UNITED STATES GOVERNMENT

Memorandum

TO : AA/TA, Erven Long

DATE: June 16, 1977

FROM : TA/RES, Miloslav Rechcigl

SUBJ : TA/H, Lee M. Howard, M.D.

SUBJECT: Non-Solicited Small Research Project Proposal Entitled, "Development and Testing of the ROBO Activated Water Meter"

PROBLEM AND RATIONALE:

A.I.D as well as other international lending organizations help develop water distribution systems in LDCs. The revenues collected from each household for water help pay for the cost of installing and maintaining the water system. Unless a reliable metering system, coupled with an adequate and honest billing and collection system exist, the collected revenues will fall short of the production, operation and maintenance costs. In many areas of the world, the revenues collected are insufficient to pay for the operation of the system because an inadequate or expensive metering system exists. This means that the water system can not keep up with current demand or improve services for the future. International water system economists agree that the key to the successful operation of a rural or urban water system is development of a means of accurately measuring water consumption and then charging appropriately.

Most water meters in use today are cast metal which are heavy, expensive and not easily adaptable to production in LDCs. Recently, some water meters have been constructed out of plastic materials and are being used in Thailand and Hong Kong with some degree of success. These plastic meters are relatively inexpensive, cost from $20 to $40, and are fairly accurate, i.e., $\pm$ 1%. Although such meters are mechanically good, they pose a number of serious problems, such as clogging, frequent maintenance, freezing, etc. In order to collect payment, an employee of the water authority agency must read the meter and submit the data to a billing office. The billing office prepares a statement of charges which is then given to the user. This procedure requires considerable labor and expense and, in many cases, does not assure collection of payment. Many times, the water consumers will just not pay their bill. Often the meter is broken by act of vandals or valuable parts are stolen. In many LDCs, the user simply does not have the money to pay a monthly water bill although he can pay on a day to day basis. It is also not uncommon to hear about corrupt watermeter readers who by various schemes, deprive the water agency from collecting fees for water used. In summary, existing water meters are labor intensive, expensive, and a high maintenance item.

On the other hand, a user activated meter does not depend on meter reading and billing for collecting payment for water used. A user activated meter is defined as a unit which is activated by an external device which can be purchased by the user at any approved store. Once the user has activated the meter, he is entitled to a predetermined volume of water at a time of his choice. In essence, the user, by purchasing the activator, has prepaid for the water that he will use. In this system, payment is received prior to use, while with ordinary billing systems, charges are assessed for water used after the water is consumed. In addition to the elimination of the need for meter reading, billing, and collection of payment, the user activated meter will also restrict revenue losses because of corrupt watermeter readers. Only on occasions when maintenance or repairs are required will the user come in contact with an employee of the water supply agency. This new user activated meter would cost only $8-12/unit versus the $20-$150 per unit now being charged water companies around the world.

RESEARCH PROPOSED:

The purpose here is to develop and test a user activated water meter. An early prototype has been designed, built and subjected to a limited testing program. Development work will include optimization of the water meter assembly, including the pelton wheel, the air, and water valves, the meter box, etc. The meter will be tested under various operating pressure conditions to check the accuracy of the pelton wheel metering system. A series of gears calibrated to dispense predetermined volumes of water will be designed, developed and tested.

The results of this study will include recommendations as to what dimensions and materials should be used for construction of the meter as well as complete shop drawings for local LDC manufacture. Two final operating prototypes will be furnished.

RESEARCH OBJECTIVE AND OUTPUTS:

The various components of the user activated water meter were subjected to preliminary tests in the laboratory. These tests have proven the components and the total unit work well. However, extensive optimization development work is required before the meter can be tested under actual field conditions. The basic objectives of this study are:

1) To design and test an inexpensive piston and cylinder assembly for strength, wear, and durability.

2) To design and fabricate, or purchase a number of gear assemblies corresponding to a predetermined volume of water. The gear assemblies will be developed and tested under various operating pressures to check the accuracy of the meter.

3) To optimize the design of the pelton wheel to increase the accuracy of the meter. The pelton wheel is the driving mechanism of the meter.

4) To redesign the meter to fit in a more compact space and test the complete unit for accuracy, wear, and durability. The meter and all of its components will be subjected to repeated operation cycles to test the complete unit.

5) To present a final set of work/shop drawings for local LDC manufacture.

The outputs will consist of (1) a thoroughly developed and optimized user activated water meter assembly, (2) five final design, working prototypes, (3) a set of work/shop drawings suitable for mass production of the water meter assembly in LDCs.

PLAN TO LINK RESEARCH AND TO UTILIZE RESULTS:

If a desirable product is produced, the final design prototypes will be demonstrated to World Bank, PAHO, WHO, IDB, ADB, UNICEF, CARE and IDRC officials. The work will be advertized in A.I.D. research publications and IRC news letters. Circular cables will be sent to the development officers in the A.I.D. Missions, alerting them of the existence of the device. The working drawings will be supplied to the Missions for in-country manufacture of the device. Engineering staffs around the world will be advised of its existence and requested to use it in A.I.D. field projects. A global marketing analysis will probably be initiated as a more final design is attained.

MANAGEMENT CONSIDERATIONS:

TA/H approximates the expenditure of 5 man days to develop the project and 10 man days to initiate information dissemination and utilization programs.

RESEARCH DESIGN AND METHODS:

The attached proposal (p. 5-14) contains the detailed study plan, an estimated budget, a detail of the proposed device to be developed, and a resume of the principle investigator to include publications.

REVIEWS OF THE PROPOSAL:

The proposal has been reviewed by Mr. James Thomson, TA/H/EH, Mr. Victor Wehman, TA/H, Mr. Dale Davies, SER/ENGR, Mr. James Cassanos, SER/ENGR. Each of the people are technically qualified in sanitary/environmental engineering and aware of equipment needs in LDC development. Each expressed a considerable interest in the development of the new user activated water meter. Each felt that it and the resultant new marketing system would have a major effect on water supply systems being able to reduce administrative costs, to enhance water conservation, and to improve revenues collection efficiency in offsetting production, operation and maintenance costs.

The proposal has been reviewed by the Office of Health and meets the requirements of an unsolicited proposal contained under AID PR 7-4.5301(e). Therefore, it is recommended that a contract be awarded to the University of Maryland, International Rural Water Resources Development Laboratory without consideration of other sources.

RECOMMENDATION:

That you approve this unsolicited Small Research Activity at the level of $34,550.

Approved: Emmett J. Kemp

Disapproved: _____

Date: Aug 16, 1977

Clearance:
TA/PPU, Robert Simpson

ENDORSEMENT BY OFFICERS OF

THE UNIVERSITY OF MARYLAND

The University of Maryland will accept and administer a grant (contract) awarded to it under the terms of this proposal for the period SEPT 1, 1977 - Aug 31, 1978.

The University of Maryland is an educational institution incorporated in the State of Maryland and retains more than five hundred employees.

