 5:15 p.m. each day, Monday through Friday. The day is broken down into eight 45-minute segments with a 15-minute break in between segments and an hour and 15 minutes for lunch.

Efforts will be made by experienced faculty to focus the technical instruction on problems indigenous to developing countries and to address each of the topics described in detail in Course Unit Listing and Descriptions (Appendix C-Tab 7) in small decentralized hydropower terms.

SDH Program role

The SDH Program staff will be responsible for the overall implementation of this training program. Their duties will include:

- coordinating with the AID ST/EY and other relevant offices, the TAC, AID Missions, developing countries, and the University of Minnesota in the development and implementation of the training program
- designing and developing courses targeted to participant's needs
- promoting the training program and recruiting appropriate candidates
- assisting in locating and providing final approval for selecting faculty
- responsibility for teaching elements of each of the course units
- overseeing development and final selection of course materials, including lecture notes, and classroom, laboratory, and field exercises
- monitoring the training program to assure that it operates effectively

- managing the training program on a day-to-day basis, including providing a training specialist on-site before and during the entire six-week program to assure that the program runs smoothly (i.e. that necessary materials are available when needed, that the course units are presented according to the time table, and that logistical arrangements are in order)
- developing evaluation tools and conducting a follow-up evaluation of training effectiveness
- refining successive training courses based on perceived strengths and weaknesses articulated in evaluations of training effectiveness
- coordinating per diem and travel arrangements
- coordinating and preparing lecture notes and field and class exercises materials, and overseeing development of looseleaf notebooks containing class materials.

Costs

The SDH Program anticipates that the per student, per week cost will be approximately $1,000 excluding air travel (which is to be paid by the AID Mission or host government). Tentative Budget for Training Programs (Appendix L-Tab 16) shows the estimated breakdown for the costs for this training program. These are only preliminary cost figures. More precise costs will be available once the final format for the six-week has been determined, decisions about housing and per diem have been made, and resource people have been selected to teach each course unit. Final costs, of course, cannot be provided until the exact number of candidates is known. However, we do not anticipate that the cost will be greater than $1,000 per person per week.

Timing

NRECA and SAFHL believe that the period immediately preceding the academic year, in late July through early August, is the most appropriate time to conduct this training permitting trainers and participants more flexibility because of summer leave. However, this training program can be arranged at other times of the year if deemed necessary.

Follow-up evaluations

To better tailor this training program to developing countries' needs for future sessions, NRECA proposes to conduct follow-up evaluations of its training methods, course content, trainers, and materials. Trainees, at the end of the program, will complete a questionnaire designed to draw out its strengths and weaknesses. A similar

questionnaire will be sent, after an appropriate period of perhaps 6-9 months, to the supervisor of each trainee to canvass their reactions to, and impressions of, the quality and effectiveness of the training. In addition, AID Mission personnel familiar with participants will be surveyed for their impressions.

This information will then be used to refine the training course content, approach, and materials for the next year's program. NRECA recognizes that, because there is a limited number of decentralized hydropower programs throughout the developing world, this course, as designed, will be useful for only a short time (perhaps 2-3 iterations). The focus or thrust of the course each year, therefore, will change as will the course units and training materials. This will require constant evaluation and refinement of the training elements.

University of Minnesota

To locate an appropriate site for this course, the SDH Program staff visited several universities including the University of Minnesota, Colorado State University, University of Missouri-Rolla, Appalachian State University, and the University of Idaho.

In selecting the most appropriate university as the location for this training program, NRECA considered the following requirements:

- existence of appropriate, well-trained faculty including engineers, hydrologists, and economists
- access to nearby small hydropower demonstration sites and on-campus hydropower equipment for hands-on training
- existence of a well-established international student program and experience in dealing with foreign students
- adequate classroom facilities
- good local ground transportation and proximity to a major airport
- access to support facilities including dormitories, motels, restaurants, banking facilities with foreign exchange capabilities, and translators.

Based on these requirements, NRECA believes that the University of Minnesota is the best location available for this U.S.-based cours.

For over 40 years, SAFHL of the University of Minnesota has conducted contract research for a wide range of clients including Federal, state, and local government agencies, private consulting firms, and other private groups. The research has covered a broad spectrum of interests, from basic research in hydromechanics to applied research on hydraulic structures, and has included both mathematical and physical modelling.

Much of the physical modelling work has been related to various aspects of hydropower development.

Located on the Mississippi, the Laboratory is an excellent training facility which includes a 90-seat capacity auditorium and is located near several operating small hydro plants. Some years ago, a low-head hydropower plant adjacent to the Laboratory was retired by the local power company. Because of its historical value and its location in an area of Minneapolis undergoing restoration, a feasibility study was completed for converting the building into a hydropower museum and an interpretive center for hydropower development in Minnesota. The Laboratory was one of the organizations actively involved in this study.

The Laboratory is currently rehabilitating and installing a turbine test facility donated by Allis-Chalmers. The donation includes:

- components of Test Stands 1, 2, and 3 to be selected by SAFHL; these test facilities were previously used by Allis-Chalmers for acceptance tests of model turbines; the components include tanks, pipes, valves, flow meters, one 300 hp motor and pump, a vacuum pump, controls, and a 100 hp dynamometer
- a portion of the test stand disassembly costs
- engineering expertise in the design, erection, and commissioning of the facility
- one model hydraulic turbine with previously developed performance curves for facility verification.

This donation has been estimated by SAFHL to be worth $350,000. The equipment donation is the first part of a multi-step process in developing a facility which may be used for research and testing. SAFHL has been granted $122,000 for the design and some of the installation costs of the turbine test facility by the Minnesota Energy Agency and Legislative Commission on Minnesota Resources (LCMR). The turbine test facility will be housed in a structure added to the existing Laboratory. Maximum versatility is a goal of the current design. SAFHL plans to have this model test stand in operation for hands-on training by next summer.

The configuration of the facility has been redesigned to enhance considerably its capability for research, testing, and operational instruction on a wide variety of turbine arraignments. The facility is capable of handling turbines with up to 100 hp capacity.

Some of the potential research topics which may be addressed with the turbine test facility are:

- the development and testing of new turbine or pump-turbine concepts and intake and outlet designs

- model tests for small manufacturers; there are currently many small manufacturers producing turbines with no testing facilities; the result is a prototype trial-and-error development which is costly and inefficient; an independent turbine testing facility could perform model tests for these small manufacturers
- acceptance tests for turbines, pump-turbines, and pumps
- training of hydropower operation engineers with the test facility; this will augment the hydropower education program currently being developed by the Laboratory, and will be a valuable component of the SDH training program
- cooperative research with manufacturers.

SAFHL points proudly to this turbine testing facility as the only one of its kind operated by an independent organization in the U.S. This capability, combined with 43 years experience in hydrodynamics and hydraulic engineering research, makes the University of Minnesota an excellent institution with research, education, and testing services for the hydropower community.

The Laboratory has recently completed a study for the Minnesota Energy Agency on the Preliminary Hydropower Production Feasibility at Twenty-One Existing Dam Sites in the State of Minnesota. Subsequently, the Minnesota Department of Natural Resources funded a grant to the Laboratory for comprehensive hydropower feasibility studies on eight publicly-owned dams in the State of Minnesota. The comprehensive feasibility studies involved detailed analysis of the site hydrology, condition of the structure and associated equipment, selection of suitable modern turbines, economics, and environmental aspects. Three of these feasibility studies have been completed; the others are in progress. The Laboratory is also performing a hydropower feasibility study on an existing dam site for the Northern States Power Company.

The Laboratory has recently been awarded a three-part Hydropower Research Grant from the State of Minnesota LCMR to survey the hydropower potential at 885 existing dam sites in the state of Minnesota, to streamline the required environmental investigations for hydropower facilities, and for research directed toward improved hydropower technology. Recent research at SAFHL related to power generation is listed in Recent Research at SAFHL (Appendix O-Tab 19).

The Laboratory has also recently sponsored its second four-day intensive short course in small hydropower, "Small-Scale Hydropower Development," July 25-29, 1982, which required expertise in planning, feasibility, and design for small-scale hydropower facilities in the U.S.

SAFHL responsibilities

The SAFHL staff will be an important factor in the success of this training program and is eager to assist in its development and implementation. The SAFHL staff will be responsible for:

- acting as liaison for the training program between NRECA/SDH and the University of Minnesota
- providing staff for teaching elements of course units, laboratory exercises, and field trips
- monitoring classes on a daily basis
- handling all laboratory exercises
- doing advance work for all field trips
- locating and providing close supervision to student assistants from graduate engineering programs working with training program
- assisting with TAC planning and evaluation
- providing a conference contact, from the Department of Conferences and Continuing Education, during planning stages to assist with logistical arrangements (i.e. obtaining and forwarding contracts for buses, hotel/dormitory space, classrooms, printing, lecture notes)
- providing conference assistant and secretary, through Department of Conferences and Continuing Education, two weeks prior to workshop and during workshop
- providing tourist information on Minneapolis and University of Minnesota (i.e. maps of each, information on theatres, restaurants, sightseeing)
- providing input into the development of a decentralized hydro training manual based on lecture notes, class, lab, and field exercises.

Other specialized training

Internship program. Based on a recommendation which emerged from the AID/NRECA seminar held recently on Private Sector Participation in Small Hydropower Programs in Developing Countries, NRECA proposes to establish a decentralized hydropower "internship" program. This special supplement to the general training program would consist of internships from two weeks to one year in duration. During this time, a trainee would join the staff of a U.S. small hydro manufacturing facility or small hydro development firm for on-the-job training in the manufacture, assembly, and

servicing of small hydro machinery; or, alternatively, on-the-job training in the development and construction of small hydropower projects in the U.S.

This special service serves a number of needs. It affords developing country engineers an opportunity to gain direct experience in a wide range of activities relating to decentralized hydropower development. In the case of an internship with a manufacturer, the experience would offer a first-hand look at types of workshop equipment, materials, and skills required for local fabrication of turbine machinery as well as their assembly and maintenance. In the case of an internship with a developer, the training focuses on experience in planning, designing, constructing, and financing a decentralized hydropower plant. Although conditions found in U.S. firms are not likely to be duplicated in developing countries, the knowledge gained could certainly be adapted to home conditions for starting up similar capabilities there.

There are secondary benefits as well. U.S. technology remains in high esteem throughout the developing world, despite recent gains by international competitors. The internship program is an excellent opportunity for developing country personnel to become exposed to U.S. equipment and engineering practices, and vice versa. The program also presents opportunities for U.S. private sector firms to develop relationships with developing country officials which may lead to sales of U.S. equipment and services, or possible co-ventures in the manufacture and development of small hydropower systems. Finally, the internship program can provide U.S. firms with access to valuable knowledge in the special needs of developing countries for certain kinds of equipment performance and specifications. Above all, and worth repeating, it offers an excellent basis for on-the-job, direct experience in decentralized hydro development techniques.

The duration of the internships can be varied since certain training needs require greater time than others. Internships of one year, for example, would allow sufficient time for a trainee to closely folow the full range of activities involved in locating a site, developing a plan and design based on feasibility studies, and arranging for financing, materials, equipment bids, and the skilled and unskilled personnel needed to implement the project. Alternatively, a one-year internship would also allow sufficient time for a trainee to participate in the day-to-day implementation schedule beginning with initial surveys and excavations up to the point of connecting the plant to the grid, in most cases.

Shorter internships of several weeks would be sufficient to provide training in casting turbine runners, assembling components, or conducting routine maintenance of plants, to name a few options. It should be pointed out that this service is not akin to formal education exchange programs or visiting professorships at universities. This is not

theoretical training; it is designed to offer practical experience for engineers in the field.

Requests for training would be reviewed in the fall of each year and assignments would be finalized in January, except in cases which require a quick response, which would be handled immediately. Once the requests are made, notification would be sent out to all participating U.S. firms to ascertain the most appropriate allocation of trainees to receiving firms, depending on the timing and nature of their activities during the coming year. Trainees would normally begin their internships by spending a minimum of two days in Washington to visit with NRECA and AID personnel for orientation purposes and to arrange travel and per diem. At the end of the internship period, a trainee to would return to Washington for a debriefing and to submit an evaluation report to NRECA on his experience before returning to his country.

Funding would be supplied by the approprite AID Mission, the host-country, or from the SDH Program training budget. Start-up funding, and possibly other funding, may be supplied by the AID Trade and Development Program or Bureau for Private Enterprise because of the potential of the program for private sector development of decentralized hydropower and possible commercial benefits to U.S. firms. Funding would generally cover the cost of travel and per diem. In general, fees would not be paid to firms receiving the interns, based on initial agreements made during the Private Sector Participation seminar. The total estimated cost of the program would be $1,000-1,500 per week for an internship of short duration and roughly $500 per week for an internship of ten weeks or more.

Study tour. In April and May of 1982 the SDH Program Principal Engineer conducted two Panamanian engineers from the Institute for Hydraulic Resources and Electrification (IRHE) on a 2 1/2 week tour of U.S. small hydropower equipment manufacturers and various hydropower sites throughout the U.S. IRHE is implementing a micro-hydropower program in Panama with AID funding assistance and providing electric service to communities far removed from the existing and planned electric power grid. In 1981 IRHE installed two micro-hydro demonstration sites and plans to install four more over the next two or three years using U.S. equipment.

NRECA developed this tour as part of its training effort. The tour included:

- preliminary briefings with various representatives of AID and the Rural electrification Administration to learn more about both organizations and their programs

- visits to NRECA member rural electric systems to get a feel for rural electrification on the cooperative model
- tours of seven U.S. small hydropower equipment manufacturers' plants, labs, and several small hydropower sites where equipment from each manufacturer was installed (including Allis-Chalmers, The James Leffel and Co., Independent Power Developers, Little Spokane Hydroelectric, Small Hydroelectric Systems, Canyon Industries, and Cornell Pumps)
- a tour of Kettering Laboratory (to see the facilities and observe its fertilizer arc reactor) and the St. Anthony Falls Hydraulic Laboratory at the University of Minnesota to look at its hydraulic and hydropower test facilities

The tour was designed to acquaint the Panamanians with several different U.S. small hydropower equipment manufacturers, to visit their plants and laboratories, to get a first-hand view of turbine manufacture and assembly, and to provide the Panamanians with an opportunity to see firsthand the U.S. equipment in operation. A special training feature involved the development of equipment specifications for bids by several of the suppliers the group visited.

Such tours can be arranged with relatively little lead time, virtually any time of the year, and for a large or small group, or even individuals. Excluding air travel from Panama, the tour cost roughly $2,000 per person for the entire 2 1/2 week period.

Other training. Undoubtedly there will be training needs which cannot be accomodated in-country, because they are so specific (i.e. for just one or two people) or because the training needs do not fit a set training program such as that proposed at the University of Minnesota. The SDH Program is structured to respond to almost any training request by matching training needs with other traditional or non-traditional training experiences. As already mentioned, the SDH Program staff has visited a number of institutions to assess them as potentially suitable locations for training purposes. Although the University of Minnesota is perhaps the best location for the intensive, six-week Overview Course, for the reasons stated, other universities/institutions may be more appropriate for other, more specialized training in the U.S.

For instance, a particular trainee may need training of a more academic nature than the Overview Course proposed at Minnesota. An individual may need an in-depth, year-long course tailored to his individual needs, on particular aspects of management in the engineering field, or may need training in hydraulics, or hydrology.

Although the University of Minnesota could certainly handle a tailored course focusing on hydraulics, Colorado State University, ranked among the top engineering

schools in the country and perhaps the best known university for its water resources program, would also be an excellent location. A short-term course in hydrology might most easily be arranged for just one or two participants at the Corps of Engineers' Hydrologic Engineering Center in Davis, California, which, although not an academic institution, provides training from an entire catalogue of courses. A request to train an individual who needs specialized training in electrical distribution system design and management could perhaps be best handled by the University of Missouri-Rolla, which has the only degreed program in engineering management in the country and conducts an electrical distribution course with NRECA each year.

Through its work in the field, the SDH Program staff knows people in each of these settings with whom it can work to develop more individualized or more tailored courses (for a larger group) whenever necessary.

Appendix A—IPD training experts

This is a partial list of specialists selected from NRECA's member systems who IPD has sent on training assignments throughout the developing world. These experts represent a wide range of fields including civil, electrical, and mechanical engineering, management, and economics.

Name	Member System Location	Country Served
W. E. Adams	Iowa	Philippines
Johnnie M. Ammons	Texas	Vietnam
Jerry L. Anderson	Washington, D.C.	Vietnam
Edgar Arnn	Illinois	Philippines
Clyde Aultz	Washington, D.C.	Brazil, Chile, Colombia, Costa Rica, and Vietnam
Ernest J. Ballard	Utah	Peru
Earl Bates	Washington, D.C. and South Dakota	Argentina, Indonesia, and Egypt
Jon Bellgowan	Washington, D.C. and Minnesota	Philippines
Glen Benjamin	Washington	Costa Rica, Nicaragua, Panama, Tanzania, and Egypt
Everett C. Bristol	Colorado	Brazil, Ecuador, Panama, and Egypt
Philip P. Costas	Washington, D.C.	Bangladesh, Indonesia, North Yemen, Philippines, and Syria
Barbara Deverick	North Carolina	Bolivia, Indonesia, and Philippines
Edward Gaither	Colorado	Bangladesh, Pakistan

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Charles E. Ham	Nebraska	Indonesia, Malaysia,Philippines, Uruguay, and Vietnam
James M. Kiley	South Dakota	Indonesia and Liberia
Lloyd J. Lake	Iowa	Bolivia, Brazil, Colombia, Indonesia, and Nicaragua
Jay D. Lasater	New Mexico	India and Philippines
James Leming	Illinois	Bangladesh
L. M. Lorenzen	Wyoming and Washington, D.C.	Bangladesh, Far East, Ivory Coast, Papua New Guinea, Thailand, and Vietnam
Ray McDonald	Washington, D.C.	Liberia
Peter T. McNeill	Kentucky	Indonesia, Korea, and Philippines
Gilbert F. Moon	Washington, D.C.	Bolivia, Costa Rica, Ecuador, and Nicaragua
John Myhre	Washington, D.C.	Costa Rica and Nicaragua
Vesta L. Orr	Texas	Vietnam, Bangladesh
Charles Overman	Pennsylvania	Liberia, Philippines, and Sri Lanka
Philip Parker	Nevada and Wisconsin	Philippines
Jose Rodriguez	New Mexico	Colombia, Costa Rica, and Nicaragua
James E. Ross	Washington and Florida	Bolivia, Colombia, Ecuador, and Nicaragua
Louie Sansing	Arkansas	India, Nicaragua, Philippines, Tunisia, and Vietnam
Marion W. Schwartz	Washington, D.C. and Mississippi	Argentina and Indonesia
John Scoltock	Washington, D.C.	Bangladesh, Indonesia, and Pakistan

Raymond Shoff	North Dakota	Indonesia, Philippines
Joseph Sloan	Minnesota	Bolivia
James A. Taylor	Washington, D.C.	Argentina, Bangladesh, Bolivia, Chile, Ecuador, Indonesia, Papua New Guinea, Peru, and Vietnam
John Taylor	Georgia	Ecuador, India, Peru, and Philippines
Harry Thiesfeld	Minnesota	Bangladesh and Indonesia
Cecil Viverette	North Carolina	Bolivia
Charles Weaver	Washington, D.C.	Brazil
William C. Wenner, Jr.	Pennsylvania	Brazil, Indonesia, and Philippines
Edward Wheeler	Wisconsin	Bangladesh

Appendix B—NRECA member systems with small hydropower plants

Cooperative	Location	Plant Capacity (MW)
Alabama Electric Co-op	Andalusia, Alabama	5.20
Alabama Electric Co-op	Gantt, Alabama	2.44
Chugach Electric Assn.	Cooper Landing, Alaska	15.00
Metlakatla Power & Light	Metlakatla, Alaska	3.00
~~Copper Valley Electric Assn.~~	~~Valdez, Alaska~~	~~2.00~~
Copper Valley Electric Assn.*	Valdez, Alaska	12.00
Colorado-Ute Electric Assn.	Ames, Colorado	3.00
Colorado-Ute Electric Assn.*	Ouray, Colorado	0.50
Colorado-Ute Electric Assn.	Tacoma, Colorado	8.00
Fall River REC	Felt, Idaho	1.20
Northern Michigan Electric Co-op	Tower, Michigan	0.56
Northern Michigan Electric Co-op	Tower, Michigan	1.20
Sho-Me Power Corporation	Camdenton, Missouri	3.00
Broad River Electric Co-op*	Goffrey, South Carolina	3.90
Moon Lake Electric Assn.	Altamont, Utah	1.20
Garkane Power Assn.	Boulder, Utah	5.20
Moon Lake Electric Assn.	Neola, Utah	0.90
Craig-Botetourt Electric Co-op	New Castle, Virginia	0.30
Dairyland Power Co-op	Ladysmith, Wisconsin	15.00
Oconto Electric Co-op	Stiles, Wisconsin	1.00
Lower Valley Power & Light	Bedford, Wyoming	1.50
Wells Rural Electric Co-op	Wells, Nevada	0.18

*under development

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Appendix C—Course unit listing and descriptions

This appendix describes the 15 course units to be used for both the in-country and U.S.-based training services outlined in Tabs 3 and 4 respectively. In addition to highlighting key elements for each course unit, the rationale for each unit is given (what will the participant gain from this unit?), as well as the developing country focus (what are the particularly troublesome areas in each topic area and how do they apply to the developing country context?). Finally, resource people are suggested as faculty and representative resource materials are given for each.

Course unit and page

1—Introduction to site assessment, 58

2—Hydrologic analysis, 59

3—Energy and power computations, 60

4—Turbine selection, 61

5—Manufacture and fabrication of turbines, 62

6—Electro-mechanical equipment, 63

7—Electrical distribution planning, 64

8—Preparing and evaluating bid specifications for turbogenerating equipment, 65

9—Civil works designs and considerations, 66

10—Cost analysis, 67

11—Demand forecasting and end-use planning, 68

12—Financial analysis, 69

13—Socio-economic analysis, 70

14—Introduction to administrative planning and implementation, 71

15—Organizational development and management considerations, 73

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Course unit 1: Introduction to site assessment

Description: This course unit will focus on techniques in conducting an appropriate site assessment, from the initial survey phase through the feasibility stage, including:

- what kinds of data are essential to conducting an investigation
- how to organize a data search of existing hydrologic, cost, and demographic data, maps, and other materials and sources of pertinent information
- techniques to estimate data if there are no readily available sources at hand
- how to conduct a preliminary selection of sites
- how to assess the environmental and socio-cultural impacts
- and other considerations, such as minimum needs vs. maximization of flow, problems of access to site, proximity to grid, and potential uses and load growth, which the site assessment should focus on.