The University of Maryland represents that it has not employed or retained a company or person (other than a full time employee) to solicit or secure this grant (contract), and agrees to furnish information thereto as requested.

Y. M. Stavisky
Principal Investigator
Department of

Chairman
Department of

Donald S. Gross, Assistant Dean
College of Engineering

Robert L. Gluckstern by D.S.S.
Robert L. Gluckstern,
Chancellor

Development and Testing of the ROBO User Activated Water Meter

proposal

submitted to

the

Agency for International Development

Office of Health/TAB

on

16 June 1977

by

Yaron M. Sternberg, Ph.D.
University of Maryland
International Rural Water Resources Development
Laboratory
College of Engineering
College Park, Maryland 20724

UNIVERSITY OF MARYLAND
COLLEGE PARK 20742

OFFICE OF CONTRACTS AND GRANTS

July 13, 1977

Mr. Victor W. Wehman, Jr.
Office of Health/TAB
Room 625 PP
Agency for International Development
Washington, D.C. 20523

Dear Mr. Wehman:

Please find enclosed one signed and four unsigned copies of a proposal entitled "Development and Testing of the ROBO User Activated Water Meter." This project is under the direction of Dr. Yaron M. Sternberg, Department of Civil Engineering at the University of Maryland.

The proposal is being submitted pending approval of Budget Committee for partial waiver of indirect costs.

Questions concerning the program content of this proposal should be addressed to Dr. Sternberg at 454-2440. Administrative matters may be directed to Mrs. Frances Schubert, Contract Administrator, at 454-3117.

Your consideration of this proposal is appreciated.

Sincerely,

Stanley M. Matelski
Acting Director

bn
Enclosures
cc: Dr. Sternberg
Dr. Ragan
Dr. Marchello
Mr. Gross

UNIVERSITY OF MARYLAND

PATENT POLICY

1. In order to safeguard the interests of the University, the public and potential inventors it is deemed necessary to provide a procedure for the protection of inventions and discoveries arising out of research. This Patent Policy, approved by the Faculty Senate on January 28, 1960, and adopted by the Board of Regents on January 29, 1960, establishes such a procedure. It applies to all faculty, staff and graduate students engaged in teaching, research and/or study in any of the various divisions and branches of the University of Maryland and State Board of Agriculture.

2. Faculty, staff and graduate students who participate either alone or in association with others in inventions or discoveries are required to disclose promptly such inventions or discoveries to the President provided that University time, facilities or materials were used in connection therewith. Time, facilities or materials paid for from funds administered by the University shall be considered as University time, facilities and materials regardless of whether the funds arise from Federal or State appropriations, student fees, donations, grants, contracts or other sources.

3. The University has an interest in all inventions and discoveries disclosed to it as required by paragraph 2, above, except where the invention or discovery results from personal research, in which case the invention or discovery shall be the sole property of the inventor. Personal research includes research not related to any special University research program, and for which the University makes no special contribution of time, facilities or materials. The payment of a salary and the provision of a normal academic environment in which to work is not to be construed as giving the University any financial equity in personal research. The name of the University may not be used in connection with inventions in which the University has no interest without prior written permission.

4. The University recognizes that the evaluation of inventions and discoveries and the administration, development and processing of patents involves substantial time and expense and requires talents and experience not ordinarily found in its staff; therefore, in most cases it expects to contract with outsiders for these services. It may, at its sole discretion, enter into a contract or contracts with an outside organization covering specific inventions or discoveries believed to be patentable and patents developed therefrom, or covering all such inventions, discoveries and patents in which the University has an interest.

5. In the event that income accrues from the administration of a patent or invention in which the University has an interest, the inventor or inventors will receive fifteen percent (15%) of the gross income from the patent subject to the exceptions set forth in paragraphs 6 and 8. To the extent consistent with State and University budget policies, any income which the University may receive from inventions will be dedicated to research with not less than fifty percent (50%) of such income designated for research in the department or college with which the inventor is affiliated.

6. Under the terms of certain contracts and agreements between the University and various agencies of government, private and public corporations and private interests, the University is or may be required to assign all patent rights to the contracting party. The University retains the right to enter into such agreements whenever such action is considered to be in its best interest.

7. The President shall appoint a University Patent Committee. Upon the request of the President, this Committee will assist him in patent matters including the determination of whether or not the University has an interest in a specific invention or discovery. The inventor or a representative designated by him shall be a non-voting member of the Patent Committee when it is considering a particular invention. The University Patent Committee may advise with faculty, staff and students on patent questions or on specific inventions or discoveries.

8. An invention resulting from personal research (see paragraph 3) may be offered to the University, and, if accepted, the University will administer such invention in accordance with this Patent Policy, the inventor receiving such income as may be specifically agreed upon in writing.

9. Faculty, staff and graduate students are required to execute promptly all contracts, assignments, waivers or other legal documents necessary to invest in the University or its assignees any or all rights to inventions or patents whenever such action is required in order to carry out the provisions of this Patent Policy.

10. Disputes on patent matters, including the interpretation of this Patent Policy, shall be referred to the President and the Board of Regents for resolution.

I have read the Official Patent Policy of the University of Maryland as printed above and I understand fully its requirements and the duties and obligations imposed upon me. In consideration for permission to work on organized and/or sponsored research projects, I agree to abide by the terms of the Official Patent Policy and to execute promptly any necessary papers and/or documents.

July 5 1977 V. M. [illegible] V. M. [illegible]

A. PROJECT SUMMARY

1. Basic Identification and Fiscal Data

Project Title: Development and Testing of the Robo User Activated Meter

New or Extension: New

Contractor and Address: University of Maryland
International Rural Water Resources Development Laboratory
College of Engineering
College Park, Maryland 20742

Principal Investigator: Dr. Yaron M. Sternberg

Duration: 12 months

Total Estimated Cost: $34,550

A.I.D. Project Manager and Sponsoring Office: Victor W. R. Wehman, Jr., P.E.
Office of Health/TAB

2. Abstract

A new type of user activated meter has been designed and partially developed for use in less developed countries. At the present time, charges for water are based on (1) metering of individual supplies and (2) a flat rate charge. The first alternative requires meter readers, billing, collection of payments, etc. The second alternative is not equitable because charges are the same for one or one hundred cubic meters of water. This practice often encourages wastage of water. The Robo user activated meter relies on compressed gas to open a valve and dispense a pre-calibrated volume of water. Thus, in essence, the user, by purchasing a compressed gas cartridge, is guaranteed a predetermined volume of water to be used at his discretion. This system eliminates meter reading, billing and collection of payments. The cartridges will be sold in various stores and sales and distribution will be controlled by the water agency. The objective of this study is to refine the design of the meter and to test it under various conditions. Recommendations for materials for mass production as well as shop drawings will be provided.

EXPANDED NARRATIVE STATEMENT

1. General Background and Rationale

One of the major difficulties in any water distribution system is accountability and receiving collections to off set production, operation and maintenance cost. Presently, there are a number of ways that charges for water use is assessed and collected. Most water meters in use today are cast metal (brass or bronze) which are heavy; expensive and not easily adaptable to production in LDCs. Recently, some water meters have been constructed out of various plastic materials, and are presently used for metering water consumption. These meters are relatively inexpensive, cost from $20 to $40, and fairly accurate, i.e., $\pm$ 1%. Although such meters are mechanically good, they pose a number of serious problems, such as clogging, frequent maintenance, freezing, etc. In order to collect payment, an employee of the water authority agency must read the meter and submit the data to a billing office. The billing office prepares a statement of charges which is then given to the user. This procedure requires considerable labor and expenses and, in many cases, does not assure collection of payment. Often the meter is broken by act of vandals or valuable parts are stolen. In many LDCs the user simply does not have the money to pay a monthly bill although he can pay on a day to day basis. It is also not uncommon to hear about corrupt water meter readers who, by various schemes, deprives the water agency from collecting fees for water used. In summary, existing water meters are labor intensive, expensive and a high maintenance item.

On the other hand, a user activated meter does not depend on meter reading and billing for collecting payment for water used. A user activated meter is defined as a unit which is activated by an external device which can be purchased by the user at any approved store. Once the user has activated the meter, he is

entitled to a predetermined volume of water available at a time of his choice. In essense, the user, by purchasing the activator, has prepaid for the water that he will use. In this system, payment is received prior to use while with ordinary billing systems charges are assessed for water used after the water is consumed. In addition to the elimination of the need for meter reading, billing and collection of payment, the user activated meter will also help reduce revenue losses because of corrupt water meter readers. Only on occasions when maintenance or repairs are required will the user come in contact with an employee of the water supply agency.

A user activated meter has an obvious appeal. Its activating agent must be unique in order to prevent fraud by easy duplication, tampering with the meter, etc. We believe that the Robo user meter has a unique activating agent which can not be easily duplicated. The activating device is a cartridge of compressed gas at pressure of approximately 860 psi at ambient temperature. The pressurized cartridge can be easily manufactured by the water authority and available for purchase in stores throughout the country. The cartridges are very small, light in weight and transportation and marketing are not considered a major problem. The selling price will be determined by the agency in charge of water supply and, as an incentive, the establishments (grocery store, general stores, small village supply store, etc.) where such cartridges are offered for sale will be guaranteed a small profit. After using the cartridge, the consumer may dispose of it or return it for recharging. The feasibility of utilizing reusable cartridges depends on numerous factors which vary from country to country.

The meter will have two security systems; a small welded steel or concrete box with a cover attached by five-sided recessed nuts and a magnetized box lock mechanism. Another "anti-cheating" device will include a small plastic cover on

each cartridge and a counter inside the meter. Prior to activation, the plastic cap will have to be removed and deposited in a special compartment inside the meter. The counter, activated by a piston, will record the total number of times that the meter has been activated. Discrepancy between the number of plastic tabs and the number registered on the counter will indicate possible tampering with the meter. The meter should cost $8-$12/unit for local manufacture.

2. Research Purpose and Expected Products

a. The purpose of this investigation is to develop and test a user activated water meter. A prototype has been designed, built and subjected to a limited testing program. Development work will include optimization of the water meter assembly, including the pelton wheel, the air and water valves, the meter box, etc. The meter will be tested under various operating pressure conditions to check the accuracy of the pelton wheel metering system. A series of gears calibrated to dispense predetermined volumes of water will be designed, developed and tested.

b. The results of this study will include recommendations as to what dimensions and materials should be used for construction of the meter as well as complete shop drawings for local LDC manufacture. Two final operating prototypes will be furnished.

3. Relevance and Significance of Proposed Work to A.I.D.

A.I.D. as well as other international lending organizations help develop water distribution systems in less developed countries. Revenues collected from each household for water help pay for the cost of installing and maintaining the water system. Unless a reliable metering system, coupled with an adequate and honest billing and collection system exist, the collected revenues will fall short of the production operation and maintenance costs. In many areas, the revenues collected are insufficient to pay for the operation of the system and the system can not improve services or meet demand.

A user activated meter eliminates the billing and collection process and will lead to increased revenue because water becomes a pre-paid commodity. In LDC countries, the consumers may not have sufficient money to pay for their periodic monthly water bill. However, almost always, the consumer will have enough money to purchase water on a daily or weekly basis. The proposed meter is rugged and cannot be as easily damaged as plastic meters. It is essentially maintenance free.

4. Relations to Existing Knowledge

There are a number of meters developed by or for LDCs. Most of the recent meters are made of plastic and are easily damaged or clogged. None of the existing meters is a user activated. All meters require periodic visits by the water authority personnel for the purpose of meter reading and billing. The user activated meter eliminates the need for billing and the associated collection of payment. The meter is based on sound hydraulic principles and known technologies. Most of the components can be made out of plastic, if desired, a material that is available in most LDCs.

5. Research Project Design and Methods

The various components of the user activated water meter were subjected to preliminary tests in the laboratory. These tests have proven that the components and the total unit work well. However, extensive development work is required before the meter can be tested under actual field conditions.

The basic objectives of this study are:

1) To design and test an inexpensive piston and cylinder assembly constructed of plastic. The above assembly was initially constructed from aluminum. However, we believe that the cylinder and the piston can be made out of plastic which will

reduce the cost of the meter. A number of cylinder and piston assemblies, constructed out of various plastic materials, will be tested for strength, wear, and durability.

2) Design and fabricate, or purchase a number of gear assemblies corresponding to a predetermined volume of water. Discussion with A.I.D. and other international lending organization representatives will indicate what volume of water should be delivered per cartridge. The proper gear assembly will be developed and tested under various operating pressures to check the accuracy of the meter.

3) Optimize the design of the pelton wheel to increase the accuracy of the meter. The pelton wheel is the driving mechanism of the meter. At low pressures or volume, there is not sufficient force to drive the pelton wheel. The present unit is an off the shelf item that was not designed for water meters. We believe that a more efficient pelton wheel can be designed which will increase the accuracy for recording low flows. A number of pelton wheels will be designed and tested and the most efficient will be selected for the meter.

4) Redesign the meter to fit in a more compact space and test the complete unit for accuracy, wear, and durability. The meter and all its components will be subjected to repeated operation cycles to test the complete unit. Needed modification will be made and testing will continue for 10 thousand cycles. If the meter is operated twice a week, one thousand cycles corresponds to 500 weeks or almost 10 years of actual operation.

5) Present a detailed report on the findings of this investigation, including recommendations for materials and shop drawings for LDC manufacture.

6. Research Competence and Resources

The University of Maryland has full research administration capability to support the proposed project in an efficient and professional manner.

Dr. Sternberg's resume is enclosed. Since 1975, Dr. Sternberg has been involved in various projects, funded by the World Bank, dealing with the application of "appropriate technology" to rural water resources projects. Those projects include the development of a bamboo slotter and testing of wooden pump handles and pivots.

The ROBO-meter was invented by Dr. Sternberg and Mr. Knight, chief instrument maker of the Department of Civil Engineering.