Rationale: This course unit will provide the participant with a basic understanding of requirements for, and value and application of carefully planned and conducted site assessments.

Developing country focus: Although the need for proper site assessment is not unique to developing countries, the usual problems encountered in conducting a valid site assessment are complicated by the lack of up-to-date, accurate data; unlike in the U.S., where the USGS and Corps of Engineers have kept accurate flow records at gauging stations on many rivers and streams throughout the U.S. for years, and where census and other essential statistical data is available for several previous generations, such data is often unavailable or difficult to obtain in developing countries; therefore, techniques in ferreting out this data, whether through a paper search and/or field investigations, are essential.

Resource people: Allen Inversin, Bard Jackson, Walter Lawrence, John Topik, John Bogert.

Resource materials: Small Hydroelectric Powerplants; Harnessing Water Power on a Small Scale--Local Experience with Micro-Hydro Technology; Micro-Hydro Sourcebook.

Course unit 2: Hydrologic analysis

Description: This course unit covers the hydrologic cycle and its application to decentralized hydropower development, including:

- precipitation
- runoff analysis
- water quality
- stream-gauging techniques, with and without instruments—on-site measuring
- data collection and data requirements
- flow duration curves—what they are, how they're developed, and how they're applied
- techniques to synthesize flow duration curves from limited streamflow records, precipitation data, and watershed charactertics
- the importance of minimum, peak, and mean flows.

Rationale: This course unit will provide participants with a basic understanding of the components of and need for adequate hydrologic analysis.

Developing country focus: Adequate hydrologic data is often unavailable in developing countries, therefore, techniques to estimate and/or collect data are essential; in addition, rainfall in the developing world, particularly in tropical areas, can be very heavy seasonally; torrential rains cause sporadically dramatic increases in streamflow leading to flooding. To avoid washing out the civil works and to avoid damage from boulders and debris in the stream's bed load to trashracks, penstocks, and the turbo-generating equipment, it's important to know the streamflow characteristics. With low-head hydropower plants and, because the head is so low to begin with, variations in flow have a dramatic effect on the head and must be planned for appropriately.

Resource people: David Zoellner, John Gulliver, Edward Bowers, Paul Kirshen, Norman Crawford, A. G. Mercer, Maurice Albertson.

Resource materials: Small-Scale Hydropower in Africa; Hydrologic Estimates for Small Hydroelectric Projects; Manual on Stream-Gauging.

Course unit 3: Energy and power computations

Description: This course unit is an overview of the relationships at a hydropower site of the potential power, energy, and load demand and includes:

- methods to measure gross head, with and without instruments
- relationships between total and net head
- methods to develop and apply headwater and tailwater curves
- how to compute available power and energy based on available head and flow
- how to estimate power use based on load duration curves.

Rationale: This course unit will provide participant with basic understanding of how to measure head and compute capacity and estimate plant factors.

Developing country focus: Choosing the optimum size plant when flow data is very uncertain and the value of energy is unknown requires a more conservative approach than what is normally taken in developed countries.

Resource people: Charles Song, John Gulliver, Paul Kirshen, Walter Lawrence, William Delp, Robert Carroll, Charles Dawsey, Edgar Arnn.

Resource materials: Micro-Hydro Sourcebook.

Course unit 4: Turbine selection

Description: This course unit describes turbine types, performance, and selection and includes:

- description of turbine classifications (the range of turbines available), applications (appropriateness of each for sites), and performance characteristics and efficiencies (head and flow needed for optimal operation)
- description of turbines and packages available from U.S. manufacturers and appropriate applications
- description of cavitation, problems caused by it, method of determining turbine setting to avoid it
- discussion of and model testing and applications
- operation and maintenance of turbines.

Rationale: This course unit will acquaint the participant with the kinds of turbines available, efficiency range of each type, appropriate site applications, and the various sources of U.S. manufactured equipment.

Developing country focus: For isolated operations, as is normally the case for rural installations in developing countries, the turbine must usually operate over a wide range of flow conditions. This tends to make impulse units more attractive than reaction units in developing countries, even though the head and flow conditions may favor a reaction unit. This wide range of flow conditions also favors the use of multiple units at one site. In addition, the turbogenerating equipment is a major cost item in developing a hydropower site, particularly to developing countries which have to use scarce foreign exchange to import expensive equipment and pay to have it shipped, often over vast distances. Therefore, it is essential that, in selecting equipment for a specific site, that care is taken to assure that the most appropriate equipment is selected.

Resource people: Roger Arndt, Cesar Farrell, John Gulliver, Joseph Wetzel, Allen Inversin, Howard Mayo, John Brown, Fritz Neumann, William Delp, Michael Johnson, Daniel New.

Resource materials: Directory of Sources of Small Hydroelectric Turbines and Packages; manufacturers' brochures, slides, and films.

Course unit 5: Manufacture and fabrication of turbines

Description: This course unit outlines the elements needed for manufacture and fabrication of turbines, including:

- what kinds and level of skills are needed for designing, fabricating, casting, foundry work)
- what are the typical problems associated with each (problems with designs, metals, quality control)
- what kinds of materials are required and where can they be obtained
- what are the steps involved in fabrication/manufacture/casting
- when should a region consider local fabrication
- what workshop equipment is needed and what support services are required.

Rationale: Participants will learn the basic elements of fabrication/manufacture/casting of turbines.

Developing country focus: Although there is much interest in developing countries in local manufacture of turbo-generating equipment, particularly because of the enormous cost of importing such equipment, very few developing countries now have the skills, equipment, materials, and designs necessary for developing such equipment. Some designs, however, have been modified to cater to the skills available in developing countries, for application at small schemes where the turbine cost is more significant.

Resource people: Mohammed Abdullah, Jaime Lobo Guerrero, Rupert Armstrong Evans, Butwal Engineering Works, William Kitching, William Delp, Michael Johnson, Robert Yoder, Reinhold Metzler.

Resource materials: Micro-Hydro Sourcebook; Harnessing Water Power on a Small Scale--Local Experience with Micro-Hydro Technology; Small Water Turbine--Instruction Manual for the Construction of a Cross-Flow Turbine; A Pelton Micro-Hydro Prototype Design; Small-Scale Hydropower in Africa.

Course unit 6: Electro-mechanical equipment

Description: This course unit is an overview of the components of the electro-mechanical equipment and the function of each, including:

- generators
- electronic governors, and load controllers
- switchgear
- transformers
- description of problems of interconnections
- operation and maintenance of electro-mechanical equipment

Rationale: This course unit will enable participants to select and specify the appropriate electro-mechanical equipment.

Developing country focus: Isolated rural communities generally don't need sophisticated frequency and voltage control as is provided on standard packages because such communities are generally not using the power for appliances which need an accurate frequency reference such as televisions, clocks, and record players.

Resource people: Bard Jackson, William Thompson, Jack Woodward, Woodward Governors, Charles Dawsey.

Resource materials: Small Hydroelectric Powerplants; Small Decentralized Hydropower for Asian Rural Development; Small-Scale Hydropower in Africa; Directory of Sources of Small Hydroelectric Turbines and Packages; REA bulletins.

Course unit 7: Electrical distribution planning

Description: This course unit provides an overview of system planning for electrical distribution systems, including:

- strategies for system planning including long-and short-range forecasting methods, and planning methods and techniques
- system design details including system protection, system performance evaluation, underground and overhead systems, and equipment protection

Rationale: This course unit provides participants with a framework for long-term engineering planning and short-range construction planning for electrical distribution.

Developing country focus: Developing countries initiating their rural electrification programs need to be aware of standards and procedures which have a proven record (withing the developing world) of providing low life-cycle cost for distribution systems.

Resource people: Bard Jackson, Jack Morris, Byron Nelson, Burns Hegler, Earl Richards, Donald Morgan.

Resource materials: REA bulletins; University of Missouri-Rolla/NRECA course materials from course on electrical distribution.

Course unit 8: Preparing and evaluating bid specifications for turbogenerating equipment

Description: This course unit is a "how-to" course in preparing bid specifications for turbogenerating equipment for decentralized hydropower plants, including:

- common mistakes in developing specs and how to avoid them
- examining case studies and actual examples of bid specs for decentralized hydropower plants in the U.S. and in developing countries.

Rationale: The appropriate length for bid specifications may vary from about one page for a 1 kW unit to several hundred pages for a 1 MW unit. Depending on the size of his staff, the manager of a developing country's decentralized hydropower program may have to prepare bid specifications himself, or resort to expensive engineering consulting firms to prepare them for him. However, regardless of who prepares them, the manager of the program must be equipped to analyze bid specifications since the cost of turbogenerating equipment is a major contributor to the overall cost of a decentralized hydropower plant.

Developing country focus: In many developing countries, decentralized hydropower is a relatively new energy technology; although the manager of a program may be familiar with writing bid specifications for other power supplies, and, as such, may know the basics, he probably has little or no experience in developing them for decentralized hydropower equipment.

Resource people: Tudor Engineering Co., Peter Smith, Peter McGrath, Michael Reagan.

Resource materials: SDH Program's studies in Rwanda and Morocco; bid specs from REA and for decentralized hydropower plants supplied by U.S. manufacturers.

Course unit 9: Civil works designs and considerations

Description: This course unit focuses on the components of various civil works designs, and the appropriateness of each for particular sites and includes:

- an overview of civil works designs with impoundments vs. run-of-the-river schemes and examples of appropriate characteristics of each
- description of civil works components including dam, weir, intake structure, forebay, headrace/power canal, trashracks, penstock, powerhouse, and tailrace
- description of basic layouts and appropriate and inappropriate applications for each
- description of alternative, less-costly (i.e. locally-available) construction materials and under what conditions they should be considered (i.e. PVC pipe, gabion structures).

Rationale: This course unit will give the participant a working knowledge of the components of the civil works for decentralized hydropower plants, with alternatives to expensive building materials and overdesigned plans and their appropriate application.

Developing country focus: Appropriate civil works designs vary considerably from areas of high labor cost (developed countries) to countries with low labor cost (developing countries).

Resource people: Allen Inversin, Jaime Lobo Guerrero, Maurice Albertson, Stone and Webster, Tudor Engineering Co., Duane Sachs, Peter Smith, John Cassidy.

Resource materials: Micro-Hydro Sourcebook; Small Hydroelectric Powerplants.

Course unit 10: Cost analysis

Description: This course unit will review alternative costing methodologies for decentralized hydropower plants including costs for:

- planning, feasibility, and design
- civil components
- turbogenerating and accessory equipment
- switchgear and electrical distribution equipment
- operation and maintenance
- other factors influencing project costs.

Rationale: Methods for assessing the full costs of a project are critical to the process of conducting economic analysis of projects. The project planning process is not linear. As projects undergo the various stages of feasibility analysis, from the preliminary site studies to the final design stage, modifications are inevitable. Cost analysis in particular must be refined at various stages throughout the project development. Preliminary design work, for example, may indicate excessively high construction costs, which in turn lead to subsequent design modifications.

Developing country focus: Standard engineering cost tables and methodologies have been developed for decentralized hydro projects which do not necessarily reflect the true costs of constructing projects in rural areas of developing countries. These existing costing methods may not accurately reflect total project costs under these conditions and may influence project managers in selecting inappropriate designs, materials and equipment. This course will expose participants to costing techniques that are more appropriate to developing country conditions.

Resource people: Bard Jackson, Paul Clark, Keith Oberg, Mark Henwood, Tudor Engineering Co., Harza Engineering, Robert Yoder, Peter Smith, Peter McGrath.

Resource materials: Small Hydroelectric Powerplants; Small Decentralized Hydropower for Asian Rural Development; Small-Scale Hydropower in Africa; Site Selection Methodology for Small Hydroelectric Power Plants; Reconnaisance Evaluation of Small, Low-Head Hydroelectric Installations; Harnessing Water Power on a Small Scale—Local Experience with Micro-Hydro Technology; SDH Economics Handbook (under development).

Course unit 11: Demand forecasting and end-use planning

Description: This course unit reviews methods of assessing present and future demand for power and examines various considerations for developing mechanical and electrical power uses of decentralized rural hydro plants including:

- institutional requirements to promote load growth and development
- base-load and load-leveling applications that yield "productive" or, income-generating benefits
- potential uses for agricultural production and processing, light industrial and commercial uses, household and community service uses, and special applications, with specific examples in each category and their respective power requirement ranges.

Rationale: The economy of decentralized hydropower projects is greatly dependent on the kinds of uses of the power generated and the capacity utilization rates that are achieved. Decentralized hydropower plants which are not tied to the grid must be planned on the basis of appropriate uses that are adequate to make the investment in the plant worthwhile.

Developing country focus: The course unit is specifically designed to expose participants to typical power needs and end-use options for rural communities in the Third World. While power use and affordability in the industrial nations is usually a "given," end uses in developing nations must be thought out during the early stages of a project and deliberately promoted during the life of the project, implying carefully tailored end-use promotion programs and the institutional development required to carry out such programs.

Resource people: Allen Inversin, Paul Clark, Philip Costas, Edward Kelly, Joseph Sloan, Robert Yoder, University of Minnesota's Department of Agricultural Economics faculty, Louisan Mamer.

Resource materials: NRECA/IPD end-use promotional documents; Micro-Hydro Sourcebook; SDH Economics Handbook (under development); REA power use/promotional materials; "End Uses of Small-Scale Energy Systems in Rural Areas," Matching Renewable Energy Systems to Village-Level Energy Needs.

Course unit 12: Financial analysis

Description: This course unit provides instruction in conducting financial analyses of decentralized hydro projects and exposes participants to various forms and sources of financial packages for projects and the criteria that are typical each.

Rationale: Financing is a key element in planning decentralized hydro projects, both in terms of developing a realistic financial plan and in identifying financial sources.

Developing country focus: Financing for hydroelectric projects may be arranged in a number of ways, depending on the project circumstances. Participants will be shown how to conduct a basic financial analysis for a project, and given a range of different financing approaches and the type of funding criteria of various financial institutions that may become involved, including multilateral banks, the United Nations, national development banks, and private financial institutions.

Resource people: Paul Clark, Peter McGrath, The World Bank/UNCDF, Philip Costas, Cora Shaw, Donal O'Leary.

Resource materials: SDH Economics Handbook (under development); Project Planning for Developing Economics; SERI handbook.

Course unit 13: Socio-economic analysis

Description: This course unit reviews the fundamental elements of an economic analysis of a project, including:

- a methodology for data collection and analysis;
- levels of economic analysis (prefeasibility/feasibility);
- alternative computations for assessing net project return (IRR calculations, benefit/cost calculations, net present worth, shadow pricing);
- external costs and benefits and how to include such factors in the overall economic analysis.

Course rationale: Socio-economic analysis of projects is an essential step in selecting and ranking sites for investment decisions. Participants will review standard procedures for conducting economic analysis, and will be exposed to analytic methodologies that provide a broad scope of economic assessment of a project's overall net value.

Developing country focus: Conventional benefit/cost and IRR formulae do not always provide a sufficient basis for making investment decisions for projects in rural areas of developing countries. Data is often difficult to collect and analyze, and various external factors, such as social development objectives and indirect benefits and costs which influence economic assessments of projects should be taken into account. This course goes beyond conventional economic analysis to take these broader economic considerations, that are difficult to assess in monetary terms, into account in making appropriate investment decisions.

Resource people: Paul Clark, Philip Costas, Tobie Lanou, Univerity of Minnesota Agricultural Economics Department faculty, Keith Oberg, Mark Gellerson, Peter Hayes, Ashley Lyman.

Resource materials: Small Hydroelectric Powerplants; Small Decentralized Hydropower for Asian Rural Development; Small-Scale Hydropower in Africa; Harnessing Water Power on a Small Scale—Local Experience with Micro-Hydro Technology; SDH Economics Handbook (under development); Site Selection Methodology for Small Hydroelectric Power Plants; Project Planning for Developing Economics; Reconnaisance Evaluation of Small, Low-Head Hyrdoelectric Installations; Simplified Methdology for Economic Screening of Potential Low-Head Small-Capacity Hydroelectric Sites.

Course unit 14: Introduction to administrative planning and implementation

Description: This course unit provides an overview of the fundamentals of planning decentralized hydropower programs and projects, and reviews the basic steps for preparing and executing projects during feasibility, design, construction, and project management stages, including:

- establishing am organizational framework for planning and executing programs and projects
- formulating a statement of goals and purposes for the organization
- policy formulation and procedures (implementation frameworks and schedules)
- resource identification and utilization (personnel and material)
- budgeting (short- and long-term financial planning; cash management)
- the proper procedures for data collection and analysis
- program/project evaluation based on stated goals purposes and outputs
- how decentralized hydropower integrates with an overall national or regional energy development program.

Rationale: Effective administration is a critical element in carrying out a national, regional, or site-specific decentralized hydropower development program. Programs and projects are fundamentally handicapped when administrative plans are not developed at the outset to ensure that all aspects of the program/project are considered beforehand by a centrally responsible party or agency. This is especially true for large national-level programs, hence the primary focus of the course is on national administrative planning for a decentralized hydro program. Issues related to sources of financing, equipment, materials, foreign exchange, technical expertise, training assistance, and questions focusing on the uses of the power generated, tariff structures, subsidies, and how the program/project relates to other development programs/projects and objectives in the affected region must be addressed as a whole. This course unit is designed to familiarize participants with the basic components of the planning process and its stages and how plans should be designed and implemented.

Developing country focus: The dispersed nature of decentralized hydro projects makes them difficult to plan, manage, and administer where central agencies are involved. Oftentimes administrative expertise is sorely lacking in developing countries to ensure that the wide range of responsibilities and activities are performed in an efficient and

timely manner. Ultimate costs of projects can increase dramatically due to ineffective administration, resulting in delays in the construction schedule, misallocation of resources, or failure to carry out essential tasks during the planning and implementation stages. This course will concentrate on administrative needs that are typically lacking in rural development projects in developing countries.

Resource people: Robert Kabat, Wayne Johnson, Department of Engineering Management faculty at University of Missouri-Rolla, Peter McGrath, Peter Smith, John Topik, TVA, Bureau of Reclamation, Corps of Engineers, Morton Gordon, Lawrence Cooley, Kaye Bowman, Clarence Kooi.

Resource materials: Site Selection Methodology for Small Hydroelectric Power Plants; Small Hydroelectric Powerplants; Small Decentralized Hydropower for Asian Rural Development; Harnessing Water Power on a Small Scale—Local Experience with Micro-Hydro Technology; Micro-Hydro Sourcebook sourcebook; NRECA training materials; University of Missouri-Rolla's materials for its engineering management courses.

Course unit 15: Organizational development and management considerations

Description: This course unit provides an in-depth look at various organizational structures, institutional frameworks, and management problem areas including:

- descriptions of organizational structures (centralized vs. decentralized) and case studies showing possible national, regional, and local options for institutional development
- analysis of leadership models and supervisor's roles and responsibilities including when and how to delegate responsibility; negotiating within the organization and with outside contractors (i.e. engineering firms—local and international) and other agencies involved.

Rationale: Effective administrative planning relies on the creation of an appropriate institutional framework. This course unit will permit the participant to view the current management scheme in which he operates from a new perspective and to consider alternative options for developing institutional infrastructure needed in the planning and execution of decentralized hydropower programs and projects.

Developing country focus: Materials, equipment, and engineering expertise are all available to developing countries from external sources. The one ingredient for project planning and implementation which cannot be imported is the institutional framework on which the other project components must rely. Institutional development is, therefore, the most critical element in a decentralized hydro program for it to be successful over the years. Each country, and potentially each region within a country, may differ in terms of what institutional solution may best apply. This course unit will expose participants to a wide range of institutional choices with which decentralized hydro programs may be planned, implemented and managed, on a national, regional, and local basis.

Resource people: Robert Kabat, Wayne Johnson, Edward Gaither, University of Missouri-Rolla Engineering Management Department faculty, Thomas Heath, Peter McNeill, James Heifner, Allen Inversin, Kaye Bowman, Robert Yoder.

Resource materials: NRECA/MS training materials; University of Missouri-Rolla Department of Engineering Management course materials; Centralized vs. Decentralized Management of Small Hydropower.

Appendix D—Training advisory committee candidates

Listed below are suggested candidates for each of the six groups that should be represented on the Training Advisory Committee.

National Rural Electric Cooperative Association/ International Programs Division	David Zoellner Program Manager Small Decentralized Hydropower Program
	Allen Inversin Micro-Hydro Engineer Small Decentralized Hydropower Program
	Bard Jackson Principal Engineer Small Decentralized Hydropower Program
	Paul Clark Training and Information Specialist Small Decentralized Hydropower Program
	Elizabeth Graham Information and Training Coordinator Small Decentralized Hydropower Program
	Edward Gaither Regional Administrator for Asia and the Pacific (former r/e project manager in Bangladesh) International Programs Division
U.S. Agency for International Development	William Eilers Deputy Director ST/EY
	Shirley Toth Programs Operations Assistant ST/EY
	Raga Elim Evaluation Coordinator Office of International Training Bureau for Science and Technology
St. Anthony Falls Hydraulic Laboratory	Roger Arndt Director
	John Gulliver Assistant Director

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Training specialists

Robert Kohls
Chief
Training and Development Division
U.S. Information Agency

Rick Maurer
Training Consultant
Organization Leadership, Inc.
Washington, D.C.

Monishe Mandy
Training Specialist
The World Bank

Steve Ebbin
Director, Conventional Energy Training Project
Institute for Internation Education

U.S. Turbine Manufacturers

William Delp
President and CEO
Independent Power Developers

Mike Johnson
President
Little Spokane Hydroelectric

Doug Miller
Hydro-turbine Division
Allis-Chalmers Corporation

Decentralized hydropower engineering consultants

Walter Lawrence
Consulting Engineer

Maurice Albertson
Professor, Civil Engineering Department
Colorado State University

John Cassidy
Chief Hydrologic Engineer
Bechtel Civil and Minerals, Inc.

Appendix E—Schedule for the training program

This schedule has been developed under the assumption that ST/EY will approve funding for this training proposal in November, 1982. Whether or not funding is approved as envisioned here, the planning framework for the training program giving the sequence of activities which would occur, shown as beginning in the first week of November in this schedule, remains unchanged.