7. Management Considerations

Work on this project will be conducted at the International Water Resources Development Laboratory, College of Engineering, University of Maryland, College Park, Maryland 20742. Hardware will be developed in close coordination with TA/H Project Manager.

TA/H/EH:ja (5/19/77) Typist

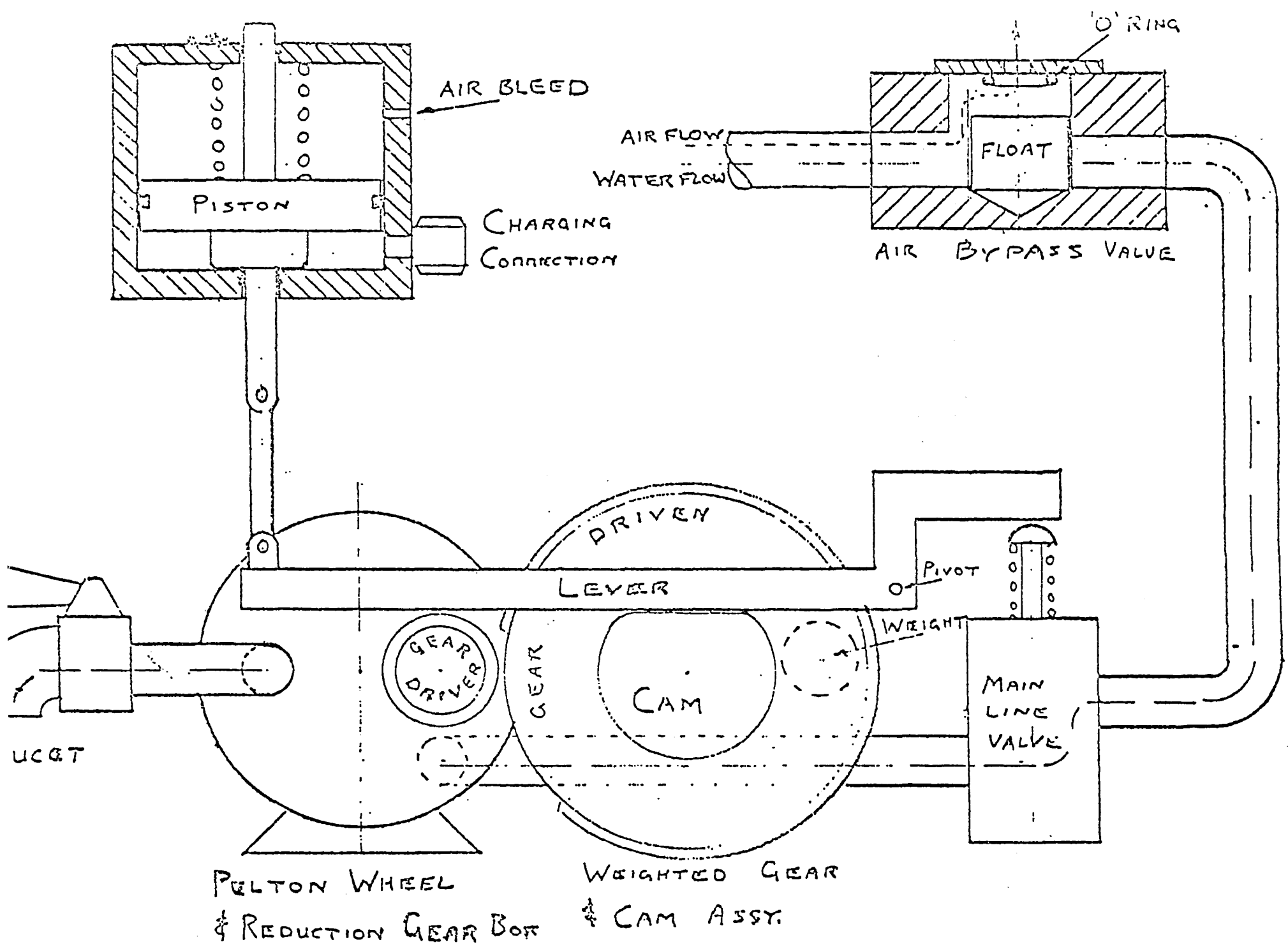
Budget

Development and Testing of the ROBO User Activated Water Meter

		Man-Month	Amount	
A.	Salaries & Wages			
	Dr. Y. M. Sternberg	3	8,100.	
	Mr. R. Knight	2	3,000.	
	Graduate Student	12	5,000.	
	Secretary	2	1,100.	
	subtotal		17,200.	
	15% fringe benefits		2,580.	
	subtotal salaries & wages		19,780.	19,780.
B.	Travel		750.	750.
C.	Phone, Duplicating, etc.		1,200.	1,200.
	subtotal A-C			21,730.
D.	Equipment		7,170.	
	overhead 26%* (except item D)		5,650.	
	Total			34,550.

*University DHEW negotiated rate is 52% TDC. University contribution is $5,650.

Proposal is being submitted pending approval of Budget Committee for partial waiver of indirect costs.


AIR BLEED
PISTON
CHARGING CONNECTION
'O' RING
AIR FLOW
WATER FLOW
FLOAT
AIR BYPASS VALVE
DRIVEN
LEVER
PIVOT
WEIGHT
GEAR DRIVER
GEAR
CAM
MAIN LINE VALVE
UCGT
PELTON WHEEL & REDUCTION GEAR BOX
WEIGHTED GEAR & CAM ASSY.

YARON M. STERNBERG
WATER RESOURCES ENGINEERING
11905 VIEWCREST TERRACE
SILVER SPRING, MARYLAND 20902
301 - 681-7747

Partial List of Projects and Clients

. Availability of ground water, city of Russell Springs, Ky.

. Sources and direction of ground water which flooded a mine, U.S. Gypsum Co., Indiana.

. Drainage of 3000 acre for a planned community, Washington Gas, D.C.

. Flood plain studies, Ben Dyer & Assoc., Md.

. Development of a stormwater management model, Department of Natural Resources, Md.

6. Development of ground water for industrial use, Stewart Petroleum Co., Md.

7. Development of ground water for a planned community, Leisure Technology Co., N.J.

8. R&D of a bamboo slotter for tube well screens, (Assam, India) World Bank, Washington, D.C.

9. R&D of hand-pumps for water supply, World Bank, Washington, D.C.

0. Evaluation of hand-pumps, International Development Research Center (IDRC), Canada.

1. Zarqa irrigation project, Jordan, U.S. A.I.D., Washington, D.C.

2. Land application for Queen Anne Co., Justin & Courtney, Md.

3. Review of small water supply projects, Nigeria, IITA.

RESUME

YARON M. STERNBERG

Present Position:	Professor of Civil Engineering, and Director of International Rural Water Resources Development Laboratory
Address:	University of Maryland Dept. of Civil Engineering College Park, Md. 20742 301-454-2438
Education:	PhD, 1965, Engineering (Hydrology) University of California MS, 1963, Engineering (Hydrology) University of California BS, 1961, Agricultural Engineering University of Illinois
Distinctions and Fellowships:	Tau Beta Pi (National Engineering Honorary Fraternity) Chi Epsilon (National Civil Engineering Honorary Fraternity) Alpha Epsilon (National Agricultural Engineering Honorary Fraternity) Sigma Xi
Professional Affiliation:	American Society of Civil Engineers American Geophysical Union American Society of Petroleum Engineers

Professional Record:

1977 - Present	Director, International Rural Water Resources Development Laboratory
1976 - 1977	Research Scholar, Office of Water Research and Technology, U.S. Dept. of Interior
1974 - Present	Professor of Civil Engineering (Water Resources) University of Maryland
1970 - 1974	Associate Professor of Civil Engineering (Water Resources) University of Maryland

1969 - 1970	Associate Professor of Geology Indiana University
1965 - 1969	Assistant Professor of Geology Indiana University
Academic Experience:	Director of a number of research projects; Maryland subsurface drainage study (1970 - 1974), Migration of pollutants in ground water (1973 - 1975), Environmental impact studies (1974 - 1976), Spray irrigation of effluent (1974 - present), Ground water modeling (1975 - present).
Professional Experience:	Consultant to various private, governmental and international organizations on surface and subsurface hydrology. A partial list of projects and clients is attached.
Publications:	See attached list.

PUBLICATIONS

Yaron M. Sternberg and Verne H. Scott, The Hele-Shaw Model - A Research Device in Ground Water Studies, Ground Water, Volume 2, No. 4, October, 1964, pp. 33-37.

_____, Mutual Interference of Water Wells, Journal of the Hydraulics Division, ASCE, Volume 93, No. HY4, July, 1967, pp. 169-181.

Yaron M. Sternberg, Transmissibility Determination from Variable Discharge Pumping Tests, Ground Water, Volume 5, No. 4, October, 1967, pp. 27-29.

_____, Analysis of Sprinkler Irrigation Losses, Journal of the Irrigation and Drainage Division, ASCE, Volume 93, No. IR4, December, 1967, pp. 111-124.

_____, Simplified Solution for Decreasing Flow to Wells, Journal of the Hydraulics Division, ASCE, Volume 94, HY1, January, 1968, pp. 177-180.

Yaron M. Sternberg and Allen F. Agnew, Hydrology of Surface Mining - A Case Study, Water Resources Research, Volume 4, No. 2, April, 1968, pp. 363-368.

Yaron M. Sternberg, Nonsteady Two-Layer Radial Flow to Wells, International Association of Scientific Hydrology, Publication No. 77, 1968, pp. 329-342.

W. G. Meinschein, Yaron M. Sternberg, and Ronald W. Klusman, Origins of Natural Gas and Petroleum, Nature, Volume 220, No. 5173, December, 1968, pp. 1185-1189.

Yaron M. Sternberg, Some Approximate Solutions for Radial Flow Problems, Journal of Hydrology, Volume 7, 1969, pp. 158-166.

_____, Flow to Wells in the Presence of Radial Discontinuities, Ground Water, Volume 7, No. 6, December, 1969, pp. 158-166.

Lawrence A. Lewis and Yaron M. Sternberg, Changes in the Configuration of Stream Channels Resulting from the Construction of Dams, Proceedings of the Indiana Academy of Sciences, Volume 80, 1971, pp. 351 - 355.

Yaron M. Sternberg, Parameter Estimation for Aquifer Evaluation, Water Resources Bulletin, Volume 7, No. 3, 1971, pp. 447-456.

Roland Thomere, Paul E. Potter and Yaron M. Sternberg, Permeability, Cementation and Grain Size: A Deductive Inquiry, Society of Petroleum Engineering Paper No. 3606, October, 1971.

Yaron M. Sternberg, Well Efficiency and the Skin Effect, Journal of the Irrigation and Drainage Division, ASCE, Volume 99, No. IR2, June 1973, pp 203-206.

_____, Efficiency of Partially Penetrating Wells, Ground Water, Volume 11, No. 4, 1973.

_____, Theory and Application of the Skin Effect Concept to Ground Water Wells, proceedings of the International Symposium on Development of Ground Water Resources, Madras, India, Vol. 2, pp. 23-32, Nov. 1973.

T. Tagamets and Y. M. Sternberg, A Predictor-Corrector Method For Solving The Convection-Dispersion Equation For Adsorption In Porous Media, Water Resources Research, Vol. 10, No. 5, pp. 1003-1011, 1974.

T. Moynahan and Y. M. Sternberg, Effects on Highway Subdrainage of Gradation and Direction of Flow Within a Densely Grated Base Course Material, Transportation Research Board, No. 497, pp. 50-59, 1974.

ENVIRONMENTAL THRESHOLD DETERMINATION

TO: AA/TA, Mr. Curtis Farrar

THRU: TA/PPU

FROM: TA/H, Lee M. Howard, M.D.

SUBJECT: Environmental Threshold Determination

Project Title: Development and Testing of the ROBO User Activated Water Meter.
Project #: 931-0001
Specific Activity (if applicable) _____
REFERENCE: Initial Environmental/Examination (IEE) contained in Project proposal dated 16 June 1977

On the basis of the Initial Environmental/Examination (IEE) referenced above and attached to this memorandum I recommend that you make the following determination:

X 1. The proposed agency action is not a major Federal action which will have a significant effect on the human environment.

_____ 2. The proposed agency action is a major Federal action which will have a significant effect on the human environment, and

_____ a. An Environmental Assessment is required; or

_____ b. An Environmental Impact Statement is required.

The cost of and schedule for this requirement is fully described in the referenced document.

_____ 3. Our environmental examination is not complete. We will submit the analysis no later than _____ with our recommendation for an environmental threshold decision.

Approved: _____

Disapproved: _____

Date: _____

INITIAL ENVIRONMENTAL EXAMINATION

Project Location: College Park, Maryland

Project Title: Development and Testing of the ROBO User Activated Water Meter

FUNDING (FISCAL YEAR AND AMOUNT): This unsolicited research project proposal was submitted for TA/RES approval in June 1977 with requested funding amounting to $34,550 for the period starting FY 77. The project is anticipated to run from August 1977 to August 1978 (12 months).

IEE Prepared by: Victor W.R. Wehman, Jr., P.E.
TA/H/EH
Environmental/Sanitary Engineer

ENVIRONMENTAL ACTION RECOMMENDED: It is recommended that this project receive a negative determination and that no additional environmental examinations be carried out on this project.

Assistant Administrator's/Directors Decision: Date: 9/18/77

for L.H. Howard

Contents of Initial Environmental Examination

I. Examination of Nature, Scope and Magnitude of Environmental Impacts

Description of Project

The objective of this project is to develop and test a new user activated water meter. A prototype has been initially designed, built and subjected to a limited testing program. The development work will include optimization of the water meter assembly for subsequent use in LDCs. The study will be carried out by Yaron M. Sternberg, Ph.D., Professor of Civil Engineering and Director of the International Water Resources Development Laboratory, College of Engineering, University of Maryland, College Park, Maryland.