Month	Week	Activity
September	4	• SDH Program delivers draft training proposal to ST/EY
		• SDH Program begins contacting resource people for availability status
October	1	• ST/EY reviews draft proposal
		• SDH Program and ST/EY meet for initial discussions about training proposal
	2	• SDH Program delivers final proposal to ST/EY
		• ST/EY reviews final proposal and sends it out for comment
	3	• ST/EY receives comments from outside reviewers
	4	• ST/EY and SDH Program review comments and make final adjustments to training proposal
November	1	• ST/EY provides final approval and funding for training programs
		• Training Advisory Committee (TAC) members are selected
		• SDH Program contacts TAC members and arranges meeting in Washington
		• SDH Program sends TAC members copy of training proposal and changes to proposal agreed to by ST/EY and SDH Program
	2	• SDH Program develops tentative agenda for TAC meeting and sends it to TAC members
		• SDH Program develops draft circular cable, draft training brochure, and develops list of recipients for each

	3	• SDH Program develops draft selection criteria for candidates for U.S.-based training and for in-country training programs, and develops draft application packet for each
	4	• TAC meets (reviews draft cable, brochure, list, selection criteria, and applications and finalizes each)
		• ST/EY sends finalized circular cable and pouches final application packets to AID Missions
		• SDH Program prints training brochure
December	1	• SDH Program sends out brochure and application packets to selected recipients and finalizes NRECA/IPD training catalogue
		• AID Missions notify host country governments about training programs and continue to work with ministries/agencies to locate interested, appropriate candidates for training programs
	2-3	• SDH Program contacts development banks and organizations to locate other sources of funding for training program
		• SDH Program works with SAFHL staff to finalize U.S.-based training program and select appropriate resource people for course units and makes preliminary logistical arrangements for housing, meals, buses, printing, class space, etc.
		• initial cable response indicating interest in training due from AID Missions with preliminary outline of training needs
	4	• SDH Program sends TAC members responses as received and final proposed course outline and list of resource people for U.S.-based training
		• SDH Program begins contacting AID Missions for more details to develop tentative scopes-of-work for in-country training
		• AID Missions to pouch application packets to SDH Program/ST/EY
January	1-3	• final applications due from AID Missions for in-country training and for candidates for U.S.-based training
		• SDH Program sends copies to TAC members as received and any tentative scopes-of-work/other information it's developed/gathered for each

		• SDH Program: drafts recommendations on candidates to select and countries to train in based on selection criteria; drafts tentative schedule for in-country training for next 9 months; drafts acceptance/rejection letter/cable; develops agenda for TAC; and sends copies of each to TAC members prior to meeting
	4	• TAC meets to consider agenda items and finalizes U.S.-based training program and list of resource people
February	1	• SDH Program notifies AID Missions by cable of decisions of TAC on training program (accepted candidates/countries) through ST/EY
		• SDH Program notifies resource people for U.S.-based training program and provides schedule for their lecture notes, exercises, etc.
	2-4	• SDH Program refines scopes-of-work for 3-5 countries in which it will train in-country and begins training
March	1	• SDH Program revises logistical arrangements for U.S.-based training program as needed
	2-4	• SDH Program develops draft training program evaluations for both U.S.-based and in-country training programs
April	1-3	• lecture notes and other course materials due from resource people from U.S.-based training program
		• SDH Program forwards copies to TAC members as received
	4	• SDH Program reviews and critiques course notes and forwards critiques to TAC members as available
May	1	• SDH Program develops tentative agenda for TAC meeting
	2-3	• SDH Program makes final logistical arrangement for U.S.-based training program
	4	• TAC meets to consider draft agenda items and other business
June	1-4	• final lecture notes due from resource people for U.S.-based training program
July	1	• final lecture notes/course materials printed at University of Minnesota for U.S.-based training program
	2-3	• SDH Program training coordinator travels to University of Minnesota to prepare for U.S.-based training program

	4	• U.S.-based training course begins (July 25-September 2; participants arrive by Saturday, July 23)
August	1-4	• U.S.-based training course conducted
September	1	• U.S.-based training course concludes (participants depart for home weekend of September 3-4)
	2	• SDH Program's training coordinator returns to Washington
	3	• SDH Program sends copies of staff/faculty/participants' evaluations of training program to TAC members
	4	• SDH Program reviews evaluations and draws up proposed changes for next iteration based on suggestions/criticisms
October	1-3	• SDH Program develops tentative agenda for TAC meeting and sends it to TAC members; continues to draft changes for next iteration of U.S.-based training program
	4	• TAC meets and considers draft agenda items and other business

Appendix F—Resource people

This is a representative list of specialists in the various disciplines involved in small decentralized hydropower development who may serve as instructors for the training services contained in this proposal.

Mohammed Abdullah (Professor and Chairman, Department of Electrical Engineering, NWFP University of Engineering and Technology, Peshawar, Pakistan). For over ten years, Dr. Abdullah, an electrical engineer, has been involved in local development and manufacture of micro-hydro turbines and has been actively engaged in the design, development, and demonstration of micro-hydro plants for rural areas with the help of the Appropriate Technology Development Organization (ATDO), an organization providing technical expertise for self help programs in Pakistan. Dr. Abdullah participated in the SDH Program's West Africa workshop in Abidjan as a resource person.

Maurice Albertson (Professor, Department of Civil Engineering, Colorado State University, Ft. Collins, Colorado). Dr. Albertson teaches courses in small hydro, appropriate technology, hydraulics, and hydrology and has extensive experience in design and development of hydraulic structures, energy dissipation, alluvial hydraulics, irrigation and drainage, hydraulic machinery, and small-scale hydro-power. He is one of the original founders of the Asian Institute of Technology in Bangkok, Thailand. He participated as a resource person at the SDH Programs West Africa workshop in Abidjan.

Max Anderson (Associate Professor of Electrical Engineering, University of Missouri, Rolla, Missouri). Dr. Anderson's area of specialization is computer applications for power systems and he teaches a course on this subject for the NRECA-University of Missouri-Rolla course for international executives and managers.

Roger Arndt (Director, St. Anthony Falls Hydraulics Laboratory, University of Minnesota; see resume, Appendix G).

Edgar Arnn (Manager, Farmers Mutual Electric Company, Geneseo, Illinois). Mr. Arnn is a former field operations and management adviser for NRECA's rural electrification program in the Phillippines.

John Bogert (Electrical Engineer, James Hansen & Associates, Springfield, Vermont). Mr. Bogert's experience has been in feasibility studies and plans for small hydro development schemes in the United States. He participated as the engineer for the Project Paper team in the SDH Program's country assessment in the Dominican Republic and was responsible for developing the technical criteria for the Project Paper for the AID-funded program.

Edward Bowers (Professor, Department of Civil Engineering, University of Minnesota, Minneapolis, Minnesota; see resume, Appendix G).

Kaye Bowman (Australian National University, Canberra, Australia). Ms. Bowman is a specialist in social impacts for rural development projects. She has practical experience in the social impact analyses of small-scale, micro- and mini-hydro development schemes in Papua New Guinea. She is involved in a three-year study initiated by the government of Papua New Guinea on social and economic impacts of rural electrification in a remote rural community. She was a resource person at the SDH Program's Asia workshop in Bangkok.

John Brown (Marketing Manager, The James Leffel and Company, Springfield, Ohio). A mechanical engineer, Mr. Brown is responsible for marketing Leffel's equipment here in the U.S. and in-country.

Butwal Engineering Works (Nepal). Butwal Engineering Works is a center of expertise for design and development of turbines for use in Nepal. Although some of its expertise is still provided by expatriates as it was almost totally originally, many Nepalese are now being involved. Butwal's turbines are exclusively crossflow style. Expertise was provided originally to Butwal by United Missions of Nepal.

Robert Carroll (Manager, Broad River Electric Co-op, Inc., Gaffney, South Carolina). Mr. Carroll, an electrical engineer, has developed a small hydro site in his member system.

John Cassidy (Civil Engineer, Small Hydro and Community Facilities, Bechtel National Corporation, San Francisco, Californiak). Dr. Cassidy, a specialist in hydraulics, is a former director of the Washington Water Research Center and a professor of civil engineering at Washington State University. He is familiar with both civil works design,

turbine design, and turbine setting. He participated in the SDH Program's Quito, Ecuador workshop.

Paul Clark (Training and Information Specialist, Small Decentralized Hydropower Program, International Programs Division, NRECA; see resume, Appendix F).

Lawrence Cooley (President, Management Systems International, Washington, D.C.). Mr. Cooley is a development economics specialist. He was team leader and team economist for the SDH Program's Ghana team that assessed the small hydro potential for the western region of that country.

Philip Costas (Assistant Administrator for Economic Analysis and Evaluation, International Programs Division, NRECA). Mr. Costas administers the division's socio-economic research activities in rural electrification in-country. He has served as a NRECA adviser in the Phillippines, Indonesia, Bangladesh, and North Yemen.

Norman Crawford (Chairman, Hydrocomp, Palo Alto, California). Dr. Crawford, a trained hydrologist, developed under contract to NRECA, a hydrologic methodology which is used in the SDH Program. He is an engineer and a principal in his firm. He was a resource person for the SDH Program's Bangkok workshop.

Charles Dawsey (Manager of Engineering, Fall River Rural Electric Cooperative, Ashton, Idaho). Mr. Dawsey is an electrical engineer with one of NRECA's member systems. He was helpful in writing up FERC and REA regulations and requirements for loans and permitting procedures for use by the SDH Program in assisting NRECA member systems in developing small hydro programs domestically. His cooperative has developed a small hydro site.

William Delp (President and CEO, Independent Power Developers, Sandpoint, Idaho). Mr. Delp manufactures small turbines, including Pelton turbines, generators, and load controllers for decentralized hydro systems. He has had experience in decentralized hydro development in Latin America.

Rupert Armstrong Evans (President, Evans Engineering, United Kingdom). Mr. Evans is a civil engineer and has experience with developing decentralized hydro units and conducting training courses around the world. He has developed an electronic load

controller and works quite often in decentralized hydro technology development with the Intermediate Technology Development Group in London. He was a resource person at the SDH Program's workshop in Abidjan, Ivory Coast.

Cesar Farrell (Associate Professor, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minnesota; see resume, Appendix G).

Edward Gaither (Regional Administrator for Asia and the Pacific, International Programs Division, NRECA). Mr. Gaither was team leader for NRECA's continuing rural electrification program in Dacca, Bangladesh for four years. He formerly managed co-ops in NRECA's member system in Trenton, Missouri and Pueblo, Colorado.

Mark Gellerson (Assistant Professor, Department of Economics, Southern Illinois University at Carbondale). Dr. Gellerson is experienced in the economic analysis of various aspects of rural electrification in Latin America and Asia. He was the economist for the SDH Program's three-man team providing technical assistance in Pakistan.

Morton Gorden (Development Specialist). A consultant, Mr. Gordon has conducted an institutional analysis for Thailand and currently is helping AID's ST/EY develop its energy plan and policies for the futures. He has conducted studies for AID Missions as well as for AID offices in Washington, D.C.

Jaime Lobo Guerrero (Lecturer, Universidad de los Andes, and partner in C.CH.L.G. Ltd., an engineering consulting firm in Bogota, Colombia). Dr. Guerrero, a mechanical engineer, has extensive experience with micro-hydro units, including design, manufacture, and installation on the local level. He has conducted workshops on manufacture, fabrication and foundry work, developed a number of micro-hydro projects, and conducted demonstration workshops on manufacturing micro-hydro turbines. He was a resource person at the SDH Program's West Africa workshop in Abidjan, Ivory Coast.

John Gulliver (Assistant Professor of Civil and Mineral Engineering, University of Minnesota, Minneapolis, Minnesota; see resume, Appendix G).

Harza Engineering (Chicago, Illinois) is a large architectural and engineering firm in the United States with substantial experience in-country, particularly in large-scale hydropower projects.

Peter Hayes (Development Economist). A doctoral candidate at the Energy and Resources Group, University of California at Berkeley, Mr. Hayes has research experience in energy issues in the Third World, and has worked in Asia in energy planning.

Thomas Heath (Director, Energy Utilization Division, U.S. Department of Agriculture, Rural Electrification Administration, Washington, D.C.). An electrical engineer, Mr. Heath is a productive use specialist and has worked in Bolivia for NRECA. He has also worked in Alaska in establishing electric cooperatives.

Burns Hegler (Professor of Electrical Engineering, University of Missouri, Rolla, Missouri). Dr. Hegler is experienced in energy conservation, electrical safety, illumination, and general circuit theory. He has taught courses in the safety aspects of utility operations and economic conductor design for the NRECA-University of Missouri-Rolla course for international executives and managers.

James Heifner (Consultant, International Programs Division, NRECA). Mr. Heifner is currently team leader for NRECA's $3 million rural electrification program in Bangladesh.

Mark Henwood (Henwood Associates, Inc., Sacramento, California). A mechanical and electrical engineer, Mr. Henwood, is a private developer of small hydro systems in California.

Allen Inversin (Micro-Hydro Engineer, Small Decentralized Hydropower Program International Programs Division, NRECA; see resume, Appendix F).

Bard Jackson (Principal Engineer, Small Decentralized Hydropower Program, International Programs Division, NRECA; see resume, Appendix F).

Michael Johnson (Little Spokane Hydroelectric, Spokane, Washington). Mr. Johnson is a consultant and manufacturer of small hydro equipment.

Wayne Johnson (Manager, Training and Special Services, NRECA). Mr. Johnson, formerly the General Manager of Whitley County REMC in Indiana, is a management specialist

who has developed many training programs for the U.S. and in-country in the area of management and rural electrification.

Robert Kabat (Manager, Management Services Department, NRECA). Mr. Kabat has over 30 years experience in the management development field and in working with rural electric utilities in the U.S. and in-country.

John Killen (Research Associate, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis; see resume Appendix G).

Paul Kirshen (Water Resources Consultant, Newton, Massachusetts). Dr. Kirshen is a consultant in all aspects of water resources planning and engineering is experienced in river basin regional development projects in Africa, Yugoslavia, and the northeastern United States. As a member of the SDH Program's team to Togo, he conducted hydrologic analysis for potential hydro sites in that country. He was a resource person at the SDH Program's decentralized hydro workshop in Abidjan, Ivory Coast.

William Kitching (Vice President, Small Hydro Electric Systems and Equipment, Acme, Washington). Mr. Kitching specializes in the manufacture of Pelton turbines, based on Small Hydro's own design, with a capacity of 100 kW.

Clarence Kooi (Energy Specialist, Regional Economic Development Services Office, Abidjan, Ivory Coast). Dr. Kooi, trained as a physicist, participated as a resource person at the SDH Program's West Africa workshop in Abidjan. He has experience in energy needs and resources from a multi-country perspective, particularly with renewable energy resources in West Africa.

Tobie Lanou (Economist, CH2M Hill, Washington, D.C.). Mr. Lanou was a member of the SDH Program's decentralized hydro assessment team to Togo and has more than 15 years experience in consulting on urban and regional Economic development problems. He was also a resource person at the Abidjan West Africa workshop.

Walter Lawrence (Consultant, Washington, D.C.). Mr. Lawrence is an electrical engineer with many years of in-country experience in international development projects, including several years with the US Agency for International Development. Through the SDH Program, he has supplied decentralized hydro assistance to Pakistan, and was a

member of SDH Program's assessment teams in Togo, Liberia, Zaire and to Dominica. He was also a resource person for the West Africa workshop conducted by the SDH Program in Abidjan, Ivory Coast.

Ashley Lyman (Professor of Economics, University of Idaho). Dr. Lyman has worked with NRECA in Bangladesh as a team economist.

Louisan Mamer (Consumer and Power Use Specialist, Washington, D.C.). A pioneer in U.S. rural electrification, Ms. Mamer was formerly with the U.S. Rural Electrification Administration (REA) and for over 40 years coordinated REA's promotional and training efforts in consumerism and power use.

Howard Mayo (Manager, Market Development, Hydro-Turbine Division, Allis Chalmers, York, Pennsylvania). Responsible for marketing Allis-Chalmers' turbines, Mr. Mayo is knowledgeable about turbine design and operational characteristics for small and large turbines and has travelled extensively throughout Argentina and Europe visiting small hydropower sites.

Peter McGrath (President, American Hydro Power Co., Villanova, Pennsylvania). Mr. McGrath is a private developer of small hydro sites in the U.S. He participated in the SDH Program's recent private sector involvement seminar.

Peter McNeill (Consultant). Until July of 1982, Mr. McNeill was team leader for the NRECA rural electrification program in Indonesia. He is a former co-op manager from the state of Kentucky, with many years of experience in rural development, rural agriculture, and rural electrification in the United States. Shortly, Mr. McNeill will take over as manager of a local Production Credit Association, a member of the Federal Land Bank, in Kentucky.

A. G. Mercer (Civil Engineer, Northwest Hydraulics, Vancouver, British Columbia). Mr. Mercer was a member of the SDH Program's two-man assessment team to Bangladesh and was responsible for assessing the hydrologic characteristics of the country.

Rheinhold Metzler (R & D Project Leader, Technical University of Furtwangen, West Germany). Mr. Metzler has several years of experience working in decentralized hydro

technology development in Nepal. While with Butwal Engineering Works in Nepal, he helped develop a small water turbine which could be completely manufactured in Nepal and helped develop appropriate machines to be powered by the turbine. A mechanical engineer, he has visited the People's Republic of China to study decentralized hydro developments there.

Derald Morgan (Emerson Electric Professor of Electrical Engineering and Department Chairman, University of Missouri, Rolla, Missouri). Dr. Morgan has expertise in high voltage apparatus and has taught in the NRECA-University of Missouri-Rolla course for international executives and managers.

Jack Morris (Assistant Professor of Electrical Engineering, University of Missouri, Rolla, Missouri). Dr. Morris' specialty is power engineering. He teaches a course in overhead distribution system design considerations for the NRECA-University of Missouri-Rolla course for international executives and managers.

NRECA/MS is the Management Services Department of NRECA. The Management Services Department provides assistance to the over 1,000 NRECA member systems in areas relating to the management of cooperatives through training, manager search, workshops, seminars, and other activities.

Byron Nelson (Associate Professor of Engineering Management, University of Missouri, Rolla, Missouri). Dr. Nelson's expertise is in industrial organizations and cost analysis. He has taught a course in engineering economics for the NRECA-University of Missouri-Rolla course for international executives and managers.

Daniel New (President, Canyon Industries, Deming, Washington). Mr. New is a manufacturer of small hydro equipment and recently participated in the SDH Program's private sector involvement seminar.

Fritz Neumann (Senior Engineer, Installation and Service Engineering Division, General Electric Company). An electrical engineer, Mr. Neumann has more than 20 years of experience with decentralized hydropower development in the U.S. and in-country.

Keith Oberg (Economist, Washington, D.C.). Mr. Oberg was a member of the SDH Program's assessment team to Dominica in the Eastern Caribbean. He has substantial

experience in-country in Latin America and has done consulting work with the Inter-American Foundation.

Donal O'Leary (Lecturer, Economic Development Institute, The World Bank, Washington, D.C.). Dr. O'Leary is an engineer with experience in water resources and institutional analysis. He was an SDH Program assessment team member to Peru and the Dominican Republic, and has conducted financial analyses for an SDH Program project. He was a resource person for the SDH Program's workshop in Abidjan, Ivory Coast.

Michael Reagan (Engineer, Energy Utilization Division, Rural Electric Administration, U.S. Department of Agriculture, Washington, D.C.). Mr. Reagan, an electrical engineer, is responsible for reviewing contracts and bid specifications in evaluating requests for REA funds for small hydropower projects in the U.S.

Earl Richards (Associate Professor of Electrical Engineering, University of Missouri, Rolla, Missouri). With a specialty in power engineering, Dr. Richards teaches courses in distribution system protection planning and computer application programs for distribution systems for the NRECA-University of Missouri-Rolla course for international executives and managers.

Duane Sachs (Sales Manager, Generation Unlimited, Newport Beach, California). Generation Unlimited is a manufacturer of small hydro equipment. Mr. Sachs recently participated in the seminar the SDH Program sponsored on private sector participation in small hydropower development.

Cora Shaw (Economic Development Institute, The World Bank, Washington, D.C.). Ms. Shaw has conducted social impact analyses as a member of SDH Program's assessment teams to the Dominican Republic and Peru.

Joseph Sloan (Manager, Anoka Electric Cooperative, Anoka, Minnesota). Dr. Sloan is an expert in electric power use and has provided technical expertise in Bolivia with NRECA for developing productive end uses. The co-op he manages is located just north of Minneapolis and has a small hydro site that the University of Minnesota has included in its survey of small hydro potential.

Peter Smith (President, Energenics Systems Inc., Washington, D.C). Mr. Smith is a private developer of small hydro systems.

Charles Song (Professor of Civil Engineering, University of Minnesota, Minneapolis, Minnesota; see resume, Appendix G).

Stone & Webster is a large architectural and engineering firm with substantial experience in energy generation, transmission, and, to a lesser extent, in distribution, and in large-scale hydropower systems.

TVA is the Tennessee Valley Authority, a regional, integrated river basin development agency, with many years of experience in regional rural electrification and large-scale hydro systems. TVA provides technical assistance in-country.

William Thompson (President, Thompson and Howe, Kimberley, British Columbia). Mr. Thompson's company manufactures electronic load controllers for small hydropower plants.

John Topik (Consultant, Grass Valley, California). A civil and mechanical engineer, he has extensive experience in decentralized hydro, irrigation, and water supply in-country. He was a member of SDH Program's technical assistance teams to Rwanda, Zaire, and Bangladesh.

Tudor Engineering Company (San Francisco, California) is a medium-sized architectural and engineering firm in the U.S. with substantial experience in developing small-scale hydro systems (5-25MW) in the U.S. Tudor recently began working in-country, and is currently involved in small hydro development in Malaysia.

U.N. Capital Development Fund (UNCDF) is an organization which provides capital for project development in developing countries. UNCDF, in the past, has provided funds for small hydro development.

U.S. Bureau of Reclamation is a government agency responsible for the management, development and conservation of water resources in the 17 western states. The Bureau has developed many large hydro facilities and has completed recently a multi-year study

of low-head and/or small hydro potential in the western United States. The Bureau provides technical assistance in-country.