The results of this study will include detailed work/shop drawings of the final design and the construction of five (5) final design operating prototypes.

If the water meter is satisfactorily developed, the designs will be dispersed to USAID/Missions and LDCs for in-country manufacture and incorporation into new or existing water distribution systems.

C. ATMOSPHERIC

1. Air additives ---------- N
2. Air pollution ---------- N
3. Noise pollution ---------- N
4. Other factors

_____ —
_____ —

D. NATURAL RESOURCES

1. Diversion, altered use of water ---------- N
2. Irreversible, inefficient commitments ---------- N
3. Other factors

_____ —
_____ —

E. CULTURAL

1. Altering physical symbols ---------- N
2. Dilution of cultural traditions ---------- N
3. Other factors

_____ —
_____ —

F. SOCIOECONOMIC

1. Changes in economic/employment patterns (See note) M
2. Changes in population ---------- N
3. Changes in cultural patterns ---(see note)--- M
4. Other factors

Note: User activated water meter will change water marketing methods in LDCs if device used. A fuller description of intended marketing measures is found in Project Proposal, Section 1, p.3. Para. 2.

IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas 1/	Impact Identification and Evaluation 2/
A. LAND USE	
1. Changing the character of the land through:	
a. Increasing the population	N
b. Extracting natural resources	N
c. Land clearing	N
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Other factors	
_____	-
_____	-
B. WATER QUALITY	
1. Physical state of water	N
2. Chemical and biological states	N
3. Ecological balance	N
4. Other factors	
_____	-
_____	-

1/ See Explanatory Notes for this form.

2/ Use the following symbols:
N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

G. HEALTH

1. Changing a natural environment ---------- N
2. Eliminating an ecosystem element ---------- N
3. Other factors

_____ —

_____ —

H. GENERAL

1. International impacts (see note) ---------- M
2. Controversial impacts ---------- N
3. Larger program impacts ---------- N
4. Other factors

Note: Will result in increased revenues for water — utilities leading to more stable fiscal management — and operation of existing water systems.

I. OTHER POSSIBLE IMPACTS (not listed above)

_____ —

_____ —

_____ —

AID 13-0-1X (7-71)

FIO/T

DEPARTMENT OF STATE
AGENCY FOR
INTERNATIONAL DEVELOPMENT

PROJECT IMPLEMENTATION ORDER/TECHNICAL SERVICES

1. Cooperating Country: AB Inter-regional

Page 1 of 6 Pages

2. PIO/T No.: 931-0001-3177709

3. [X] Original or Amendment No. ____

4. Project/Activity No. and Title: 931-0001
Small Research Program
(Dev. & Test. ROBO User Act. Water Meter)

931C001 (3) (24)
PD-AA6-722-E1

DISTRIBUTION

5. Appropriation Symbol: 72-11X1026

6.A. Allotment Symbol and Charge: 425-31-099-00-22-71

6.B. Funds Allotted to: [X] A.I.D./W [ ] Mission

7. Obligation Status: [X] Administrative Reservation [ ] Implementing Document

8. Funding Period (Mo., Day, Yr.): From 9/15/77 To 9/14/78

9.A. Services to Start (Mo., Day, Yr.): Between 9/1/77 and 9/30/77

9.B. Completion date of Services (Mo., Day, Yr.): 9/14/78

10.A. Type of Action: [X] A.I.D. Contract [ ] Cooperating Country Contract [ ] Participating Agency Service Agreement [ ] Other

10.B. Authorized Agent: CM/COD

Estimated Financing $1.00=		(1) Previous Total	(2) Increase	(3) Decrease	(4) Total to Date
11. Maximum A.I.D. Financing	A. Dollars		35,000		35,000
	B. U.S.-Owned Local Currency				
12. Cooperating Country Contributions	A. Counterpart				
	B. Other				

FUNDS RESERVED BY [signature] 8/25/77
POSTED SER/FM/CSD

13. Mission References

14. Instructions to Authorized Agent

Prepare and enter into a contract with the University of Maryland for the execution of the work outlined herein and described in detail in the attached proposal submitted by the University to AID on June 16, 1977.

Article # Voucher Identification. In each instance of voucher (SF1034) submission made by the contractor for payment hereunder, the following identification data will appear on the face of the voucher:

Contract: AID/_____
Project 931-0001
Project Office TAB/H/EH

15. Clearances – Show Office Symbol, Signature and Date for all Necessary Clearances.

A. The specifications in the scope of work are technically adequate
TA/H/EH:VWehman V. Wehman 7/27/77

B. Funds for the services requested are available
TA/PPU:MMozynski [signature] 8/24/77

C. The scope of work lies within the purview of the initiating and approved Agency Programs
TA/H:LMHoward [signature]

D.
TA/PPU:LWakefield [signature] 8/19/77

E.
TA/H:HPCordova [signature] 7/28/77

F.
TA/RES:WBechcigl [signature] 8/16/77

16. For the cooperating country: The terms and conditions set forth herein are hereby agreed to

Signature and date:

Title:

17. For the Agency for International Development

Signature: Kenneth Milam

Title:

18. Date of Signature: 8/24/77

GPO 867-268

SCOPE OF WORK

19. Scope of Technical Services

A. Objective for which the Technical Services are to be Used

Develop and test a user activated water meter

B. Description

The contractor will:

1. Design and test an inexpensive piston and cylinder assembly for strength, wear and durability.
2. Design and fabricate, or purchase a number of gear assemblies corresponding to a predetermined volume of water. The gear assemblies will be developed and tested under various operating pressures to check the accuracy of the meter.
3. Optimize the design of the pelton wheel to increase the accuracy of the meter. The pelton wheel is the driving mechanism of the meter.
4. Redesign the meter to fit in a more compact space and test the complete unit for accuracy, wear, and durability. The meter and all of its components will be subjected to repeated operation cycles to test the complete unit.
5. Present a final set of work/shop drawings for local LDC manufacture.

(See Page 6 of 6)

C. Technicians

(1) (a) Number	(b) Specialized Field	(c) Grade and/or Salary	(d) Duration of Assignment (Man-Months)

See Illustrative Budget

(2) Duty Post and Duration of Technicians' Services

N.A.

(3) Language requirements

N.A.

(4) Access to Classified Information

None

(5) Dependents: ☐ Will ☒ Will Not Be Permitted to Accompany Technician

D. Financing of Technical Services

(1) By AID - $35,000 (See Illustrative Budget) (2) By Cooperating Country - N.A.

AID 1350-1X (9-73) PIO/T	Cooperating Country: TAB Inter-regional	PIO/T No.: 931-0001-3177709	Page 3 of 6 Pages
	Project/Activity No. and Title: 931-0001 Small Research Program (Dev. & Test. ROBO User Act. Water Meter)		

20. Equipment and Supplies *(Related to the services described in Block 19 and to be procured outside the Cooperating Country by the supplier of these services)*

N.A.