U.S. Army Corps of Engineers is a government agency which has many years of experience in water resource development, including hydropower. The Corps has experience with large and small-scale hydropower and has completed a national survey of present and future hydropower facilities and future potential in the United States. The Corps provides technical assistance in hydropower design and construction in-country.

Joseph Wetzel (Assistant Director, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minnesota; see resume Appendix G).

Jack Woodward (Head, Department of Electrical Engineering, University of Auckland, New Zealand). Dr. Woodward is an electrical engineer with experience in the development of mini- and micro-hydro schemes in Asia and the Pacific, particularly in Papua New Guinea. He has been involved in the development of load controllers and low cost generators for micro-hydro schemes. He participated as a resource person in the SDH Program's West Africa workshop in Abidjan.

The World Bank is a multi-lateral development bank providing loans through its member groups to developing countries. Large portions of the Bank's loans are for energy projects.

Robert Yoder (Agricultural Economist, Cornell University). Robert Yoder has had substantial experience in developing micro-hydro schemes in Nepal, and currently is working in Nepal with Cornell University on a multi-year project. He was resource person for the SDH workshop in Bangkok, Thailand.

David Zoellner (Manager, Small Decentralized Hydropower Program, International Programs Division, NRECA; see resume Appendix F).

G—Resumes of SDH Program staff

DAVID RICHARD ZOELLNER

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Education

Civil Engineering, Ph.D., Texas A&M University, 1972
Biology, M.S., University of Alabama, 1967
Biology, B.S., University of Alabama, 1963
Academic Societies, Beta Beta Beta (Biology Honorary)

General Experience

Experienced in administering national and international programs in natural resource management, analysis and development. Fields of interest and specialty have included living and water resources - marine systems, water quality, water power, water resources development and conservation. Key past topics have included: water quality policy, legislative effectiveness, environmental trends and indicators, management information needs, energy and environmental policy, resource development and research evaluation.

Detailed Experience

Assistant Administrator, International Programs Division, National Rural Electric Cooperative Association (1980-present). Responsibilities include: Administration of a $3 million program funded by USAID Office of Energy to facilitate the application of decentralized hydropower technology in developing countries. Program assistance to date, has been provided to 16 countries in resource assessment services; regional workshops have been held in Latin America, Asia and Africa for over 300 attendees; seminars with specialists in finance and in the private sector have been held; 18 specialized publications have been developed and a training program plan is underway.

Environmental Planner, Institute for Water Resources, U.S. Army Corps of Engineers (COE) (1978-1979). As a management team member of the National Hydropower Study, a 3-year, $7 million feasibility assessment for Congress, identified and analyzed energy, water and environmental policies and issues attendant to hydropower planning, development and operation. Determined budget allocations, developed detailed government estimates for key studies, and managed and participated in select policy study. As chairman, Technical Program

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Committee, for Waterpower '79, cosponsored by COE and Dept. of Energy developed the conference plans, assembled and briefed conference committee, selected and monitored contract support service, developed technical program concept, assembled same, and designed and monitored the publishing of the proceedings.

Resource Scientist, Center for Resource and Environmental Systems Studies, SRI International formerly Stanford Research Institute (1976-1978). Project activities and responsibilities included proposal development, project management (staff and budget), report preparation, and client liaison. Studies emphasized natural resources - current and future problems, issues, policies and options for management decision making. Principal work conducted in areas of: legislative assessment in water quality (analysis of impact of Federal law on water quality and molluscan shellfish industry); environmental indicators for Council on Environmental Quality; interagency environmental coordination; impact assessment of decontrolling prices and regulations on crude oil and petroleum distillates; geologic isolation of radioactive wastes; and geothermal energy development.

Staff Officer, Environmental Studies Board, National Research Council/National Academy of Sciences (1974-1975). Provided professional staff support to the Study Committee on Water Quality Policy. Committee activities included establishment of subcommittees or panels in the areas of technology and costs, modeling, waste water reuse, secondary treatment, institutional arrangements, and ecosystem analysis. Professional staff activities included planning conferences, and other meetings of the advisory committee; coordinating documents for review and information exchange; drafting panel and progress reports; and supervising support staff in providing necessary services.

Research Scientist, Environmental Systems and Management Program, Center for the Environment and Man, Inc. formerly Traveler's Research Center (1971-1974). Participated in water and land resources studies with emphasis on marine biology, water quality, and institutional aspects of planning and implementation. Work included the areas of: coastal management; coastal wetlands; environmental monitoring; environmental reconnaissance; and, dredging.

Teaching

Physical Sciences Department, Prince George's Community College suburban Washington, D.C. area (Spring Semester, 1978). Taught a three-credit course in Oceanography to non-science students covering physical, chemical, and biological principles and characteristics; duties included delivering lectures, administering quizzes, presenting audio-visual material, assigning and reviewing out-of-class projects, field trips, and administering final examination.

Trinity University, Hartford, Connecticut (Fall Semester, 1973). Participated as a team member in teaching an upper-level course in environmental principles and practices; delivered lectures and administered quizzes.

University of Alabama, Tuscaloosa, Alabama (Academic years 1964-65, 1965-1966). Taught six labs per week, 24 students per lab, in courses of General Zoology, General Botany, and Invertebrate Zoology; duties included preparing laboratory

demonstrations and laboratory lectures; assisted with proctoring and grading lecture section examinations.

Graduate Experience

A&M University, Texas (1967-1971). Graduate program included a broad background in the area of environmental engineering with emphasis on waste treatment, water quality, and water resources, and additional training oceanography, mathematics, hydraulics, and biology. Ph.D. Dissertation: "The Development of a Hyperbaric Reactor for the Biological Oxidation of a Colloid."

A&M University, Texas (September 1967-December 1971). FWQA Training Grant, Environmental Engineering. Grant for support while obtaining degree in area of pollution control.

A&M University, Texas (1969-1970). Elected by students from a five-state region to serve on Student Committee on Pollution and the Environment (SCOPE), an advisory body to the Secretary of Interior.

University of Alabama (1963-1967). Graduate studies emphasized marine science and included training in commercial fisheries, oceanographic techniques and ecology. M.S. Thesis: "The Relation of Substrate to the Accumulation of Marine Fouling Organisms."

University of Texas (June 1967-September 1967). NSF Research Grant, marine Science Institute. Coursework and research in marine sciences.

U.S. Department of Interior, Aquatic Biologist (June 1966-September 1966). Comprehensive survey of stream quality in North Central Alabama.

Stanford University. NSF fellowship (R/V te Vega) (June 1965-September 1965). Cruise from American Samoa to Monterey, California, learning applications of oceanography and receiving lectures in biological oceanography.

University of Alabama. Research Assistant, Alabama Marine Resources Lab. (September 1963-September 1964). Involved in comprehensive study of ecology, hydrography and commercial fisheries of Mobile Bay; construction and maintenance of offshore artificial fish reefs; and determining toxicity of pesticides on oysters.

Consulting

Inter-American Development Bank, Washington, D.C. (Winter 1980). Developed information criteria manual for environmentally-related loan applications.

Decision Science Consortium, Inc., Reston, Virginia (Spring 1979). Developed impact assessment methodology for water resource decision process.

Nero and Associates, Inc., Portland, Oregon (Fall 1979). Developed research team and coordinated briefing to U.S. Department of Interior on Outer Continental Shelf oil and gas development impact assessments.

Organization of American States, Washington, D.C. (Spring 1978). Reviewed water resource assessment methodology for river basin planning in South America.

Office of Technology Assessment, Oceans Program, U.S. Congress, Washington, D.C. (Spring 1978). Assisted in the development of a study plan to examine the question of high and low-level radioactive waste disposal in the seabed.

Selected Publications

Papers

Small Hydro Equipment Opportunities (in development), Agricultural Engineering, Journal of American Society of Agricultural Engineers, 1982.

Small Hydro potential in Developing Countries, Proceedings, UNITAR Conference on Small Energy Resources, September 10-18, 1981, Los Angeles, California, 1981.

Small Hydro for Rural Energy, Proceedings, OAS Energy Conference, September, 1980, Sao Paulo, Brazil, 1980.

Water Resource Impacts of Hydropower Development and Operation, Proceedings, ASCE Conference on Water Resources and Hydroelectric Energy Development, 1979.

Issues in Ocean Policy Related to Land Use Planning and Regulation, National Ocean Study, U.S. Senate Subcommittee on Oceans and Atmosphere, 1975.

Reports - Principal Responsibility

Water Quality and Molluscan Shellfish: An Overview of the Problems and the Nature of Appropriate Federal Laws, Stanford Research Institute, GPO 003-020-00135-1 (U.S. Government Printing Office), for U.S. Congress (via National Marine Fisheries Services), 1977.

Interagency/Intergovernmental Coordination for Environmental Planning. Handbook for Federal Agency Coordination, Vols. I & II, Stanford Research Institute, Project No. 4744, for U.S. Air Force, 1977.

Environmental Reconnaissance Techniques for Connecticut River Basin Watersheds, Report No. 4155-498. New England River Basins Commission, 1974.

Reports - Editing, Drafting, and Technical Assistance

Environmental Quality Indicators: A Sourcebook work of Graphics for President's Council on Environmental Quality, 1977.

Technology Transfer in the Marine Environment of Long Island, CEM, Inc., Report No. 4133-475, for Nassau-Suffolk Regional Planning Board, Marine Resources Council, 1973.

A Methodology for Applying Research to Environmental Planning and Management: A Case Study of Issues Important to the Chesapeake Bay Region, CEM, Inc., Report No. 4138-491 for National Oceanic and Atmospheric Administration, 1973.

Wetlands on Long Island, CEM, Inc., Report No. 4103-460 for National Oceanic and Atmospheric Administration, 1972.

Reports - Contributory Analysis and Coordination

Environmental Analysis for Geothermal Energy Development in the Geysers Vol. II, Master Enviornmental Assessment, Stanford Research Institute, CRESS Report No. 3 for State of California, 1977.

Proposed Outline of Safety Analysis Report for Facilities for Geologic Isolation of Radioactive Wastes, Stanford Research Institute, CRESS Report No. 24 for Oak Ridge National Laboratory, 1977.

Environmental Impact Assessment of the Exemption of Middle Distillates from Mandatory Allocation and Price Controls for U.S. Federal Energy Administration, 1976.

Guidelines for Dredged Material Placement in Marsh Creation, CEM, Inc., Report No. 4165-511 for U.S. Army Engineers, 1975.

Report to the Advisory Panel on Water Reuse, Study Committee on Water Quality Policy, National Academy of Sciences National Commission on Water Quality, 1975.

Report of the Advisory Panel on Secondary Treatment, Study Committee on Water Quality Policy, National Academy of Sciences for National Commission on Water Quality, 1975.

Advisory Report of the Joint Panel on Ecosystem Analysis, National Academy of Sciences/The Institute of Ecology for National Commission on Water Quality, 1974.

Applicability of Limited Capability Buoys to Potential Operational Data Uses, CEM, Inc., Report No. 4128-466 for National Oceanic and Atmospheric Administration, 1972.

Professional Societies

Society for International Development
International Water Resources Association
American Fisheries Society
Water Pollution Control Federation
Marine Technology Society
American Association for the Advancement of Science

Foreign Language Capability

French, Spanish

BARD C. JACKSON

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Education

Electrical Engineering (Power Systems), M.S., Georgia Institute of Technology
Navy Nuclear Prototype Training Unit, 1972
Navy Nuclear Power School, 1971
Electrical Engineering (Power Systems), B.S. "cum laude," California State University at Long Beach

Experience

Principal Engineer, Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association, Washington, D.C. (1980-present). Responsible for the technical content of the SDH Program. Respond to requests from developing countries for assistance with planning and designing small-scale hydropower projects. Have managed over a dozen teams of specialists who conducted decentralized hydro assessments and provided technical assistance to developing countries including Peru, Dominican Republic, Togo, Dominica, Zaire, Thailand, Rwanda, Morocco, Panama, Ghana, Tunisia, and Bangladesh; and personally participated in assisting Rwanda, Dominica, and Panama. Participated in conferences and seminars as necessary to monitor the "state-of-the-art" in decentralized hydropower technology.

Electrical Engineer, Department of Energy, Division of Power Supply and Reliability (1978-1980). Analyzed performance of bulk power systems to make engineering determinations of network performance when subjected to contingencies. Monitored utilities transfers of electric power and use of natural gas which displaced use of oil. Analyzed regional impacts on fuel consumption for proposed regulatory actions. Studied economic and regulatory factors affecting reliable bulk power performance using production cost and loss-of-load probability techniques. Received reports of bulk power system emergencies and assisted in investigation of their causes and effects.

Electrical Engineer, Rural Electrification Administration, SEAE (1975-1978). Performed engineering assignments related to the design, construction, and operation of rural electric systems. Assisted REA cooperatives with environmental documents, reliability criteria, and transmission line planning criteria as required to support REA financing. Reviewed substation and transmission line designs for conformance to REA and NESC standards.

Electrical Officer, USS Sanctuary (AH-17), U.S. Navy (1972-1974). Responsible for the entire electrical operations of the ship. Supervised technical personnel in the Electrical and Intra-Communications shops. Collateral duties included Engineering Department Adminstration Officer, Formal Survey Officer, and

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Motion Picture Officer. Qualified Power Plant supervisor, OOD Underway, and Command Duty Officer.

Volunteer, Peace Corps (1970). Assisted with Rural Electrification Program in Northeast Brazil.

Publications

Methodology for Prefeasibility Studies of Candidate Mini-Hydro Sites, 1981.

Methodology for Country Assessments of Mini-Hydropower Potential, 1981.

Distribution Considerations for Mini-/Micro-Hydro Projects, 1980.

Foreign Language Capability

"survival" Spanish and French

ALLEN R. INVERSIN

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Education

Secondary science teaching certification, College of Education, University of Maryland, 1976
Engineer in Aeronautics and Astronautics Degree, Massachusetts Institute of Technology (MIT), Cambridge, June, 1968
S.M. (Honors), MIT, January, 1968
S.B. (Aeronautical and Astronautical Engineering), MIT, 1966

Experience

Micro-Hydro Engineer, Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association, Washington, D. C. (1980-present). Responsible for gathering and evaluating technical and field information relating to small decentralized hydropower (SDH) developments. This process involves the review of available reports and documentation and supplementing this information by in-country visits; preparation of appropriate documentation to provide guidance to organizations and developing country government departments in implementing SDH schemes, and providing technical information and advice on decentralized hydropower developments to NRECA staff.

Staff Engineer, Appropriate Technology Development Unit, The PNG University of Technology, Lae, Papua New Guinea (serving with International Voluntary Services, Inc. 1976-1980). Researched, designed, fabricated, and tested several devices including major reports with micro-hydro electricity generating sets and hydraulic ram pumps, with work directed toward designs more appropriate in the local context; documented efforts and final designs in fully illustrated manuals which included detailed descriptions of construction, performance data, and relevant notes. Co-ordinated the self-help installation of a water supply and micro-hydro scheme in a remote mountain village (Baindoang), inputs included design, supervision of fabrication of hardware, logistical planning, maintaining liaison with villagers, and training.

Volunteers in Technical Assistance (VITA)/Papua New Guinea (PNG) Field Representative (1976-78). Provided VITA's first detailed view of development realities in PNG; assisted with and evaluated its by-mail technical assistance; prepared recommendations for the appropriate technology component of a Southern Highlands Provice proposal for the World Bank.

Science Educator, Royal Lao Government (RLG), Ministry of Education, Vientiane, Laos (serving with International Voluntary Services, Inc. (1969-75). Taught primarily physics and mathematics at the National Teacher Training College,

including the preparation of teaching materials stressing active student participation in the learning process; contributed to science teaching workshops. Co-edited a 300-page science teaching and improvisation handbook in the Lao language, a task which included the preparation of materials and guiding the contributions from a team of science teachers. Coordinated a joint RLG-USAID student work program during the summer to provide work opportunities nationwide, primarily in the rural areas for secondary school students.

Engineer, Helio Aircraft Corp., Bedford, Massachusetts (1968). Involved in problem solving for design modifications of STOL aircraft.

Foreign Language Capability

French, Lao, Pidgin English (PNG) - all fair to good in speaking, reading, and writing
Spanish, German, Marathi - studied, but proficiency lost through non-use

PAUL JESSON CLARK

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Education

Economics/Middle East Studies, M.A., The School of International Service, The American University, Washington, D.C., 1979
Political Science/International Affairs, B.A., The Colorado College, Colorado Springs, Colorado, 1972

Experience

Training and Information Specialist, Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association, Washington, D. C. (February, 1981-present). Duties include coordinating collection and dissemination of information pertaining to program; organizing and conducting international workshops on mini-hydropower including development of program, logistical planning, and management of publication of proceedings; developing training programs; and developing economic analysis of mini-hydro development.

Committee Advisor to U.S. Senator Jim Sasser, Budget Committee (June, 1977-January, 1981). Advised Senator on fiscal (spending, tax), monetary, international economic, and energy policies; and all legislative matters coming before the Committee. Organized hearings and drafted legislation, speeches, position papers, and legislative correspondence relating to economic issues.

Legislative Assistant to U.S. Senator Gary Hart (January, 1975-April, 1977). Developed positions relating to tax, energy, and foreign policy matters, including drafting legislation and providing recommendations on Senator's votes and actions in these fields.

Publications

"Cost Implications of Small Hydropower Systems," Proceedings on Small-Scale Hydropower in Africa (March 1-5, 1982, Abidjan, Ivory Coast).

"End Uses of Small-Scale Energy Systems in Rural Areas," Proceedings of the First U.S.-China Conference on Energy, Resources and Environment, Pergamon Press, New York (November 7-12, 1982; Beijing, People's Republic of China).

Foreign Language Capability

French, some Arabic

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202-857-9622

Education

Madison College, Harrisonburg, Virginia, Psychology major; Sigma Phi Lambda Honor Fraternity; Psi Chi (Psychology) Honor Fraternity, 1971-1973
Longwood College, Farmville, Virginia, 1970-1971

Experience

Assistant Training and Information Specialist, Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association (July 1981-present). Developed training proposal to train managers of hydro programs from developing countries at U.S.-based university in all aspects of decentralized hydro, and similar, more tailored, training program to be conducted in-country; assisted in planning and management and coordinated logistical arrangements for African regional workshop on decentralized hydropower; assist in collecting and disseminating information on small hdyropower technology and development in U.S. and developing countries.

Researcher (March 1981-July 1981). Researched, compiled, and cross-referenced data on political contributions by Political Action Committee (PACs) for last three national election years; wrote abstracts of PACs for PAC guide to be published by political scientist; interviewed executive directors of PACs about history of PAC, method and criteria for selecting candidates for political contributions, membership composition, key legislative issues of interest, other types of candidate support (media, polling, precinct targeting).

Consultant, Teleprompter, Inc. (April 1981). Helped write political analysis of city in Arizona as guidance and background for franchise bid for cable television company; interviewed community activists to determine kinds of programming sought by visual and performing arts community; interviewed school administrators to learn requirements for and potential uses of cable television for educational purposes.

Executive Assistant to Deputy Assistant to the President for Political Liaison and White House Personnel, The White House (May 1979-January 1981). Researched and drafted memoranda to the President recommending candidates for appointment; established system to track available slots and statutory requirements for candidates for approximately 700 Presidential and Secretarial advisory boards and commissions throughout Federal government; liaison with several Federal departments to locate candidates for appointment and conducted ongoing talent outreach to identify prospective candidates for advisory boards through contacts with various special interest groups (Hispanics, state government officials, Democratic party officials, business and community leaders); wrote and

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edited report, The Carter Administration and Hispanics: A Partnership to Progress, outlining the Carter Administration's efforts to delineate and alleviate problems unique to the Hispanic community in dealing with the Federal government; disbursed, tracked, and reviewed assignments of professional staff of 6; supervised work of interns and clerical staff.

Assistant to Deputy Campaign Manager, Carter/Mondale Re-Election Committee, (August 1980-November 1980). From national headquarters, acted as conduit and ombudsman between state campaign managers for 19 western states and national campaign in all aspects of campaign (budgets, information, campaign materials, political intelligence, polls); coordinated trips to western states of President, Vice President, and Cabinet officers for campaign purposes and wrote political overviews of states for President for campaign trips; wrote daily reports on each state's activities; advised state campaign managers on expenditures for political purposes; helped write and design special interest media.

Research Assistant, Democratic National Committee (February 1979-May 1979). Assisted in coordinating national Democratic Party's delegate selection plan for national convention through contacts with State Party Chairs and DNC Executive Committee members; researched and compiled candidate filing requirements based on state statutes and state Democratic Party plans; reviewed 1976 delegate selection plans and state statutes to determine possible conflicts with new delegate selection rules; compiled legal files on state election laws.

Office Supervisor, Graduate Program in Science, Technology, and Public Policy, The George Washington University (May 1978-December 1978). Handled financial management of budgets totalling $250,000 for research grants and contracts; researched and helped write proposals to obtain Federal funds for research grants and contracts; coordinated series of science and energy policy seminars for members of the science and technology policy community; counseled students on graduate program coursework requirements; assigned, supervised, and reviewed work of secretarial staff and student assistants.

Caseworker for Rep. Joseph L. Fisher, 10th District of Virginia (January 1975-May 1978). Established and operated district office for U.S. Cngressman; acted as ombudsman handling constituents problems with Federal government (upgrading military discharges; obtaining Federal workers' compensation, or Social Security disability benefits); developed briefing papers for Congressman for meetings with constituents; helped communities obtain Federal funds for sewer and water treatment facilities through EPA, FmHA, and HUD; acted as liaison for and monitored meetings of local government officials to determine when congressional intervention would be helpful; monitored legislation of particular interest to farming community (arranged series of meetings with farmers culminating in Congressman's interest in sponsoring legislation to raise exemption for estate tax purpose to help keep small family farms and businesses intact); arranged two-year series of town meetings to discuss issues of interest with constituents; spoke to groups on behalf of Congressman; supervised support staff.

Vice Chairman, Loudoun County Democratic Committee (June 1976-November 1976). Coordinated county-wide campaigns for Carter, Zumwalt, and Fisher; coordinating literature distribution and telephone canvassing; arranged fund raising events; arranged production and placement of radio and newspaper advertisements; coordinated election day coverage of polling places.

Campaign staff, Fisher for Congress (June 1974-December 1974). Helped coordinate activities of volunteers; helped plan, promote, and operate series of coffees and neighborhood meetings with candidate; compiled district-wide list of campaign volunteers for future campaigns; helped coordinate distribution of literature.

Foreign Language Capability

some Spanish, some French

Appendix H—Resumes of SAFHL staff

ROGER E. A. ARNDT

Education

Civil Engineering, Hydrodynamics, Ph.D., 1967, Massachusetts Institute of Technology (MIT)
Civil Engineering, Hydrodynamics, S.M., MIT, 1962
Civil Engineering, B.C.E., City College of New York, 1960

Experience

Director, St. Anthony Falls Hydraulic Laboratory, Chairman and Director of Graduate Studies, Fluid Mechanics Program, and Professor, Department of Civil and Mineral Engineering, University of Minnesota (1977-present)

Associate Professor of Aerospace Engineering, Pennsylvania State University (1971-1977)

Assistant Professor, Aerospace Engineering, Pennsylvania State University (1967-1971)

NASA Fellow, Massachusetts Institute of Technology (1964-1967)

Sr. Research Engineer, Lockheed California Company (1963-1964)

Research Engineer, Allegany Ballistics Laboratory (1962-1963)

Professional Societies

Acoustical Society of America
American Institute of Aeronautics and Astronautics
American Society of Civil Engineers
American Society of Engineering Education
American Society of Mechanical Engineers
American Society for Testing and Materials
International Association for Hydraulic Research
New York Academy of Sciences
Sigma Xi
American Water Resources Association

Honors

Lorenz G. Straub Award
George Taylor Teaching Award
AIAA Outstanding Faculty Advisor Award (4 years)
Who's Who in America
Who's Who in Technology Today
First Theodor Ranov Distinguished Lecturer
Who's Who in the Mid-West
Who's Who in Aviation and Aerospace: U.S. Edition

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Who's Who in Engineering
Fellow, American Society of Mechanical Engineers

Consulting

Bell Aerospace Company, IIT Research Institute, Ames Directorate, Army Air Mobility Research Laboratory, Richards of Rockford, Yarway Corporation, Wylie Laboratories, Office of Naval Research - London, Netherlands Ship Model Basin, Honeywell Corporation, Bolt Beranek and Newman, Inc., Inc., U.S. Bureau of Reclamation, Babcock and Wilcox, Thermal Systems, Inc., Sci, Med Inc.

Publications

Over 50 published papers in refereed journals.

Presentation

"Small Turbine Technology: A Selective Review." Presented to NRECA Small Hydropower Workshop, Quito, Ecuador, August 19, 1980.

Other Activities

Associate Editor, Journal of Fluids Engineering

International Committees

Member, Cavitation Committee, International Association for Hydraulic Research

National Committees

Chairman, Polyphase Flow Committee, American Society of Mechanical Engineers

Member, Technical Committee on Aeroacoustics, American Institute of Aeronautics and Astronautics

Member, Fluid Mechanics Committee, American Society of Mechanical Engineers

Member, Student Activities Committee, American Insitute of Aeronautics and Astronautics

Member, Noise Committee, Acoustical Society of America

Member, Committee on Environment, American Society of Mechanical Engineers

Member, G-2 Committee on Cavitation Erosion, American Society for Testing Materials

JOHN S. GULLIVER

Dr. Gulliver is an Assistant Professor in Civil and Mineral Engineering at the University of Minnesota. He received the Bachelor of Science Degree in Chemical Engineering at the University of California, Santa Barbara, in 1974, and M.S. and Ph.D. Degrees in Civil and Mineral Engineering at the University of Minnesota. His general areas of expertise are environmental hydraulics and hydropower development. At the St. Anthony Falls Hydraulic Laboratory, Dr. Gulliver has recently, or is currently supervising seven hydropower feasibility studies and is conducting a survey of hydropower potential at existing dam sites in the State of Minnesota. As a consultant, he has participated in the design of hydraulic structures for hydropower facilities, development and review of equipment bid documents, and license and permit applications. Current research topics include the environmental impact of hydropower development in the State of Minnesota, vortex formation at hydropower plant intakes, and reaeration at hydraulic structures.

Published Reports and Memoranda

Observations of Cooling Water Discharge Effects on Ice Covers and Dissolved Oxygen Levels in Selected Minnesota Lakes and Streams, by H. Stefan, D. E. Ford, and J. Gulliver, SAFHL Project Report No. 155, University of Minnesota, March 1975.

A Review of Methods to Separate Sediments from Storm Water Associated with Construction Operations, by J. F. Ripken, J. Killen, and J. Gulliver, SAFHL Ext. Memo No. 137, University of Minnesota, September 1975.

Methods for Separation of Sediment from Storm Water at Construction Sites, by J. F. Ripken, J. Killen, and J. Gulliver, U.S. EPA Report 660/2-77/033, February 1977. (Revision of No. 2)

Analysis of Surface Heat Exchange and Longitudinal Dispersion in Narrow Open Field Channels with Application to Water Temperature Prediction, by John Gulliver, M.S. Thesis, University of Minnesota, January 1978.

Operational Water Temperature Characteristics in Channel No. 1 of the USEPA Monticello Ecological Research Station, by M. Hahn, J. Gulliver, and H. Stefan, SAFHL Ext. Memo No. 151, University of Minnesota, January 1978.

Physical Characteristics of the Experimental Field Channels at the USEPA Ecological Research Station in Monticello, Minnesota, by M. G. Hahn, J. S. Gulliver, and H. Stefan, SAFHL Ext. Memo No. 156, University of Minnesota, April 1978.

Soil Thermal Conductivity and Temperature Prediction in the Bed of the Experimental Field Channels at the USEPA Ecological Research Station in Monticello, Minnesota, by J. S. Gulliver and H. Stefan, SAFHL Ext. Memo No. 165, University of Minnesota, January 1980.

Pore Water Temperatures and Heat Transfer in a Riffle (Rock) Section of the Experimental Field Channels at the USEPA Ecological Research Station at Monticello, Minnesota, by H. Stefan and J. S. Gulliver, SAFHL Ext. Memo No. 166, University of Minnesota, April, 1980.

Analysis and Modeling of Water Temperature Dynamics in the USEPA Monticello Field Channels, by H. Stefan, J. Gulliver, M. G. Hahn, and A. Y. Fu, SAFHL Project Report No. 193, University of Minnesota, June 1980.

Preliminary Analysis of Hydropower Production Feasibility at Twenty-One Existing Dam Sites in the State of Minnesota, by J. Gulliver, R. J. Garver, R. E. A. Arndt, and C. E. Bowers, SAFHL Project Report No. 196, University of Minnesota, August 1980.

Numerical and Graphical Procedures for Estimation of Community Photosynthesis and Respiration in Experimental Streams, by J. S. Gulliver, T. W. Mattke, and H. G. Stefan, SAFHL Project Report No. 198, University of Minnesota, December 1980.

Reaeration and Productivity Analysis from Dissolved Oxygen Routing in Open Channels, by J. S. Gulliver, Ph.D. Thesis, University of Minnesota, December 1980.

Photosynthesis and Respiration Rates in the Monticello Experimental Streams: 1978/79 Diel Field Data and Computed Results, by J. S. Gulliver and H. G. Stefan, SAFHL External Memo No. 172, University of Minnesota, February 1981.

Air-Water Surface Exchange of Oxygen: Theory and Application to Experimental Streams, by J. S. Gulliver, and H. G. Stefan, SAFHL External Memo No. 173, University of Minnesota, May 1981.

Hydropower Feasibility at the Kettle River Dam MN 00513, by J. S. Gulliver, R. J. Knowlton, and R. J. Garver, SAFHL Project Report No. 200, University of Minnesota, July 1981.

Feasibility of Hydropower Capacity Additions at the Granite Falls Dam MN 00510 by L. Gake, R. Garver, J. Gulliver, and R. Renaud, SAFHL Project Report No. 203, University of Minnesota, August 1981.

Hydropower Feasibility at the St. Cloud Dam MN 00506, by R. J. Knowlton, J. S. Gulliver, and R. Renaud, SAFHL Project Report No. 204, University of Minnesota, September 1981.

Publications in Refereed Journals

"Effluent Mixing Zone in a Shallow River," by H. Stefan and J. Gulliver, Journal of the Environmental Engineering Division, ASCE, Vol 104, No. EE2, April, 1978, pp. 199-213.

"Unsteady One-Dimensional Settling of Suspended Sediment," by S. Dhamotharan, J. S. Gulliver, and H. G. Stefan, Water Resources Research, Vol. 17, No. 4, August 1981.

"Simulating Phytoplankton Response to Lake Destratification," by J. S. Gulliver and H. G. Stefan, accepted for publication in: Journal of the Environmental Engineering Division, ASCE, 1982.

"Stream Productivity Analysis with DORM," by J. S. Gulliver and H. G. Stefan, submitted for publication to: Water Research, 1982.

Proceedings and Oral Presentations

"Analysis of Surface Heat Exchange and Longitudinal Dispersion in a Narrow Open Field Channel," by John Gulliver. Presented at the Second Annual Alvin G. Anderson Award, University of Minnesota, May 1977.

"A Comparison of Preliminary and Comprehensive Hydropower Feasibility Estimates," by J. S. Gulliver and R. J. Garver. Proceedings of Waterpower '81, An International Conference on Hydropower, June 22-24, 1981, pp. 596-610.

CESAR FARELL

Citizenship

United States

Languages

Spanish, French, English, Portuguese

Education

Doctor of Philosophy (Mechanics and Hydraulics), The University of Iowa, Iowa City, Iowa, August 1968
Thesis Title: "On the Wave Resistance of a Submerged Spheroid"

Master of Science (Mechanics and Hydraulics), The University of Iowa, Iowa city, Iowa, June 1965
Thesis Title: "Effect of Lifting-Beam Geometry on the Vibration of Multiple-Leaf Gates"

Degree of Engineer (Hydromechanics, Hydraulic Machinery, Hydro- and Termal-Power Development), Facultad de Ingenieria y Agrimensura, Universidad de la Republica, Montevideo, Uruguay, April 1962.

Awards and Distinctions

Artigas Scholarship, Universidad de la Republica, Montevideo, Uruguay.

United States Government Grant (Fulbright), September 1963 - August 1964.

University of Iowa Fellowship, September 1964 - May 1965.

Appointed, by the Ministere de l'Education Nationale, France, Maitre de Conferences Associe at the Universite Scientifique et Medicale de Grenoble, 1974 - 1975.

Fulbright-Hays Lecturer and Research Scholar, Caracas, Venezuela, May - August 1978.

U.S. Professor, International Communication Agency, Universidade Federal do Rio Grande do Sul, Porto Alegre, and Universidade de Sao Paulo, Brazil, September 1978.

Visiting Professor, Department of Hydraulic Engineering, Escola Politecnica, Universidade de Sao Paulo, Brazil, Summer 1980 and Summers 1982 - on. New graduate course added: Turbulence, Theory and Applications in Hydraulic Engineering.

Visiting Professor, Universidad Nacional Autonoma de Mexico, Mexico City, December 1981.

Positions Held

Instructor, Mechanics and Fluid Mechanics, and Research Associate, Departamento de Mecanica de los Fluidos, Facultad de Ingenieria, Montevideo, Uruguay, 1958-1963.

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Instructor, Mathematical Analysis, Facultad de Ciencias Economicas y de Administracion, Montevideo, Uruguay, 1957-1962.

Instructor, Department of Mechanics and Hydraulics (Fluid Mechanics, Mechanics of Solids, Computational Methods) and Research Associate, Institute of Hydraulic Research, The University of Iowa, Iowa City, Iowa, 1965-1968.

Assistant Professor, Department of Mechanics and Hydraulics, and Research Engineer, Institute of Hydraulic Research, The University of Iowa, Iowa City, Iowa, 1968-1973.

Associate Professor, Department of Mechanics and Hydraulics, and Research Engineer, Institute of Hydraulic Research, The University of Iowa, Iowa city, Iowa, 1973-1978.

Maitre de Conferences Associe, Institut de Mecanique, Universite Scientifique et Medicale de Grenoble, France, 1974-1975.

Fulbright-Hays Lecturer and Research Scholar, Laboratorio Nacional de Hidraulica and Universidad Central, Caracas, Venezuela, May-August 1978.

U.S. Professor, International Communication Agency, Universidade Federal do Rio Grande do Sul, Porto Alegre, and Universidade de Sao Paulo, Brazil, September 1978.

Associate Professor, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minnesota, 1978-present.

Visiting Professor, Curso de Pos - Graduacao em Engenharia Civil, Universidade Federal do Rio Grande do Sul, Brazil, Summer 1979.

Visiting Professor, Centro Tecnologico de Hidraulica, Departamento de Aguas e Energia Electrica and Universidade de Sao Paulo, Sao Paulo, Brazil, Summer 1980.

Membership in Professional Societies

Member, International Association for Hydraulic Research
Member, American Society of Mechanical Engineers
Member, American Society of Civil Engineers

Professional Activities

Chairman, Fluids Committee, Engineering Mechanics Division, ASCE, 1979 -

Editorial Board Member, Journal of Engineering Mechanics, ASCE (Publications Chairman, Fluid Mechanics).

Member, ASCE Aerospace Division Aerodynamics Committee, 1979 -

Liaison Member, ASCE Structural Division Committee on Wind Effects, 1979 -

Member, ASCE Task Committee on Proposed Standards for Wind Tunnel Testing of Buildings and Structures

Reviewer, Applied Mechanics Reviews, National Science Foundation, ASME Journal of Fluids Engineering, ASCE Journal of Engineering Mechanics

Technical Program Organizer, ASCE Fluid Mechanics Sessions, Joint ASME/ASCE Mechanics Conference, Boulder, Colorado, June 1981.

Consultant, Laboratorio Nacional de Hidraulica, Caracas, Venezuela (1977-1978) and Centro Tecnologico de Hidraulica, Departamento de Aguas e Energia Electrica, Sao Paulo, Brazil.

Selected Invited Seminars, Lectures, and Short Courses

"Wind Loading of Cooling Towers," Institut für Konstruktiven Ingenierbau, Ruhr-Universität Bochum, February 7, 1975.

"Spectral Analysis, " Insituut Voor Wetenschappen Van Het Leefmilieu, Vrije Universiteit Brussel, February 9, 1975.

"Influence de la rugosite sur la reparition de pression engendree par le vent sur les constructions arrondies, notamment les tours de refroidissement," and "Effet des parois d'une soufflerie sur l'ecoulement autour de cylindres circulaires et de modeles de tours de refroidissement," Electricite de France, Direction des Etudes et Recherches, Chatou, February 26 and 27, 1975.

"On the Second-Order Theory of the Wave Resistance of a Submerged Spheroid, With an Appendix on the Numerical Calculation of the Corresponding Green's Function," Institüt fur Schiffbau, Universität Hamburg, June 24, 1975.

"Surface Roughness Effects on the Mean Wind Pressure Distribution on Hyperbolic Cooling Towers," Institute für Hydromechanik, Universitat Karlsruhe, July 1, 1975.

"Surface Roughness Effects on the Flow Around Circular Cylinders and Cooling Towers," College of Engineering, Colorado State University, Fluid Mechanics and Wind Engineering Program Seminar Series, February 2, 1977.

"On Second-Order Contributions to the Wave Resistance of a Submerged Spheroid," Ship Performance Department Hydromechanics Colloquium, David W. Taylor Naval Ship Research and Development Center, Washington, D.C., March 24, 1977.

"Condiciones de semejanza en escurrimiento turbulento alrededor de cuerpos sumergidos," "Distribucion de presiones alrededor de cuerpos redondeados," and "Escurrimiento supercritico alrededor de cuerpos rugosos," Laboratorio Nacional de Hidraulica, Caracas, Venezuela, April 20-22, 1977.

"Estadistica para Ingenieros," short intensive course, Instituto de Mejoramiento Profesional, Colegio de Ingenieros, Caracas, Venezuela, July 11-15, 1977.

"Hydraulic Models," short intensive course, Universidad de Los Andes, Merida, and Universidad del Zulia, Maracaibo, Venezuela, Summer 1978.

"Turbulencia: Modelos de Calculo y Aplicaciones," Laboratorio Nacional de Hidraulica, Caracas, Venezuela, Summer 1978.

"Wind Load on Cooling Towers and Other Round-Walled Structures," invited lecture, short course on Wind Load, Tornadoes, and Building Codes, Kansas City, Missouri, June 1979, sponsored by Department of Civil Engineering and Extension Division, University of Missouri - Columbia.

"Turbulencia e analise de sinais estocasticos," short intensive course, Centro Tecnologico de Hidraulica, Universidade de Sao Paulo, Brazil, Summer 1980.

"Vortex Dynamics and Similitude in Free Surface Flows," short intensive course, Centro Tecnologico de Hidraulica, Universidade de Sao Paulo, Brazil, March 1981.

"Small-Scale Hydropower," Universidade de Sao Paulo at Sao Carlos, Brazil, September 9, 1981.

"Vortex Formation on Pump and Turbine Intakes" and "Flow Effects on Structures," short intensive courses, Universidad Nacional Autonoma de Mexico, Mexico City, December 1981.

Professional Experience: Project/Grant Supervision

"Ship Hydrodynamics (Wave and Viscous Resistance of a Submerged Spheroid," September 1968 - August 1973, Office of Naval Research, Co-Principal Investigator.

"Wake Characteristics (Grid Turbulence in Density-Stratified Liquids)," September 1968 - December 1969, Office of Naval Research, Principal Investigator.

"Analysis of Glass Experimental Recoil Mechanism," October 1968 - January 1969, Rock Island Arsonal, Co-Principal Investigator.

"Hydrodynamics of Flow in the Lower Urinary Tract," February 1970 - January 1971, Public Health Service, Principal Investigator.

"Wind-Tunnel Model Study of the Mean Pressure Distribution on the Stacks of Multiple-Fan Cooling Towers," May 1970 - May 1971, The Marley Company, Kansas City, Missouri, Principal Investigator.

"Hydrodynamics of Swimming," June 1970 - May 1971, Graduate College, The University of Iowa, Co-Principal Investigator.

"An Experimental Investigation of the Turbulent Structure of Sediment Suspensions," June 1970 - June 1972, Agricultural Research Service, United States Department of Agriculture, Oxford, Mississippi, Principal Investigator.

"Surface Roughness and Reynolds Number Effects on the Mean and Fluctuating Pressures on Rounded Structures," December 1970 - March 1971, The Marley Company, Kansas City, Missouri, Principal Investigator.

"Aerodynamics of Hyperbolic Cooling Towers," September 1972 - February 1975, National Science Foundation, Principal Investigator.

"Effects of External Ribs on the Mean Wind Pressure Distributions on Hyperbolic Cooling Towers," October 1973 - August 1974, The Marley Company, Kansas City, Missouri, Principal Investigator.

"Model Study of the Inlet and Sump of the Clinton First Avenue Pump Station," October 1975 - December 1976, U.S. Army Corps of Engineers, Rock Island District, Principal Investigator.

"Model Study of Stabilization of Missouri River Bed by Low Sills: George Neal Power Station Near Sioux City, Iowa," October 1976 - December 1977, Gibbs and Hill, Inc., Omaha, Nebraska, Co-Principal Investigator.

"Mean and Fluctuating Pressure Distributions on Circular Cylinders with Large Roughness," November 1976 - May 1978, National Science Foundation, Co-Principal Investigator.

"Mean and Fluctuating Pressure Distributions on Circular Cylinders with Large Roughness," October 1978 - December 1981, National Science Foundation, Principal Investigator.

"Fluctuating Loads on Rounded Structures: Effects of Turbulence in the Oncoming Stream," September 1980 - June 1981, Graduate School, University of Minnesota, Principal Investigator.

"Fluctuating Loads on Rounded Structures," International Scientific Cooperative Program, Universidade Federal do Rio Grande do Sul, Brazil, October 1980 - September 1982, National Science Foundation, Principal Investigator.

"CE 3400 Fluid Mechanics Laboratory," Educational Development Grant, September 1981 - June 1982, Center for Educational Development, Principal Investigator.

Professional Experience Prior To Graduate Studies

Departamento de Mecanica de los Fluidos, Montevideo, Uruguay:
Participation in and partial supervision of a number of projects concerning the design and operation of fixed-bed river models, of models to study the stability of movable beds, and various other studies in hydraulic, hydropower, and energy engineering, during tenure as Research Associate, March 1958 - August 1963.

Technical Department, Mellor-Goodwin del Uruguay, Montevideo:
Provided assistance in the solution of energy generation problems in industrial plants, 1960 - 1961.

Publications

Contributions to Books and Monographs:

"Hydraulic Turbines," Chapter 5 in Small Hydropower Systems Design, J. J. Fritz and J. Henry, Editors, to be published (by R. E. A. Arndt, C. Farell, and J. Wetzel).

Papers Published

"Rough-flow criterion in open-channels and scale selection for fixed-bed river models," Journal of Hydraulic Research, Vol. 3, No. 2, 1965, pp. 59-72 (by O. J. Maggiolo and C. Farell).

"Efecto de la geometria de la viga de operacion en la vibracion de compuertas de hojas multiples," Proceedings, II Congreso Latinoamericano de Hidraulica, Caracas, July 1966, pp. 199-216.

"Flujo potencial alrededor de un elipsoide alargado de revolucion en movimiento axial uniforme paralelo a una pared," Proceedings, III Congreso Latinoamericano de Hidraulica, Buenos Aires, December 1968, pp. 145-152.

"Unified analysis of grid turbulence," Journal of the Engineering Mechanics Division, ASCE, Vol. 96, No. EM2, April 1970, pp. 121-141 (by E. Naudascher and C. Farell).

"Analisis del movimiento producido por el pasaje de una malla a traves de liquidos homogeneos y estratificados," Proceedings, IV Congreso Latinoamericano de Hidraulica, Oaxtepec, Mexico, August 1970, pp. 155-166.

"On the flow about a spheroid near a plane wall," Journal of Ship Research, Vol. 15, No. 3, September 1971, pp. 246-252.

"The modelling of wind loading on large cooling towers," Proceedings, Combined 2nd Annual Thermal Power Conference and 8th Biennial Hydraulics Conference, Washington State University, Pullman, Washington, October 1971, pp. 139-166.

"On the evaluation of certain integrals containing products of Bessel functions," Industrial Mathematics, Vol. 21, Part 2, 1971, pp. 85-89 (by D. D. Penrod and C. Farell).

"On the wave resistance of a submerged spheroid," Journal of Ship Research, Vol. 17, No. 1, March 1973, pp. 1-11.