A. (1) Quantity	(2) Description	(3) Estimated Cost	(4) Special Instructions
N.A.			

B. Financing of Equipment and Supplies

(1) By AID – $ (2) By Cooperating Country

21. Special Provisions

☑ A. This PIO/T is subject to AID (contracting) (PASA implementation) regulations.

☑ B. Except as specifically authorized by AID, or when local hire is authorized under the terms of a contract with a U.S. Supplier, services authorized under this PIO/T must be obtained from U.S. sources.

☑ C. Except as specifically authorized by AID/W, the purchase of commodities authorized under this PIO/T will be limited to the U.S. under Geographic Code 000.

☑ D. Other *(specify)*: Contractor must be authorized to enter into necessary subcontracts without prior approval of AID contracts office.

22. Reports by Contractor or Participating Agency *(Indicate type, content and format of reports required, including language to be used if other than English, frequency or timing of reports, and any special requirements)*

Contractor shall submit three copies of the final report listed as being a product of the contract to the Documentation Coordinator, TA/PPU/EUI, Technical Assistance Bureau or his designee. No interim reports (other than phone calls or visits to the TA/H project manager's office for short term discussions of progress) will be required. Final report will be in English and at least include (1) a summary of successes/failure during the meter development, (2) a description of the actual procedures followed versus what was initially contemplated; (3) a projected cost estimate for large scale, local country manufacture of the water meter assembly; (4) inked design/working drawings suitable for international organization distribution.

Contractor shall submit 10 copies of final report to the project manager, TA/H. The final report shall be reviewed in draft form with the TA/H project manager before submission of official final report.

Final report shall be submitted no later than 15 days following the last day of the contract.

The final report shall include a title page showing the title of the report, project title as set forth in this contract and the contract number. One copy of the final report shall be clearly typed or printed on white paper so that it may be photographed to produce a microfilm master. There shall be an author-prepared abstract.

23. Background Information *(Additional information useful to Authorized Agent and Prospective Contractors or Participating Agency; if necessary cross reference Block 19.C(4) above.)*

N.A.

24. Relationship of Contractor or Participating Agency to Cooperating Country and to AID

A. Relationships and Responsibilities

N.A.

B. Cooperating Country Liaison Official

N.A.

C. AID Liaison Officials

Sanitary Engineer, TA/H/EH

LOGISTIC SUPPORT

25. Provisions for Logistic Support

A. Specific Items *(Insert "X" in applicable column at right. If entry needs qualification, insert asterisk and explain below in C. "Comments")*

N.A.

	In Kind Supplied By		From Local Currency Supplied By	
	AID	Cooperating Country	AID	Cooperating Country
(1) Office Space				X
(2) Office Equipment				X
(3) Housing and Utilities				X
(4) Furniture				X
(5) Household Equipment *(Stoves, Refrig., etc.)*				X
(6) Transportation in Cooperating Country				X
(7) Interpreter Services				X
Other: *(Specify)* (8)				X
(9)				X
(10)				X
(11)				X
(12)				
(13)				
(14)				
(15)				

B. Additional Facilities Available From Other Sources

N.A.

C. Comments

ILLUSTRATIVE BUDGET

See Page 6 of 6

AID-1000-1X (7-80) CONTINUATION SHEET	DEPARTMENT OF STATE AGENCY FOR INTERNATIONAL DEVELOPMENT	☒ Worksheet ☐ Issuance	PAGE 6 OF 6 PAGES
		1. Cooperating Country TAB Inter-regional	2.a. Code No. 931-0001-3177709
FORM SYMBOL	TITLE OF FORM	2.b. Effective Date	2.c. ☒ Original OR Amendment No:
	P!O/T	3. Project/Activity No. and Title 931-0001 Small Research Program (Dev. & Test. ROBO User Act. Water Meter)	

Indicate block numbers.

Use this form to complete the information required in any block of a PIO or PA/PR form.

BLOCK 19.B.

The outputs will consist of (1) a thoroughly developed and optimized user activated water meter assembly, (2) five final design, working prototypes, (3) a set of work/shop drawings suitable for mass production of the water meter assembly in LDCs.

BLOCK 25.C.

ILLUSTRATIVE BUDGET

		Man-Month	Amount $	
A.	Salaries & Wages			
	Dr. Y. M. Sternberg	3	8,100	
	Mr. R. Knight	2	3,000	
	Graduate Student	12	5,000	
	Secretary	2	1,100	
	subtotal		17,200	
	15% fringe benefits		2,580	
	subtota salaries & wages		19,780	19,780
B.	Travel		750	.750
C.	Phone, Duplicating, etc.		1,200	1,200
	subtotal A-C			21,730
D.	Equipment		7,170	
	overhead 26% (except item D)		5,650	
	TOTAL			$34,550

AID 1350-1X (7-71)

PIO/T

DEPARTMENT OF STATE
AGENCY FOR
INTERNATIONAL DEVELOPMENT

PROJECT IMPLEMENTATION ORDER/TECHNICAL SERVICES

1. Cooperating Country: TAB Inter-regional

Page 1 of 6 Pages

2. PIO/T No.: 931-0001-3177710

3. [X] Original or Amendment No. ____

4. Project/Activity No. and Title: 931-0001
Small Research Program 931000 1-(4)
(Development & Testing of the ROBO Valve)
PD AA6-722-F1

DISTRIBUTION

5. Appropriation Symbol: 72-11X1026

6.A. Allotment Symbol and Charge: 426-31-099-00-22-71

6.B. Funds Allotted to: [X] A.I.D./W [ ] Mission

7. Obligation Status: [X] Administrative Reservation [ ] Implementing Document

8. Funding Period (Mo., Day, Yr.): From 9/15/77 To 6/14/78

9.A. Services to Start (Mo., Day, Yr.): Between 9/1/77 and 9/30/77

9.B. Completion date of Services (Mo., Day, Yr.): 6/14/78

10.A. Type of Action: [X] A.I.D. Contract [ ] Cooperating Country Contract [ ] Participating Agency Service Agreement [ ] Other

10.B. Authorized Agent: CM/COD

Estimated Financing $1.00=		(1) Previous Total	(2) Increase	(3) Decrease	(4) Total to Date
11. Maximum A.I.D. Financing	A. Dollars		32,000		32,000
	B. U.S.-Owned Local Currency				
12. Cooperating Country Contributions	A. Counterpart				
	B. Other				

13. Mission References

14. Instructions to Authorized Agent

Prepare and enter into a contract with Dr. Yaron M. Sternberg for the execution of the work outlined herein and described in detail in attached proposal submitted to AID by Dr. Sternberg on June 16, 1977.

Article# Voucher Identification: In each instance of voucher (SF1034) submission made by the Contractor for payment hereunder, the following identification data will appear on the face of the voucher.