"Unsteady nonuniform flow in the entrance of a pipe," Journal of Applied Mechanics, Transactions, ASME, Vol. 95, Ser. E., No. 3, September 1973, pp. 672-678; presented at the 1973 ASME Joint Applied Mechanics and Fluids Engineering Conference, Georgia Institute of Technology, Atlanta, Georgia, June 1973 (by F. Noblesse and C. Farell).

"On the experimental determination of the resistance components of a submerged spheroid," Journal of Ship Research, Vol. 17, No. 2, June 1973, pp. 72-79 (by C. Farell and O. Guven).

"Numerical calculation of the wave integrals in the linearized theory of water waves," Journal of Ship Research, Vol. 21, No. 1, March 1977, pp. 1-10; also IIHR Report No. 166, Institute of Hydraulic Research, The University of Iowa, November 1975, 55 pp. (by H. T. Shen and C. Farell).

"Laboratory simulation of wind loading on rounded structures," Proceedings, IASS World Congress on Space Enclosures, Montreal, July 1976, pp. 905-913 (by C. Farell, O. Guven and V. C. Patel).

"Mean wind loading on rough-walled cooling towers," Journal of the Engineering Mechanics Division, ASCE, Vol. 102, No. EM6, December 1976, pp. 1059-1081 (by C. Farell, O. Guven and F. Maisch).

"A model for high-Reynolds-number flow past rough-walled circular cylinders," Journal of Fluids Engineering, Transactions, ASME, Vol. 99, Ser. I, No. 3, September 1977, pp. 486-494; presented at the Symposium on Flow Effects on Structures, ASME Winter Annual Meeting, New York, N.Y., December 1976 (by O. Guven, V. C. Patel, and C. Farell).

"Effect of wind-tunnel walls on the flow past circular cylinders and cooling tower models," Journal of Fluids Engineering, Transactions, ASME, Vol. 99, Ser. I, No. 3, September 1977, pp. 470-479; presented at the Symposium on Flow Effects on Structures, ASME Winter Annual Meeting, New York, N.Y., December 1976 (by C. Farell, S. Carrasquel, O. Guven, and V. C. Patel).

"Escurrimiento alrededor de cilindros circulares: un "nuevo" tema de investigacion," Proceedings, VIII Congreso Latinoamericano de Hidraulica, Quito, Ecuador, October 1978.

"Surface roughness effects on the mean flow past circular cylinders," Journal of Fluid Mechanics, Vol. 98, Part 4, June 1980, pp. 673-701 (by O. Guven, C. Farell, and V. C. Patel).

"Equacoes das tensoes de Reynolds e da energia cinetica para movimentos turbulentos," accepted for publication in Boletim Tecnico DAEE, Departamento de Aguas e Energia Eletrica, Centro Technologico de Hidraulica, Sao Paulo, Brazil.

"Analise estocastica das fluctuacoes de velocidade no escoamento de un canal," accepted for publication in Boletim Tecnico DAEE, Departamento de Aguas e Energia Eletrica, Centro Tecnologico de Hidraulica, Sao Paulo, Brazil.

"Flow around fixed circular cylinders: fluctuating loads," Journal of the Engineering Mechanics Division, ASCE (Special Volume on Advances in Fluid Mechanics), Vol. 107, No. EM3, June 1981, pp. 565-588.

"Boundary-layer development on a circular cylinder with ribs," presented at 102nd WAM, ASME, Washington, D.C. November 1981 (by O. Guven, C. Farell, and V. C. Patel); to be submitted for publication to Journal of Fluids Engineering, ASME.

"Vortex dynamics and similitude in free surface flows," to be submitted for publication to Journal of Engineering Mechanics, ASCE (by C. Farell and A. R. Cuomo) and for presentation at the BHRA International Conference on the Hydraulic Modeling of Civil Engineering Structures, Coventry, England, September 1982.

Invited Papers

"Flow around circular cylinders: unsteady loads," St. Anthony Falls Hydraulic Laboratory Project Report No. 188, University of Minnesota, Minneapolis, Minnesota, November 1979, 47 pp, 7 figs.; invited paper, Office of Naval Research-NASA Workshop on High Reynolds Number Cylinder Flows, NASA Ames Research Center, November 1979.

"Flow around rounded rough-walled structures: experimental and analytical studies," invited paper, Special Session on Wind Loading and Response of Large-Scale Cooling Tower Shells, 1977 ASCE Annual Convention, San Francisco, California, October 1977, 22 pp. (by C. Farell and V. C. Patel).

"Drag of bodies moving through fluids," in Selected Topics on Biomechanics, Proceedings of the C.I.C. Symposium on Biomechanics, Indiana University, Bloomington, Indiana, October 1970, The Athletic Institute, Chicago, Illinois, 1971, pp. 169-178.

"The effects of surface roughness on the mean and fluctuating pressures on large rounded structures," Proceedings of the Conference on Wind Loads on Structures, California Institute of Technology, Pasadena, December 1970, pp. 100-105 (by J. F. Kennedy and C. Farell).

Reports

"A review of available information on surface roughness and Reynolds number effects on the mean and fluctuating pressures on rounded structures," IIHR Limited Distribution Report No. 4, Institute of Hydraulic Research, The University of Iowa, March 1971, 30 pp.

"Wind-tunnel model study of the mean pressure distribution on the stacks of multiple-fan cooling towers," IIHR Limited Distribution Report No. 5, Institute of Hydraulic Research, The University of Iowa, May 1971, 12 pp., 121 figs. (by C. Farell and C. Alonso).

"External roughness effects on the mean wind pressure distribution on hyperbolic cooling towers," IIHR Report No. 164, Institute of Hydraulic Research, The University of Iowa, August 1974, 51 pp. (by C. Farell and F. E. Maisch).

"Surface roughness effects on the mean flow past circular cylinders," IIHR Report No. 175, Institute of Hydraulic Research, The University of Iowa, May 1975, 184 pp. (by O. Guven, V. C. Patel, and C. Farell).

"Model study of the inlet and sump of the Clinton First Avenue Pump Station," IIHR Report No. 196, Institute of Hydraulic Research, The University of Iowa, November 1976, 21 pp., 42 figs.

"Model study of stabilization of Missouri-River bed by low sills: Neal Power Station, near Sioux City, Iowa," IIHR Limited Distribution Report No. 50, Institute of Hydraulic Research, The University of Iowa, December 1977, 41 pp., 38 figs. (by C. Farell, Y. F. Lee, and J. F. Kennedy).

"Introduction to the study of vortex dynamics and similitude in free surface flows," Centro Tecnologico de Hidraulica Technical Report, Sao Paulo, in press (by C. Farell and A. R. Cuomo).

Papers Presented

"On the linearized theory of the wave resistance of a submerged spheroid," presented at the XIIth International Congress on Applied Mechanics, Stanford University, August 1968.

"Grid turbulence in density-stratified fluids," presented at the 19th Annual ASCE Hydraulics Division Specialty Conference, The University of Iowa, Iowa City, August 1971 (by C. Farell and M. C. Tao).

"Hydrodynamics of flow in the lower urinary tract," presented at the 24th Annual Conference on Engineering in Medicine and Biology, Las Vegas, Nevada, November 1971 (by C. Farell and F. Noblesse).

"On the equations of flow in the lower urinary tract," presented at the 25th Annual Conference on Engineering in Medicine and Biology, Bal Harbour, Florida, October 1972.

"Analysis of velocity fluctuations and suspended sediment concentration data in open channel flow," presented at the 3rd Biennial Symposium on Turbulence in Liquids, University of Missouri-Rolla, September 1973 (by V. Danushkodi, C. Farell, and F. Locher).

"Second-order wave resistance theory of a submerged spheroid," presented at the 17th British Theoretical Mechanics Colloquium, University of Manchester, Institute of Science and Technology, April 1975 (by C. Farell and H. T. Shen).

"Wind loading on hyperbolic cooling towers," presented at the Second U.S. National Conference on Wind Engineering Research, Colorado State University, Fort Collins, Colorado, June 1975 (by C. Farell, O. Guven, F. Maisch, and V. C. Patel).

"On the calculation of nonlinear wave forces," Proceedings, 2nd Annual ASCE Engineering Mechanics Division Specialty Conference, Raleigh, North Carolina, May 1977, pp. 71-74 (by H. T. Shen and C. Farell).

"Flow around ribbed cylinders: experimental and analytical studies," Proceedings, 2nd Annual ASCE Engineering Mechanics Division Specialty Conference, Raleigh, North Carolina, May 1977, pp. 139-141 (by C. Farell, V. C. Patel, and O. Guven).

"On the flow past rough-walled circular cylinders," Proceedings, 6th Canadian Congress of Applied Mechanics, Vancouver, Canada, May-June 1977, pp. 649-650, (by C. Farell, V. C. Patel, and O. Guven).

"Flow around rounded structures: unsteady loads," Proceedings, Third U.S. National Conference on Wind Engineering Research, University of Florida, Gainesville, Florida, February 1978 (by C. Farell and I. Celik).

"Scale effects in the formation of intake vortices," presented at the Joint ASME/ASCE Mechanics Conference, Boulder, Colorado, June 1981 (by A. R. Cuomo and C. Farell).

"Pressure fluctuation measurements on rough-walled cylinders in uniform flows," presented at the Joint ASME/ASCE Mechanics Conference, Boulder, Colorado, June 1981 (by B. Franck and C. Farell).

Discussions Published

Discussion of "Form-induced hydraulic forces on three-leaf intake gates," by R. A. Elder and J. M. Garrison, Journal of the Hydraulics Division, ASCE, Vol. 91, No. HY2, March 1965, pp. 320-329 (by E. Naudascher and C. Farell).

Discussion of "Critical analysis of open-channel resistance," by H. Rouse, Journal of the Hydraulics Division, ASCE, Vol. 92, No. HY2, March 1966, pp. 395-399.

Discussion of "Dynamics of contained oil slicks," by D. L. Wilkinson, Journal of the Hydraulics Division, ASCE, Vol. 99, No. HY7, July 1973, pp. 1167-1169 (by C Farell, S. C. Jain, and O. Guven).

Discussion of "Model-prototype comparison of free surface vortices," by G. E. Hecker, submitted to Journal of the Hydraulics Division, ASCE (by C. Farell and A. R. Cuomo).

C. EDWARD BOWERS

Biography

C. Edward Bowers, Professor, Department of Civil Engineering, St. Anthony Falls Hydraulic Laboratory, University of Minnesota

Education

Civil Engineering B.S., University of Wyoming (1942)
Civil Engineering M.S., University of Minnesota (1949)
Individual courses and seminars at George Washington University (1945), Utah State University (1965), University of Illinois (1972), University of Nebraska (1974), and University of Minnesota (1975)

Honors

4 year scholarship, University of Wyoming, 1937-1942
Standard-Oil Fellowship, University of Minnesota, 1947
Collingwood Award, American Society of Civil Engineers (1949)
Sigma Tau, National Engineering Honorary (1939)
Tau Beta Pi, National Engineering Honorary (1960)
Sigma Xi, National Research Honorary
Listed in Who's Who (1972. . .), Who's Who in Engineering
Listed in American Men of Science

Employment Record

Professor, University of Minnesota, St. Anthony Falls Hydraulic Laboratory (1963-present)

Associate Professor, University of Minnesota (1961-1963)

Professor (1/2 time) and Research Associate (1/2 time), University of Minnesota, St. Anthony Falls Hydraulic Laboratory (1959-1963)

Research Associate, St. Anthony Falls Hydraulic Laboratory (1951-1959)

Hydraulic Engineer (Research), Bureau of Reclamation, Denver, Colorado (1950-1951)

Research Fellow, St. Anthony Falls Hydraulic Laboratory (1948-1950)

Graduate Student, University of Minnesota (1946-1948)

Hydraulic Engineer and Ensign, David Taylor Ship Research and Development Laboratory, U.S. Navy (1942-1947)

Summary of Experience

Current duties in the Department of Civil and Mineral Engineering and the St. Anthony Falls Hydraulic Laboratory include the teaching of courses in Water Resources Engineering, Hydrology, and Hydrologic Design, Computer Applications

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in Water Resources, and Advanced Hydraulic Laboratory plus research in Hydrology and Hydraulic Engineering. Recent research includes (a) Computer Analysis of Various Operating plans for Headwater Reservoirs on the Mississippi River, (b) Mathematical Modeling of Selected Watersheds in the Copper-Nickle Area of Northeastern Minnesota (c) Flood Forecasting on Minnesota Watersheds, (d) Breakwater Studies on Lake Superior, (e) Diversion Outlet Structure for Mangla Dam in Pakistan, (f) Laboratory Studies of Tunnels, Gates, and Stilling Basins for South Saskatchewan Project in Canada.

Duties at the Bureau of Reclamation included Model Studies of Spillway for Cachuma Dam and miscellaneous studies of Davis Dam Spillway and Heart Butte Dam Spillway.

Duties at the David Taylor Naval Ship Research and Development Laboratory included (1) model studies of optimum cross-sectional dimensions of a modernized Panama Canal, (2) facility development for ship studies, and (3) miscellaneous research in fluid mechanics and hydraulics.

Recent Publications

"The Effects of Different Operating Plans for the Six Mississippi River Headwaters Dams," with N. P. Nelson, C. K. Gutschick, and W. C. Schevenius, St. Anthony Falls Hydraulic Laboratory Project Report No. 184, August 1979, 25 500 pages.

"Preliminary Analysis of Hydropower Production Feasibility at Twenty-One Existing Dam Sites in the State of Minnesota," with J. Gulliver, R. J. Garver, and R. E. A. Arndt, St. Anthony Falls Hydraulic Laboratory Project Report No. 196, August 1980, 25 pages.

"Computer Programs in Water Resources," with C. S. Chu, Water Resources Research Center, University of Minnesota Bulletin No. 97, April 1977, 263 pages.

"An Optimization Technique for a Mathematical Urban Runoff Model," with C. S. Chu, International Symposium on Urban Storm Water Management, Lexington, Kentucky, July 1978.

"Stochastic Analysis of Spring Meteorological Data in the Upper Midwest," with K. Kim, St. Anthony Falls Hydraulic Laboratory Project Report No. 156, June 1975.

"Hydrologic Investigations of Selected Watersheds in Copper-Nickel Region of Northeastern Minnesota," with C. Savard and A. Gray, conducted for Minnesota Environmental Quality Council, SAFHL EM-159, August 1978.

"Forecasting Rainfall and Snowmelt Floods on Upper Midwest Watersheds," with K. Kim, C. Chu, and D. Baker, St. Anthony Falls Hydraulic Laboratory Project Report No. 151, 1974.

"Simulation of the Quantity and Quality of Flow in a River Basin," with C. S. Song and A. F. Pabst, St. Anthony Falls Hydraulic Laboratory Project Report No. 145, 1973.

"Model Study for the Spillway and Outlet Works of the Yguazu Dam," with E. Silberman, St. Anthony Falls Hydraulic Laboratory Project Report No. 135, 1972.

"Fluctuating Pressures in Spillway Stilling Basins," with F. Y. Tsai, Journ. of Hydraulics Division of the American Society of Civil Engineers, HY6, November 1969.

"The Real-Time Computation of Runoff and Storm Flow in the Minneapolis-St. Paul Interceptor Sewers," with G. J. Harris and A. F. Pabst, St. Anthony Falls Hydraulic Laboratory Ext. Memo No. M-118, December 1968.

"Hydraulic Studies of the Spillway of the Karnafuli Hydroelectric Project, East Pakistan," with F. Tsai and R. Kuha, St. Anthony Falls Hydraulic Laboratory Project Report No. 73, September 1964.

CHARLES C. S. SONG

Citizenship

United States

Education

National Taiwan University - B.S. - 1953 - Civil Engineering
State University of Iowa - M.S. - 1956 - Mechanics and Hydraulics
University of Minnesota - Ph.D. - 1960 - Civil Engineering

Professional Positions

Professor of Civil Engineering, University of Minnesota (1979-present)
Associate Professor of Civil Engineering, University of Minnesota (1963-1979)
Assistant Professor of Civil Engineering, University of Minnesota (1961-1963)
Research Fellow, St. Anthony Falls Hydraulic Lab, University of Minnesota (1958-1960)
Civil Engineer, Edeskuty and Associates, Minneapolis, Minnesota (1957-1958)
Civil Engineer, Ellerbe and Co., St. Paul, Minnesota (1956-1957)
Research Assistant, State University of Iowa (1954-1956)
Teaching Assistant, National Taiwan University, Taiwan (1953-1954)

Professional Consulting Experiences

Vibration of Rum River Dam, Barr Engineering, Minneapolis, Minnesota, 1968.

Mathematical Model of Random Wave Generator, MTS System Corp., Minneapolis, Minnesota, 1968-1969.

Minnesota Water Resources Data Collection System, Department of Natural Resources, St. Paul, Minnesota, 1970.

Water Quality Mathematical Modeling, Metropolitan Waste Control Commission, St. Paul, Minnesota, 1976.

Mathematical Model of Spent Nuclear Fuel Rack Under Seismic Conditions, ESI, Inc., Minneapolis, Minnesota, 1977-1978.

Seismic Analysis of Nuclear Spent Fuel Storage Facilities, PAR Systems, Inc., St. Paul, Minnesota, 1978 - present.

Mathematical Modeling of Body Moving in Water, PAR Systems, Inc., St. Paul, Minnesota, 1978 - present.

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Mathematical Modeling of Transient Flows in Sewer Systems, EMA, Inc., 1977 - present.

Mathematical Modeling of Transient Flows in Sewer Systems, LST, Rochester, N.Y., 1981.

Current Research Interests

Mathematical modeling of unsteady flows in open channel and pipes.
Kinematic wave and surrogate dynamic wave model.
Modeling of fluvial channel with sediment transport.
Theoretical mechanics based on energy principles.

Professional Organizationa and Honor Societies

ASCE, Member
AWRA, past President, Minnesota Chapter
IAHR, Member
ASME, Applied Mechanics Review Committee
SNAME, Hydroelastic Panel Member
Sigma Xi, Member
Phi Tau Phi, Member

Award Received

J. C. Stevens Award, ASCE, August 1980

Contributions to Teaching:

New Courses Developed

Incompressible Potential Flow
Special Topics in Hydrodynamic Theory—Linear Potential Flow Theory, CE 8-435
Water Resources Systems Planning, CE 8-420
Water Resources Systems Simulation, CE 8-419
Hydraulic Transients, CE 8-400

Courses Taught

Those listed under new courses developed plus,
Fluid Mechanics, CE 101, CE 103, CE 3-400
Water Resources Engineering CE 5-401
Introduction to Water Resources Management, CE 5-420 (guest lecturer)
Intermediate Fluid Mechanics with Applications, CE 187, CE 5-434
Incompressible Boundary Layer Flow, CE 8-422
Hydrodynamics of the Boundary Layer, CE 8-432
Open Channel Flow, CE 5-410
Mechanics of Sediment Transport, CE 8-413
Short Course on Small Hydropower Feasibility Study

IT Committee

Department Head Search Committee
Scholastic Standard Committee

Departmental Committees

Graduate Study Committee
Undergraduate Study Committee
Scholastic Standard Committee, including Chairmanship
Water Resources Engineering Graduate Examination Committee-Chairman
Grievance Committee

Extra University Professional Activities

NSF, Division of Higher Education in Science Advisory Panel, November 14-16, 1974
Applied Mechanics Reviews, Review Committee (Since 1970)
The Society of Naval Architects and Marine Engineers, Committee on Hydrodynamics, Hydroelasticity Panel (Since 1968)
American Water Resources Association, President of Minnesota Chapter

Graduate Advisees

Ph.D. Theses Completed

Phenomenon of Viscous Separation, 1970, Behram Mozayeny
Generation of Internal Waves in Stratified Fluid, 1973, Chyisheng Hwang
Forecasting Snowmelt Runoff in the Upper Midwest, 1973, Arthur F. Pabst
Gravity and Free Surface Effect on a Fully Cavitating Flow, 1975, (completed final oral examination on November 7, 1974), Alwin C. H. Young

M.S. Theses Completed

Propagation of Flood Waves in a Rectangular Open Channel, 1967, Behram, Mozayeny
Experimental Study of Taylor Instability Using Newtonian and non-Newtonian Fluids, 1967, Kenneth Key-Ya Chen
Laminar Boundary Layer Between Two Parallel Streams, 1969, Pierre Mignot
Vibration of Cavitating Body, 1970, Wu-Seng Lung
Stochastic Modeling for Water Temperature in Natural Streams, 1976, Julio H. Wong
Mixed - Flow Hydraulic Transient Analysis for Simple Pipe System, 1977, Kim Sau Leung
Hydraulic Transients in Sewer System, 1978, James Angus Cardle

Plan B.M.S. Awarded

James C. Lefvre, Chyisheng Hwang, Chen Lee, Chun-Yen Chien, John Craig Johnson

List of Publications

"Instability of Ventilated Cavities" (with E. Silberman), Journal of Ship Research, Vol. 5, No. 1, June 1961. Also published as St. Anthony Falls Hydraulic Laboratory Technical Paper No. 29-B, November 1959.

"Pulsation of Ventilated Cavities", Journal of Ship Research, Vol. 5, No. 4, March 1962. Also published as St. Anthony Falls Hydraulic Laboratory Technical Paper No. 32-B, 1961.

Experimental Studies of Cavitation Noise in a Free-Jet Tunnel (with E. Silberman), St. Anthony Falls Hydraulic Laboratory Technical Paper No. 33-B, July 1961.

Unsteady, Symmetrical, Supercavitating Flows Past a Thin Wedge in a Jet, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 34-B, January 1962.

Unsteady, Symmetrical Flows Past a Thin Wedge in a Solid Wall Channel (with F. Y. Tsai), St. Anthony Falls Hydraulic Laboratory Technical Paper No. 38-B, June 1962.

"Pulsation of Two-Dimensional Cavities", Fourth Symposium of Naval Hydrodynamics, Washington, D.C., August 1962.

A Note on the Linear Theory of Two-Dimensional Separated Flows about Thin Bodies, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 39-B August 1962.

A Quasi-Linear and Linear Theory for Non-Separated and Separated Two-Dimensional, Incompressible, Irrotational Flow about Lifting Bodies, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 43-B, 1963.

"Von Mises Transformation for Boundary Layer Theory", ASCE EM2, April 1964.

"Two-Dimensional Supercavitating Plate Oscillating Under a Free Surface", Journal of Ship Research, Vol. 9, No. 1, June 1965. Also published as St. Anthony Falls Hydraulic Laboratory Technical Paper No. 47-B, December 1963.

Measurement of the Unsteady Force on Cavitating Hydrofoils in a Free Jet, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 49-B, June 1964.

A Feasibility Study of a High-Speed Two-Dimensional Test Section for the DTMB 36-Inch Water Tunnel, St. Anthony Falls Hydraulic Laboratory External Memorandum No. M-102, July 1965.

"Supercavitating Flat-Plate with an Oscillating Flap at Zero Cavitation Number", Journal of Ship Research, Vol. 11, No. 1, March 1967. Also published as St. Anthony Falls Hydraulic Laboratory Technical Paper No. 52-B, June 1965.

"A Note on the Effect of a Slot and a Leakage on Force Characteristics of Supercavitating Flat Plates", ASME 66-WA/FW-38, Nov. 27-Dec. 1, 1966. Also published as St. Anthony Falls Hydraulic Laboratory Technical Paper 53-B, September 1965.

Experimental Investigation of Taylor Instability Using Non-Newtonian Fluids (with F. Y. Tsai), St. Anthony Falls Hydraulic Laboratory Project Report No. 84, June 1966.

An Experimental Study of the Hydroelastic Instability of Supercavitating Hydrofoils (with John Almo), St. Anthony Falls Hydraulic Laboratory Project Report No. 89, February 1967.

"Propagation of Flood Waves in an Open Channel" (with Bahram Mozayeny), ASCE Hydraulics Division 16th Annual Conference, August 1968.

"Numerical Integration of a Double Integral with Cauchy-Type Singularity," AIAA Journal, Vol. 7, No. 7, July 1969, pp. 1389-1390.

Vibration of Cavitating Hydrofoils, St. Anthony Falls Hydraulic Laboratory Project Report No. 111, June 1970.

"Flutter of Supercavitating Hydrofoils - Comparison of Theory and Experiment," Journal of Ship Research, Vol. 16, No. 3, September 1972.

Cerron Grande Project, St. Anthony Falls Hydraulic Laboratory, Project Report No. 139, January 1973.

"Stochastic Model of Air and Water Temperatures in the Minnesota River Basin (with A. F. Pabst and C. E. Bowers), Journal of Environmental Engineering, ASCE, EE 6, December 1973.

Generation of Internal Waves in Stratified Fluids, St. Anthony Falls Hydraulic Laboratory, Project Report No. 144, June 1973.

Simulation of the Quantity and Quality of Flow in a River Basin (with C. E. Bowers and A. Pabst), St. Anthony Falls Hydraulic Laboratory, Project Report No. 145, April 1974.

Hydraulic Model Tests for Mayfield Power Plant, St. Anthony Falls Hydraulic Laboratory, Project Report No. 148, April 1974.

Hydraulic Model Study of South Yard Pier and Wave Screens, St. Anthony Falls Hydraulic Laboratory, Project Report No. 153, November 1974.

"Gravity and Free Surface Effect on a Fully Cavitating Flow" (with A. Young), ASME Journal of Fluid Engineering, Dec. 1975.

Hydraulic Transient Analysis for the Culver-Goodman Tunnel (with T. M. Ring, A. C. H. Young, and K. S. G. Leung), St. Anthony Falls Hydraulic Laboratory Project Report No. 157, Dec. 1975.

"Two-Phase Flow Hydraulic Transient Model for Storm Sewer System, 2nd International Conference on Pressure Surges, BHRA Fluid Engineering, September 1976.

Hydraulic Flow Studies for the Elevated Water Tank of a Sound Suppression Water System (with J. F. Ripken, J. M. Wetzel, W. Q. Dahlin, and J. E. Ferguson), St. Anthony Falls Hydraulic Laboratory, Memorandum No. 138, October 1976.

"Stochastic Properties of Daily Temperature in River," (with C. Y. Chen), ASCE Journal of the Environmental Engineering Division, Vol. 103, No. EE 2, April 1977.

"Interfacial Boundary Condition in Transient Flows," ASCE 2nd Annual Engineering Mechanics Division Specialty Conference, Raleigh, North Carolina, (with John Killen), May 1977.

"Model Study of the Van Lare Overflow Distribution Structure," St. Anthony Falls Hydraulic Laboratory Project Report No. 174, July 1978.

"Verification of Transient Mixed-Flow Model," ASCE 26th Annual Hydraulic Division Specialty Conference, College Park, Maryland, August 1978.

"River Temperature Variation with Freezing and Storage," (with Kim Sau Leung), ASCE Journal of the Environmental Engineering Division, Vol. 104, No. EE 5, October 1978.

"Theory of Minimum Rate of Energy Dissipation" (with Chih Ted Yang) ASCE Journal of the Hydraulic Division, Vol. 105, No. HY 7, July 1979.

"Velocity Profiles and Minimum Stream Power" (with Chih Ted Yang) ASCE Energy Division and Hydraulic Division Joint Conference, San Francisco, August 1979.

"Modeling of River with Sediment Transport," (with Chih Ted Yang) ASCE Energy Division and Hydraulic Division Joint Conference, San Francisco, August 1979.

"Dynamic Adjustment of Alluvial Channels, Part 1, Adjustments of the Fluvial System," edited by Rhodes, D. D. and Williams, G. P., Kendall/Hunt Publishing Co., Dubuque, Iowa, 1979, pp. 55-68.

"The Dynamic Mixed-Flow Model for Metropolitan St. Louis Sewer District," (with Kim Sau Leung and James A. Cardle), St. Anthony Falls Hydraulic Laboratory, Project Report No. 185, September 1979.

"Physical Modeling of the Chippewa River-Mississippi River Confluence," (with John C. Johnson, Dean Long, Mark D. Selby), St. Anthony Falls Hydraulic Laboratory Project Report No. 180, May 1979.

"The Effects of Submergence on Structural Response in Confined Pools," (with Albert J. Sturm, Jr.), Nuclear Engineering and Design Co., pp. 287-296. 1980.

"Mathematical Modeling for Cross-Irondequoit Tunnel and Associated Facility," (with Kim Sau Leung), St. Anthony Falls Hydraulic Laboratory Project Report No. 195, July 1980.

"Minimum Stream Power: Theory," (with C. T. Yang), ASCE, HY9, Sept. 1980.

"Kinematic Wave and Minimization Approach to Modeling of Channels with Sediment," Water and Power Resources Service, Seminar on Hydraulic Laboratory Techniques and Instrumentation, Oct. 1980.

"Physical Modeling of the Chippewa River-Mississippi River Confluence," St. Anthony Falls Hydraulic Laboratory Project Report No. 180, January 1980.

"Hydraulic Geometry and Minimum Rate of Energy Dissipation," (with C. T. Yang and M. J. Woldenberg), Water Resources Research, accepted for publication.

"A Theory of Equilibrium and Stability," (with C. T. Yang), ASCE Water Forum '81, San Francisco, August 1981.

"Modeling of River with Sediment Transport," (with S. Dhamotharan and A. W. Wood), ASCE Water Forum '81, San Francisco, August 1981.

JOSEPH M. WETZEL

Mailing Address

St. Anthony Falls Hydraulic Laboratory
Mississippi River at 3rd Avenue S.E.
Minneapolis, Minnesota 55414

Telephone

612-373-2782

Education

B.S., B.C.E., University of Minnesota, 1952, with honors

Professional Experience

Teaching Assistant, Lecturer, and Research Fellow, University of Minnesota, latter since 1954 (principal investigator for many years in basic fluid mechanics research areas such as cavitating hydrofoils, drag-reducing fluid flow in pipelines, and turbulent boundary layers).

Publications

Experimental Studies of Pneumatic and Hydraulic Breakwaters, Project Report No. 46, St. Anthony Falls Hydraulic Laboratory, 1955.

Experimental Studies of Air Ventilation of Vertical, Semi-Submerged Bodies, Project Report No. 57, St. Anthony Falls Hydraulic Laboratory, 1957.

"Ventilation of Bodies Piercing a Free Surface", Second Symposium on Naval Hydrodynamics, Office of Naval Research, Department of the Navy ACR-38, 1958, pp. 447-463.

An Exploratory Investigation of Mobile Breakwaters (with H. D. Frederiksen), Project Report No. 60, St. Anthony Falls Hydraulic Laboratory, 1959.

Lift and Drag on Surface-Piercing Dihedral Hydrofoils in Regular Waves (with F. R. Schiebe), Project Report No. 64, St. Anthony Falls Hydraulic Laboratory, 1960.

Experimental and Analytical Studies of the Longitudinal Motions of a Tandem Diehedral Hydrofoil Craft in Regular Waves, Technical Paper No. 30-B, St. Anthony Falls Hydraulic Laboratory, 1960.

Ventilated Cavities on Submerged Three-Dimensional Hydrofoils (with F. R. Schiebe), Technical Paper No. 36-B, St. Anthony Falls Hydraulic Laboratory, 1961.

Longitudinal Motions and Stability of Two Hydrofoil Systems Free to Heave and Pitch in Regular Waves (with W. H. C. Maxwell), Technical Paper No. 37-B, St. Anthony Falls Hydraulic Laboratory, 1961.

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Tandem Interference Effects of Flat Non-Cavitating Hydrofoils (with W. H. C. Maxwell), Project Report No. 61, St. Anthony Falls Hydraulic Laboratory, 1962.

Force Characteristics of Flapped, Ventilated Hydrofoils In Smooth and Rough Water (with W. H. C. Maxwell), Project report No. 66, St. Anthony Falls Hydraulic Laboratory, 1963.

Further Studies of Ventilated Cavities on Submerged Bodies (with F. R. Schiebe), Project Report No. 72, St. Anthony Falls Hydraulic Laboratory, 1964.

Studies of the Flow Characteristics of a Compressible, Bubbly Mixture about Supercavitating Bodies and in a Converging-Diverging Nozzle (with F. R. Schiebe and Klaus E. Foerster), Technical Paper No. 48-B, St. Anthony Falls Hydraulic Laboratory, 1964.

Tandem Interference Effects for Non-Cavitating and Supercavitating Hydrofoils, Technical Paper No. 50-B, St. Anthony Falls Hydraulic Laboratory, 1965.

Force Characteristics of Restrained, Naturally Ventilated Hydrofoils in Regular Waves (with K. E. Foerster), Project Report No. 68, St. Anthony Falls Hydraulic Laboratory, 1966.

Measurements of the Leading-Edge Separation Bubble for Sharp-Edged Hydrofoil Profiles (with K. E. Foerster), Project Report No. 83, St. Anthony Falls Hydraulic Laboratory, 1966.

Unsteady Force and Cavity Characteristics for Ventilated Hydrofoils (with K. E. Foerster), Project Report No. 85, St. Anthony Falls Hydraulic Laboratory, 1967.

Further Experiments on a Jet Flap Hydrofoil in Ventilated Flow (with K. E. Foerster), Project Report No. 92, St. Anthony Falls Hydraulic Laboratory, 1967.

"Impact Tube Measurements in Dilute Polymer Solutions" (with F. Y. Tsai), AIChE Journal, Vol. 14, No. 4, July 1968, pp. 663-664.

"Effects of Polymer Addition on Friction in a 10-inch-Dia. Pipe" (with R. H. Forester, R. E. Larson, and J. W. Hayden), Journal of Hydronautics, Vol. 3, No. 1, January 1969, pp. 59-62.

"Turbulence Measurements in Dilute Polymer Flows" (with J. A. Almo and J. M. Killen), Symposium on Turbulence Measurements in Liquids, University of Missouri-Rolla, September 8-9, 1969.

Shear and Diffusion in a Large Boundary Layer Injected with Polymer Concentrate (with J. F. Ripken), Project Report No. 114, St. Anthony Falls Hydraulic Laboratory, 1970.

Model Studies of a Cooling Tower Basin (with P. A. Frederickson), Memorandum No. M-127, St. Anthony Falls Hydraulic Laboratory, 1971.

A Study of the Fragmentation of Rock by Impingement with Water and Solid Impactors (with J. F. Ripken), Project Report No. 131, St. Anthony Falls Hydraulic Laboratory, (for ARPA and BuMines).

Model Studies of the PHM Water Jet Inlet System (with L. M. Bergstedt and J. F. Ripken), Memorandum No. M-133, St. Anthony Falls Hydraulic Laboratory, 1973.

Hydrodynamic Studies for a Large, High-Speed, Variable Pressure, Free Surface Flow Facility (with J. F. Ripken and L. M. Bergstedt), Memorandum No. M-134, St. Anthony Falls Hydraulic Laboratory, 1974.

"The Influence of Polymer Injection on a Developing Boundary Layer" (with J. F. Ripken) paper presented at 17th American Towing Tank Conference, California Insitute of Technology, Pasadena, California, 1974.

"The St. Anthony Falls Hydraulic Laboratory High Speed, Variable Pressure, Free Surface Flow Facility" (with J. F. Ripken) paper presented at 14th International Towing Tank Conference, Ottawa, September 1975.

Model Studies of the Bed Regime of Alluvial Channels as Influenced by Submerged Groins (with S. Dhamotharan and W. Q. Dahlin), Project Report No. 159, St. Anthony Falls Hydraulic Laboratory, 1976.

Hydraulic Transient Flow Studies for a Sound Suppression Water System (with C. S. S. Song, J. F. Ripken, J. Ferguson, and W. Q. Dahlin), Memo No. 139, St. Anthony Falls Hydraulic Laboratory, 1976.

Hydraulic Flow Studies for the Elevated Water Tank of a Sound Suppression Water System (with J. F. Ripken, W. Q. Dahlin, J. Ferguson, and C. S. S. Song), Memo No. 138, St. Anthony Falls Hydraulic Laboratory, 1976.

Hydraulic Model Studies of the Spray Nozzles for a Sound Suppression Water System (with J. F. Ripken), Memo No. 143, St. Anthony Falls Hydraulic Laboratory, 1977.

Maintenance and Regulation of Navigable Channels by the Use of Submerged Contractions (with S. Dhamotharan and W. Q. Dahlin), paper presented at 2nd International Symposium on Dredging Technology, Texas A&M University, BHRA Fluid Engineering, Nov. 1977.

Hydraulic Model Studies for Modifications of the Cooling Water Intake for Unit No. 4 - Clay Boswell Plant of the Minnesota Power and Light Company, (with J. F. Ripken), Project Report No. 171, St. Anthony Falls Hydraulic Laboratory, 1978.

Model Studies of the San Lorenzo Spillway, Executive Hydroelectric Commission Lempa River, El Salvador, Central America (with W. Q. Dahlin), Project Report No. 173, St. Anthony Falls Hydraulic Laboratory, 1978.

Laboratory Evaluation of Methods to Separate Fine Grained Sediment from Stormwater (with L. M. Bergstedt and J. A. Cardle) EPA-600/2-79-076, July 1979.

Model Studies of the San Lorenzo Spillway, Supplement 1. Effect of Aeration Ramps on Flow Pattern (with W. Q. Dahlin), Project Report No. 173, St. Anthony Falls Hydraulic Laboratory, 1980.

Model Studies of a Cooling Water Discharge Structure Modification-Monticello Nuclear Generating Plant (with S. Dhamotharan and W. Q. Dahlin), Project Report No. 192, St. Anthony Falls Hydraulic Laboratory, 1980.

Culver-Goodman Tunnel Control Structure Model Studies (with W. Q. Dahlin), Project Report No. 197, St. Anthony Falls Hydraulic Laboratory, 1981.

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JOHN M. KILLEN

Education

B.E.E., 1944; M.S.C.E., 1956; and Ph.D., 1968, University of Minnesota

Professional Experience

Guest Professor, University Karlsruhe, summer quarter (1978)

Research Associate, St. Anthony Falls Hydraulic Laboratory, University of Minnesota (1977-present)

Guest Scientist, University of Karlsruhe (on leave from University of Minnesota) (1975-1977)

Research Associate, St. Anthony Falls Hydraulic Laboratory, University of Minnesota (1968-1975)

Research Fellow, St. Anthony Falls Hydraulic Laboratory, University of Minnesota (1953-1968)

Assistant Scientist, St. Anthony Falls Hydraulic Laboratory, University of Minnesota (1948-1953)

Electrical Engineer, Neurophysiology Department, University of Minnesota (1946-1948)

U.S. Navy—Radio, Radar and Sonar Technician (1944-1946)

Laboratory Assistant, Electrical Engineering Department, University of Minnesota (1941-1944)

Publications

"An Electrical Method for Measuring Air Concentration in Flowing Air-Water Mixtures" (with O. P. Lamb), Technical Paper No. 2-B, St. Anthony Falls Hydraulic Laboratory, 1950.

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The Surface Characteristics of Self-Aerated Flow in Steep Channels, Ph.D. Thesis, University of Minnesota, 1968.

"An Experimental Study of the Effects of Dilute Solutions of Polymer Additives on Boundary Layer Characteristics" (with J. A. Almo), Technical Paper No. 36-A, St. Anthony Falls Hydraulic Laboratory. (Reprint from Vicous Drag Reduction, Plenum Press, 1969.)

"A Feasibility Study of a Field Instrument for the Measurement of Suspended Sediment Concentration," Project Report No. 109, St. Anthony Falls Hydraulic Laboratory, 1969.

"A Study of the Air-Water Interface in Air-Entrained Flow in Open Channels" (with A. G. Anderson), Technical Paper No. 41-A, St. Anthony Falls Hydraulic Laboratory. (Presented at 13th Cong. IAHR, Kyoto, Japan, 1969.)

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"A Buoyancy-Propelled-Test-Body Laboratory Facility," Project Report No. 149, St. Anthony Falls Hydraulic Laboratory, 1974.

"A Review of Methods to Separate Sediments from Storm Water Associated with Construction Operations" (with J. F. Ripken and J. S. Gulliver), Memorandum No. M-137, St. Anthony Falls Hydraulic Laboratory, September 1975.

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Discussion. "Polymer Flow in the Porous Media," IUTAM Symposia on Structure of Turbulence and Drag Reduction, Washington, D.C., June 1976.

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Appendix I—Allocation of resource people by course unit

Recognizing that at any given time a certain resource person may not be available or may not have the required language skills to participate in a particular training endeavor, the SDH Program staff has identified several people with the requisite technical skills to assist in teaching each of the 15 course units.

NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Abdullah, Mohammed					X										
Albertson, Maurice		X							X						
Anderson, Max							X								
Arndt, Roger				X											
Arnn, Edgar			X												
Bogert, John	X														
Bowers, Edward		X													
Bowman, Kaye														X	X
Brown, John				X											
Butwal Engineering Works					X										
Carroll, Robert			X												
Cassidy, John									X						
Clark, Paul										X	X	X	X		
Cooley, Lawrence														X	
Costas, Philip											X	X	X		
Crawford, Norman		X													
Dawsey, Charles			X			X									
Delp, William			X	X	X										
Evans, Rupert Armstrong					X										
Farrell, Cesar				X											
Gaither, Edward															X
Gellerson, Mark													X		
Gorden, Morton														X	
Guerrero, Jaime Lobo					X				X						
Gulliver, John		X	X	X											
Harza Engineering										X					
Hayes, Peter													X		

NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Heath, Thomas															X
Heifner, James															X
Hegler, Burns							X								
Henwood, Mark										X					
Inversin, Allen	X			X					X		X				X
Jackson, Bard	X					X	X			X					
Johnson, Michael				X	X										
Johnson, Wayne														X	X
Kabat, Robert														X	X
Kelly, Edward											X				
Killen, John			X			X									
Kirshen, Paul		X	X												
Kitching, William					X										
Kooi, Clarence														X	
Lanou, Tobie													X		
Lawrence, Walter	X		X												
Lyman, Ashley													X		
Mamer, Louisan											X				
Mayo, Howard				X											
McGrath, Peter								X		X		X		X	
McNeill, Peter															X
Mercer, A. G.		X													
Metzler, Rheinhold					X										
Morgan, Derald							X								
Morris, Jack							X								
NRECA/MS staff														X	X
Nelson, Byron							X								
New, Daniel				X											
Neumann, Fritz				X											
Oberg, Keith										X			X		
O'Leary, Donal												X			
Reagan, Michael								X							
Richards, Earl							X								
Sachs, Duane									X						

NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Shaw, Cora												X			
Sloan, Joseph											X				
Smith, Peter								X	X	X				X	
Song, Charles			X												
Stone & Webster									X						
TVA														X	
Thompson, Bill						X									
Topik, John	X													X	
Tudor Engineering Co.								X	X	X					
U/UNCDF												X			
U. Minnesota Department of Agricultural Economics											X	X	X		
U.S. Bureau of Reclamation														X	
U.S. Corps of Engineers														X	
Wetzel, Joseph				X											
Woodward, Jack						X									
Woodward Governors						X									
The World Bank												X			
Yoder, Robert					X					X	X				X
Zoellner, David		X													

Appendix J - Resource materials

The resource materials used for the SDH Program's training efforts will come from a wide variety of selected sources, including a number of publications which have been produced for the Program and a number of others currently under development. Other sources include course materials currently used by engineering, water resources, economics, and management departments at the various U.S. universities which will contribute to this training program; U.S. turbine manufacturers; publications developed by private engineering firms under contract to U.S. Departments and agencies; and hydropower technology for in-country training, research, and development centers worldwide. Listed on the following four pages are a number of these resource materials, showing the course units in which they would be used. The materials for each training assignment will be selected on a case-by-case basis according to the country or region, and the specific focus or emphasis of each.