Contract AID/
Project 931-0001
Project Office TAB/H/EH

FUNDS RESERVED BY

POSTED 8/11/77
SER/FM/CSD

15. Clearances – Show Office Symbol, Signature and Date for all Necessary Clearances.

A. The specifications in the scope of work are technically adequate
TA/H/EH, VWehman V. Wehman 7/27/77

B. Funds for the services requested are available
TA/PPU, MMozynski MCM 8/4/77

C. The scope of work lies within the purview of the initiating and approved Agency Programs
TA/H, Lee M. Howard

D.
TA/PPU, LWakefield 8/3/77

E.
TA/H, HPCordova 7/28/77

F. TA/RES, JErickson 8/2/77
TA/RES, MRechcigl 8/4/77

16. For the cooperating country: The terms and conditions set forth herein are hereby agreed to

Signature and date:

Title:

17. For the Agency for International Development

Signature:

Title:

18. Date of Signature: 8/8/77

GPO 867-266

Project/Activity No. and Title

931-0001 Small Research (Development & Testing of the ROBO Valve)

SCOPE OF WORK

19. Scope of Technical Services

A. Objective for which the Technical Services are to be Used

The development and testing of a water valve/faucet, constructed out of high impact plastics that will work on two basic principles-buoyancy and pressure differential.

B. Description

The Contractor will:

1) To review and select a number of plastic or elastomer materials to be used as valves, seat assemblies, and outside assemblies.

2) To optimize the angle of the cone of the valve with respect to operating pressures and seating characteristics.

3) To fabricate 20 of the ROBO valves based on the results of the materials review and design calculations.

4) To subject the valves to a five hundred thousand cycle operation sequence to look at various combinations of materials/designs.

5) To develop final shop drawings capable of being used in mass production.

(continued on page 6)

C. Technicians

(1) (a) Number	(b) Specialized Field	(c) Grade and/or Salary	(d) Duration of Assignment (Man-Months)
See Illustrative Budget			

(2) Duty Post and Duration of Technicians' Services

N.A.

(3) Language requirements

N.A.

(4) Access to Classified Information

None

(5) Dependents ☐ Will ☒ Will Not Be Permitted to Accompany Technician

D. Financing of Technical Services

(1) By AID - $ 32,000 (see Illustrative Budget) (2) By Cooperating Country - N.A.

AID 1350-1X (9-73) PIO/T	Cooperating Country TAB Inter-regional	PIO/T No.	Page 3 of 6 Pages
	Project Activity No. and Title 931-0001 Development & Testing of the ROBO Valve		

20. Equipment and Supplies *(Related to the services described in Block 19 and to be procured outside the Cooperating Country by the supplier of these services)* N.A.

A. (1) Quantity	(2) Description	(3) Estimated Cost	(4) Special Instructions
N.A.			

B. Financing of Equipment and Supplies

(1) By AID – $ N.A. (2) By Cooperating Country –

21. Special Provisions

☒ A. This PIO/T is subject to AID (contracting) (PASA implementation) regulations.

☒ B. Except as specifically authorized by AID, or when local hire is authorized under the terms of a contract with a U.S. Supplier, services authorized under this PIO/T must be obtained from U.S. sources.

☒ C. Except as specifically authorized by AID/W, the purchase of commodities authorized under this PIO/T will be limited to the U.S. under Geographic Code 000.

☒ D. Other *(specify)*:

Contractor must be authorized to enter into necessary subcontract without prior approval of AID Contract Office.

22. Reports by Contractor or Participating Agency (*Indicate type, content and format of reports required, including language to be used if other than English, frequency or timing of reports, and any special requirements*)

Contractor shall submit three copies of the final report listed as being a product of the Contract to the Documentation Coordinator, TA/PPU/EUI, Technical Assistance Bureau or his designee. No interim reports (other than phone calls or visits to the TA/H Project Manager's office for short term discussions of progress) will be required. Final report will be in English and at least include (1) a summary of the successes/failures during the development; (2) a description of the actual procedures followed versus what was initially contemplated; (3) a projected cost estimate for large scale, local country manufacture of the valve assembly; and (4) inked design/working drawings suitable for international organization distribution.

Contractor shall submit 10 copies of final report to Project Manager, TA/H. The final report shall be reviewed in draft form with the TA/H Project Manager before submission of official final report. Final report shall be submitted no later than 15 days following the last day of the contract.

The final report shall include a title page showing the title of the report, project title as set forth in this Contract and the Contract number. One copy of the final report shall be clearly typed or printed on white paper so that it may be photographed to produce a microfilm master. There shall be an author-prepared abstract.

23. Background Information (*Additional information useful to Authorized Agent and Prospective Contractors or Participating Agency; if necessary cross reference Block 19.C(4) above.*)

See attached proposal.

24. Relationship of Contractor or Participating Agency to Cooperating Country and to AID

A. Relationships and Responsibilities

N.A.

B. Cooperating Country Liaison Official

N.A.

C. AID Liaison Officials

Sanitary Engineer, TA/H/EH

AID 1350-1X (9-73)	Cooperating Country TAB Inter-regional	PIO/T No.	Page 5 of 6 Pages
PIO/T	Project/Activity No. and Title 931-0001 Small Research Program Development & Testing of the ROBO Valve		

LOGISTIC SUPPORT

25. Provisions for Logistic Support A. Specific Items *(Insert "X" in applicable column at right. If entry needs qualification, insert asterisk and explain below in C. "Comments")* N.A.	IN KIND SUPPLIED BY: AID	IN KIND SUPPLIED BY: COOPERATING COUNTRY	FROM LOCAL CURRENCY SUPPLIED BY: AID	FROM LOCAL CURRENCY SUPPLIED BY: COOPERATING COUNTRY	TO BE PROVIDED OR ARRANGED BY SUPPLIER
(1) Office Space					X
(2) Office Equipment					X
(3) Housing and Utilities					X
(4) Furniture					X
(5) Household Equipment *(Stoves, Refrig., etc.)*					X
(6) Transportation in Cooperating Country					X
(7) Transportation To and From Country					X
(8) Interpreter Services/Secretarial					X
(9) Medical Facilities					X
(10) Vehicles (official)					X
(11) Travel Arrangements/Tickets					X
Other: (specify) (12)					
(13)					
(14)					
(15)					

B. Additional Facilities Available From Other Sources

N.A.

☐ APO ☐ PX ☐ COMMISSARY

☐ OTHER (specify, e.g., duty free entry, tax exemption)

N.A.

C. Comments

(See Illustrative Budget attached - page 6)

(Continued from page 2)

The outputs will consist of (1) a thoroughly developed valve/faucet design, (2) five (5) working final design prototypes and (3) a set of workshop drawings suitable for mass production of the valve assemblies.

BUDGET

A.	Salaries & Wages		
	Dr. Y.M. Sternberg	100 days @ $125 per day	$12,500
	Mr. R. Knight	75 days @ $100 per day	7,500
	Graduate student help	6 months	2,500
	Secretarial help	30 days @ $40 per day	1,200
		Sub-total	$23,700
B.	Material & Supplies		$ 6,500
C.	Drafting, Duplications, etc.		$ 1,000
D.	Space rental		$ 750
		Total	$31,950
		Rounded to	$32,000