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Appendix J—Resource materials

Title	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bid specifications from REA and U.S. equipment manufacturers for small hydropower plants								X							
"Centralized vs. Decentralized Management of Small Hydropower," SDH Program publication which analyzes issues of various management approaches for small hydropower programs															X
Directory of Sources of Small Hydroelectric Turbines and Packages, SDH Program publication which describes U.S. and developing country manufacturers and their equipment lines				X		X									
SDH Economics Handbook, under development by SDH Program, which consists of four sections on costing, end-use planning, financial planning, and socio-economic analysis											X	X	X	X	
"End Uses of Small-Scale Energy Systems in Rural Areas," Proceedings of the First U.S.-China Conference on Energy, Resources and Environment (November 7-12, 1982, Beijing, PRC)											X				
Harnessing Water Power on a Small-Scale — Local Experience with Micro-Hydro Technology, Ueli Meier, Swiss Center for Appropriate Technology	X				X					X			X	X	
Hydrologic Estimates for Small Hydroelectric Projects, SDH Program publication developed to assist field engineers in estimating stream flow duration and peak flows in regions where very little data is available		X													

Title	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Manual on Stream-Gauging, World Meterological Society		X													
Manufacturer's brochures, slides, and training films				X											
Matching Renewable Energy Systems to Village-Level Energy Needs, John Ashworth and Jean Neuendorffer, a guide for matching the characteristics of energy needs in developing country sites with those of available renewable energy technologies.											X				
Micro-Hydro Sourcebook, SDH Program publicatic n which provides a wide range of information useful in implementing micro-hydropower schemes	X		X		X				X		X			X	
Morocco Trip Report, SDH Program's country survey report for Morocco								X							
NRECA end-use promotional documents											X				
NRECA training materials														X	X
A Pelton Micro-Hydro Prototype Design, Appropriate Technology Development Institute					X										
Project Planning for Developing Economics, W.W. Shaner												X	X		
Reconnaissance Evaluation of Small, Low-Head Hydroelectric Installations, Tudor Engineering Company, handbook which describes a methodology for making an appraisal-level evaluation on small low-head hydro plant										X			X		

Title	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rural Electric Administration (U.S. Department of Agriculture) bulletins and power use promotional materials						X	X	X			X				
Simplified Methodology for Economic Screening of Potential Low-Head Small-Capacity Hydroelectric Sites, Electric Power Research Institute manual which outlines procedures for power producers to make a quick, reliable analysis of potential low-head, small-capacity sites													X		
"Site Selection Methodology for Small Hydroelectric Power Plants," SDH Program's Dominican Republic country report										X			X	X	
Small Decentralized Hydropower for Asian Rural Development proceedings of the SDH Program's workshop in Bangkok, Thailand, June 8-12, 1981						X				X			X	X	
Small Decentralized Hydropower in Rwanda, SDH Program's country survey report								X							
Small Hydroelectric Powerplants proceedings of the SDH Program's workshop in Quito, Ecuador, August 9-21, 1980	X					X			X	X			X	X	
Small-Scale Hydropower in Africa, proceedings from the SDH Program's workshop held March 1-5, 1982 in Abidjan, Ivory Coast		X				X				X			X		

Title	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Small Water Turbine — Instruction Manual for the Construction of a Cross-Flow Turbine, German Appropriate Technology Exchange					X										
Solar Energy Research Institute Handbook, outlines sources of financing for renewable energy projects												X			
University of Missouri-Rolla/NRECA course on electrical distribution course materials							X								
University of Missouri-Rolla Department of Engineering Management course materials														X	X

Appendix K—Classroom, laboratory, and field exercises

Hands-on training in the field will be stressed in all NRECA small hydropower training service and programs. To complement this experiential approach to training, all classroom sessions will feature instructor-guided exercises, whether for site assessment, civil design, costing and economic analysis, or managmenet planning. Classroom exercises for the Overview Course will consist of a single series of data reflecting the physical, economic and socio-institutional characteristics of a hypothetical project. If possible, the data given to the trainees will be consistent with the physical characteristics of a nearby field training site where trainees will be asked to develop the data under actual field conditions. Thus, trainees will, during the course of six weeks, be presented with the full range of problems and tasks involved in developing a complete plan for a small hydropower project. In-country training will also emphasize classroom and field exercises of a similar nature, and will be developed on a case-by-case basis according to the focus of each training program and the availability of appropriate field sites to be used in the training. The following pages outline various classroom, laboratory and field exercises that are to be used in each of the 15 course units.

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Course unit 1: Introduction to site assessment

Exercises: These exercises are designed to familiarize the participant with:

- the problems that may arise when attempting to conduct a site assessment with limited data
- techniques for obtaining the information necessary to conduct an appropriate site assessment.

A. Given:

- topographical maps (real or dummied up showing relief, streams, roads, villages, etc.; preferably LDC maps rather than U.S maps)
- demographic information
- map of present (and planned extension) electric grid
- rainfall data (preferable map with isohyets)
- selection criteria

Develop:

- plan of candidate sites (similar to country survey guidelines the SDH Program's assessment teams prepare)

B. Given:

- specific site information (physical characteristics)
- outline of analysis elements (social, environmental, economic, etc.) for prefeasibility and feasibility studies selection criteria

Develop:

- information requirements for each analysis and likely location of some in your country
- on the basis of the criteria given (and using data on specific sites in LDC), rank the sites (3, 5, 10, etc. sites).

Course unit 2: Hydrologic analysis

Exercises: These exercises are designed to acquaint the participant with the tools basic to conducting an adequate hydrologic analysis.

A. Given:

- basic land (soil, geology, vegetation) characteristics (use maps if helpful), minimal rainfall data, etc. (as in the SDH Program's hydrologic methodology)
- two or three candidate sites and their characteristics
- input from interviews of locals

Develop:

- flow data for a given site from run-off calculations - from flow duration curve, select flow for power planning

B. Given:

- field site
- with or without water
- gauge (velocity)

Develop:

- estimates of stream flow

Course unit 3: Energy and power computations

Exercises: These exercises are designed to give the participant experience in:

- computing duration curves and available power and energy
- measuring head with and without instruments.

A. Given:

- head and flow data for a particular site

Develop:

- computations for available power and energy

B. Given:

- flow duration and headwater curves

Develop:

- power duration curves

C. Given:

- field site
- instruments (hand level, inclinometer, altimeter)

Develop:

- gross head figures using survey instruments

Course unit 4: Turbine selection

Exercises: These exercises are designed to familiarize the participant with problems found in LDC's in selecting the appropriate equipment and with maintenance problems.

A. Given:

- site characteristics, alternative conept designs
- power requirements
- list of turbines, costs, performances

Develop:

- bid specifications

B. Given:

- field site
- turbine undergoing maintenance

Develop:

- techniques for maintenance

Course unit 5: Manufacture and fabrication of turbines

Exercise: This exercise is designed to familiarize the participant with the process involved in, and the requirements for, setting up the manufacturing and fabrication of turbines at the local level in developing countries.

Given:

- materials
- design

Develop:

- steps to fabricate and manufacture a turbine
- requirements for a manufacturing/fabrication facility including, cost, skills, equipment, etc.

Course unit 6: Electro-mechanical equipment

Exercises: These exercises have been designed to:

- assist participants in the selection and specification of the appropriate electro-mechanical equipment for specific sites
- give participants experience in synchronizing and interconnecting with the grid.

A. Given:

- demand characteristics
- power plant, specifications, including electrical equipment requirements

Develop:

- transformer selection

B. Given:

- power plant (field site)

Develop:

- techniques for synchronization and interconnect (procedures, guidelines)

Course unit 7: Electrical distribution planning

Exercise: This exercise reinforces what the participant learned during the lectures and from the resource materials and requires him to think through the steps required to develop an electric distribution system.

Given:

- data on village demographics (location, number of homes, small business, etc.)
- data on likely end uses (small businesses, other productive end uses)
- background costs (costs for 3-phase and single phase, etc.)

Develop

- an electric distribution plan for the village

Course unit 8: Preparing and evaluating bid specifications for turbogenerating equipment

Exercise: This exercise has been designed to acquaint the participant with the process of preparing and evaluating bid specifications for decentralized hydropower equipment.

Given:

- ranges of cost and performance for electrical and mechanical equipment
- case study(ies)

Develop

- bid specifications for each item; compare results with actual specifications in case study(ies)

Course unit 9: Civil works designs and considerations

Exercise: This exercise has been designed to give the participant experience in designing the components of civil works for decentralized hydropower plants (both high and low head).

Given:

- site characteristics (flow data, stream dimensions, etc.)
- dummied up maps (large scale showing proximity to users, village, etc.; small scale of streams, contour lines, etc.)

Develop:

- alternative concept design(s) of site(s) (high head and low head)
- power computations for each alternative

Course unit 10: Cost analysis

Exercise: This exercise has been designed to acquaint participants with costing techniques appropriate to developing country conditions that adequately reflect true total project costs.

Given:

- cost indices for equipment, labor, materials, import tariffs, and transportation (provide for different LDC's, for different regions within an LDC, and for partially or totally imported goods and services)
- unit costs of alternative energy options
- availability of local materials, labor, skills, and equipment fabrication capabilities
- alternative concept designs (developed in course unit 4 and 9)

Develop:

- cost analyses for alternative concept designs
- analyses of SDH option compared with alternatives (diesel, grid extension, other renewable)

Course unit 11: Demand forecasting and end-use planning

Exercise: These exercises have been designed to enable the participant to develop appropriate end-use plans that enhance the capacity utilization rates to make an investment in a decentralized hydropower plant worthwhile.

Given:

- local economic setting, including per capita income, income distribution, disposable income, existing activities (with potential for enhancement) and potential new activities, migration and demographic characteristics

Develop:

- a productive end-use plan for the given facility, to include elements of implementation (techniques, personnel, audio-visuals, etc.)
- four or more demand forecasts for different kinds of facilities (village, agriculture, industrial, mix)

Course unit 12: Financial analysis

Exercise: This exercise has been designed to acquaint the participant with the step-by-step process of developing a realistic financial analysis for a project and the funding critieria of various financial institutions that may be involved.

Given:

- project costs and avoided costs (developed in course unit 10)
- annual power output and sales (developed in course units 3, 9, and 11)
- discount rante
- life of project
- donor/loaner agency requirements for financing (interest, grace period, maximum and minimum amount available, using, for instance, "IDB Guidelines for Loan Applications")

Develop:

- step-by-step project financial analysis including IRR, cash-flow computations, and B/C ratio (perhaps developing two or three analyses, depending on source of funds-development bank, bilateral donor, commercial bank, or in-country source such as agriculture bank, government bank, ministry, etc.

Course unit 13: Socio-economic analysis

Exercise: This exercise has been designed to expand the participants knowledge beyond the conventional economic analysis to include broader economic considerations of great concern to developing countries, which, while difficult to assess in monetary terms, are essential to making the appropriate investment decisions.

Given:

- data from actual case study, including alternative option costs and benefits

Develop:

- calculations, in net present worth terms, for benefit/cost ratio (to be compared with actual case history).

Course unit 14: Introduction to administrative planning and implementation

Exercises: This exercise has been designed to familiarize the participant with the basic components of the planning process, its stages, and how plans should be designed and implemented, and the institutional arrangements necessary for the planning and management of a national decentralized hydropower plan.

A. Given:

- a country's institutional organization and goals (of rural electrification, of SDH rural development, etc.)
- the types of sites to be developed (grid-connected, isolated, serving agriculture, serving villages, etc.) based on case studies or dummied up

Develop:

- an administrative plan for implementing a small hydro development program, including staffing, distribution of responsibilities, budget, and implementation schedule

B. Given:

- descriptions of existing administrative plan in students country (to be submitted by student prior to course)

Develop:

- modifications in existing administration plan and implementation schedule as now perceived by student

Course unit 15: Organizational development and management considerations

Exercises: This exercise has been designed to expose the participant to a wide range of institutional choices and to assist in the designing of appropriate management infrastructure for specific cases.

Given:

- series of possible case study SDH resource scenarios (e.g., many small hydro sites, distributed over entire country; few sites in remote places not likely to be grid connected; some micro sites in remote areas, other larger sites in center of grid)
- various institutional options for carrying out administrative and management plan (e.g. National electric utility; various ministries and offices, such as Energy, Rural Development, Rural Electrification, Water Resources; regional organizations and governorships; local municipalities or council governments; rural cooperatives; private enterpreneurs, etc.)

Develop:

- institutional framework needed to manage small hydro program, both at national and possibly sub-national and local levels.

Given:

- description of existing institutional framework in student's country (to be submitted by student prior to course)

Develop:

- modifications in existing institutional framework as now perceived by student

Appendix L—Tentative budget for the training program

This budget assumes that the funds required will be added to the existing SDH Program budget. It is also assumed that the substantial SDH Program staff time required to develop, manage, and coordinate the program will be funded under monies already contained in the existing Cooperative Agreement between the ST/EY and NRECA.

U.S.-Based Training Program Budget

Fixed Costs

Resource People Travel (15 trips @ $400/trip)	$ 6,000*	
Resource People Per Diem (15 people @ $75/day for 3 days each)	3,375*	
Resource People Presentations and Preparation (90 class hours @ $200/class hour)	18,000*	
SDH Program Training Coordinator Per Diem (50 days @ $75/day)	3,750*	
Buses for tours and site visits	6,000*	
		$37,125*
U. Minn. Faculty and Staff Salaries	17,500**	
U. Minn. Presentations and Preparation (60 hours @ $200/hour)	12,000**	
U. Minn. Conference Coordination Assistant	4,000**	
	33,500**	
Overhead @ 60% (government audited rate)	20,100**	
Subtotal Fixed Costs		53,600**
TOTAL FIXED COSTS		90,725

Variable Costs (per participant)

Per Diem ($75/day for 42 days)		3,150*
Instructional Materials	100**	
Teaching Assistants (1 for every 10 participants)	200**	
	300**	
Overhead @ 60% (government audited rate)	180**	
Subtotal Variable Costs		480**
TOTAL VARIABLE COSTS		3,630

* Paid directly by SDH Program
** Paid to U. Minn. through subagreement with SDH Program

Budget for 20 participants

Fixed Costs	$90,725
Variable Costs	72,600
TOTAL COSTS	$164,925
Per Participant/Per Week Cost	$1,360/week

Budget for 30 participants

Fixed Costs	$90,725
Variable Costs	108,900
TOTAL COSTS	$199,625
Per Participant/Per Week Cost	$1,110/week

Budget for 40 participants

Fixed Costs	$90,725
Variable Costs	145,200
TOTAL COSTS	$235,925
Per Participant/Per Week Cost	$980/week

In-country Training Budget

Budget Per Country

Given: 3 trainers for training in developing country for 4 weeks

Per Diem (20 days @ $100/day for 3 people)***	$6,000
Travel (trips for 3 @ $2,500 each)	7,500
Salary (plus overhead; $400/day per person for 3 people for 25 days; includes 1 week of preparation)	30,000
Other expenses (development of lecture materials, per diem for participants not covered otherwise, rental on training center)	6,500
TOTAL COST PER COUNTRY	$50,000

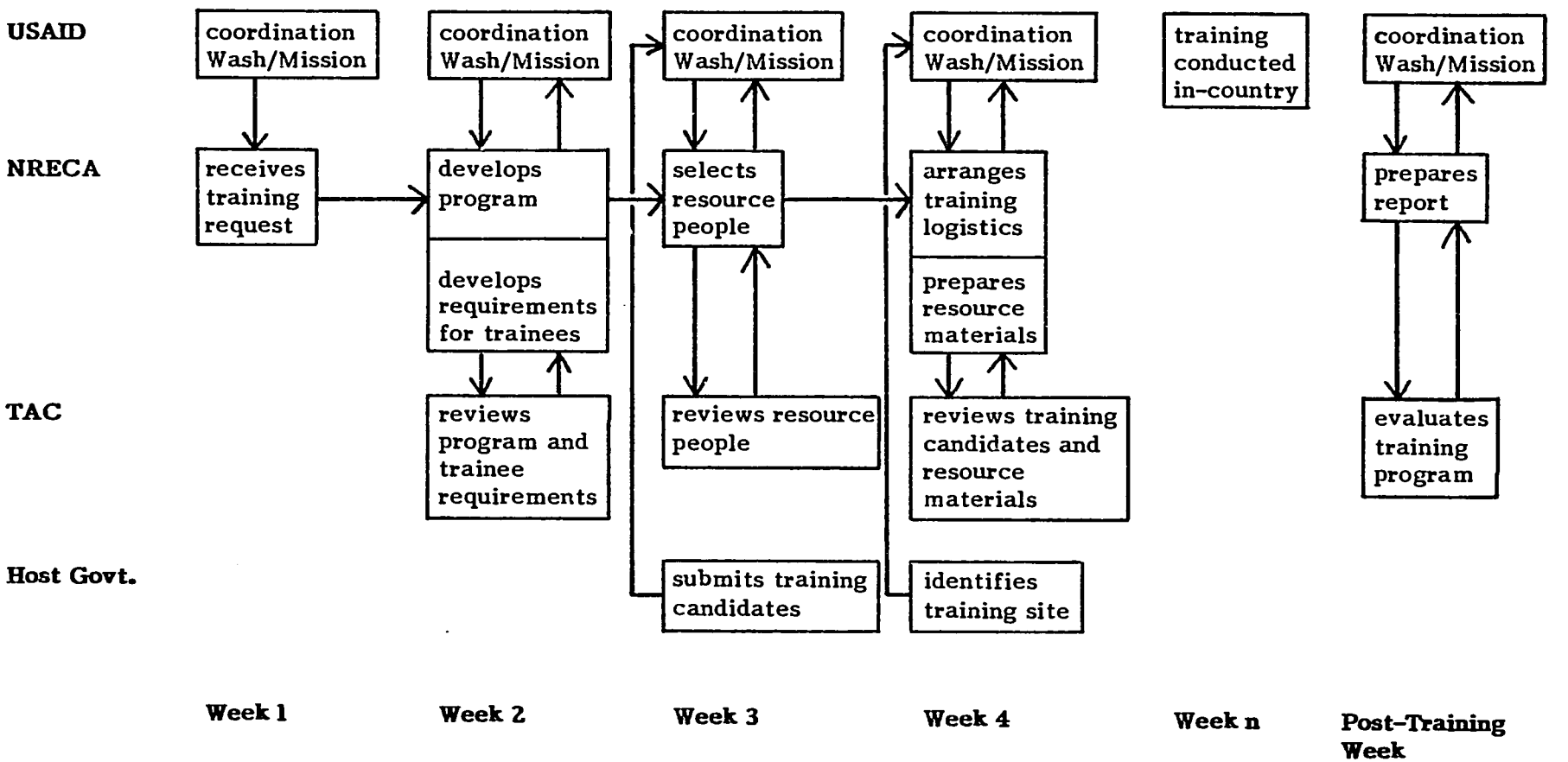
Total Training Budget

U.S.-Based Training(for approximately 30 participants)	200,000
In-country Training (for training in 5 countries)	250,000
Other Training Costs (TAC travel/development of training materials)	50,000
	$500,000

***It is assumed that participants' per diem will be covered by the appropriate host country government ministry or agency or the local AID Mission.

Appendix M—NRECA's expedited response process for in-country training

This schematic shows graphically how NRECA can respond quickly to requests for in-country training.



Appendix N—Tentative weekly schedules for U.S.- based training program

Week 1	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Orientation	Tour Minneapolis-St. Paul	Introduction and Overview	Introduction to Site Assessment	Hydrologic Analysis
9:30–10:15					
10:30–11:15					(Exercise)
11:30–12:15				(Exercise)	
1:30–2:15		Orientation			(Exercise)
2:30–3:15	Tour University of Minnesota		Tour SAFHL Facilities		
3:30–4:15				(Exercise)	
4:30–5:15				(Discussion Groups)	(Discussion Groups)

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Week 2	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Energy and Power Computations	Tour NSP Hydro Plants on Apple and Chippewa Rivers	Turbine Selection	SAFHL Lab Demonstration and Exercises	Manufacture and Fabrication
9:30–10:15	(Exercise)				
10:30–11:15			(Exercise)		
11:30–12:15					
1:30–2:15	(Exercise)			Manufacturer's Presentation	
2:30–3:15	(Exercise)			Manufacturer's Presentation	(Exercise)
3:30–4:15				Manufacturer's Presentation	Manufacturer's Presentation
4:30–5:15	(Discussion Groups)		(Exercise)	Manufacturer's Presentation	Manufacturer's Presentation

Week 3	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Electro-Mechanical Equipment	Electrical Distribution	Bid Specifications	Civil Works	Civil Works
9:30–10:15					
10:30–11:15					
11:30–12:15	(Exercise)	(Exercise)			
1:30–2:15	(Exercise)				
2:30–3:15	Manufacturer's Presentation			(Exercise)	
3:30–4:15	Manufacturer's Presentation	Visit Utilities	(Exercise)		(Discussion Groups)
4:30–5:15	Tour NSP Plant at St. Anthony Falls		(Discussion Groups)		(Discussion Groups)

Week 4	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Tour Small Hydro Plants and Sites in northern Minn.	Tour Small Hydro Plants and Sites in northern Minn.	Tour Small Hydro Plants and Sites in northern Minn.	Cost Analysis	Cost Analysis
9:30–10:15					
10:30–11:15					(Discussion Groups)
11:30–12:15					
1:30–2:15					
2:30–3:15					
3:30–4:15					Demand Forecasting
4:30–5:15				(Exercise)	

Week 5	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Demand Forecasting	Discussion Groups	Financial Analysis	Socio–Economic Analysis	Socio–Economic Analysis
9:30–10:15		(Discussion Groups)			
10:30–11:15		Financial Analysis	(Exercise)		
11:30–12:15	(Exercise)				
1:30–2:15	(Exercise)				
2:30–3:15				(Exercise)	
3:30–4:15			(Discussion Groups)		(Discussion Groups)
4:30–5:15			(Discussion Groups)		(Discussion Groups)

Week 6	Monday	Tuesday	Wednesday	Thursday	Friday
8:30–9:15	Introduction to Administrative Planning		Organizational Development	Evaluation and Review	Evaluation and Review
9:30–10:15					
10:30–11:15		(Discussion Groups)			
11:30–12:15		(Discussion Groups)	(Exercise)		
1:30–2:15		Organizational Development	(Exercise)		
2:30–3:15			(Discussion Groups)		
3:30–4:15			(Discussion Groups)		
4:30–5:15	(Exercise)		(Discussion Groups)		

Appendix O—Recent research at SAFHL

Project	Sponsor	Contract Amount
Design of a Turbine Test Stand	Minnesota Energy Agency	$ 22,000
Hydropower Research	State of Minnesota Legislative Commission on Minnesota Resources	200,000
Installation of Turbine Test Stand	State of Minnesota Legislative Commission on Minnesota Resources	100,000
Preliminary Analysis of Low-Head Hydropower Potential in Minnesota	Minnesota Energy Agency	10,000
Feasibility Studies of Restoring Low-Head Hydropower Structures in Minnesota	Minnesota Department of Natural Resources	150,000
Model Studies of San Lorenzo Spillway, El Salvador	Harza Engineering Co.	149,200
Model Studies, Circulating Water System, Sherburne Generating Plant	Northern States Power Co.	42,000
Hydraulic Model Studies, Condenser Cooling Water Intakes for Callaway Point	Sverdrup and Parcel	23,000
Studies of Various Aspects of Collector Well and Cooling Water Intake, James H. Campbell Plant	Johnson Division, UOP	234,100