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WASH

WATER AND SANITATION FOR HEALTH PROJECT

Operated by
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The WASH Project is managed by Camp Dresser & McKee International, Inc. Principal cooperating institutions and subcontractors are: Associates in Rural Development, Inc., International Science and Technology Institute, Inc., Research Triangle Institute, Training Resources Group, University of North Carolina at Chapel Hill.

TECHNICAL ASSISTANCE TO MANUFACTURERS OF AID HANDPUMPS AND ROBOSCREENS IN HONDURAS

WASH FIELD REPORT NO. 85

SEPTEMBER 1983

Prepared For:

USAID Mission to the Republic of Honduras
Order of Technical Direction No. 29

September 16, 1983

Mr. Anthony Cauterucci
Mission Director, USAID
Tegucigalpa
Honduras

Attention: Mr. William H. Smith

Dear Mr. Cauterucci:

On behalf of the WASH Project I am pleased to provide you with 10 (ten) copies of a report on manufacturing AID-design handpumps and plastic well screen in Honduras and selecting sites to field test these devices in rural Honduran communities. This report covers Phase I work of a two-phase technology transfer effort which was intended to develop local manufacturing capability and provide comparative performance data for future pump selection for the PRASAR Project. Phase II work was carried out under WASH Project Order of Technical Direction (OTD) No. 85, for which a separate report is being prepared.

This is the final report written by Ben E. James, Jr. of the Georgia Institute of Technology and extensively edited by Paul F. Howard, P.E., CDM WASH Project Officer. The report is based on field work carried out in Honduras by Georgia Tech personnel between May 1981 and April 1982.

This assistance is in response to a request by the Mission in Cable Tegucigalpa 00093 on January 7, 1981. The work was undertaken by the WASH Project on February 19, 1981 by means of Order of Technical Direction No. 29, authorized by the USAID Office of Health in Washington.

If you have any questions or comments regarding the findings or recommendations contained in this report we will be happy to discuss them.

Sincerely,

Dennis B. Warner

Dennis B. Warner, Ph.D., P.E.
Director
WASH Project

cc: Mr. Victor W.R. Wehman, Jr., P.E., R.S.
AID WASH Project Manager
S&T/H/WS

DBW:PFH:pwr

WASH FIELD REPORT NO. 85

TECHNICAL ASSISTANCE TO MANUFACTURERS OF AID HANDPUMPS AND ROBOSCREENS IN HONDURAS

PHASE I

Prepared for the USAID Mission to the Republic of Honduras
Under Order of Technical Direction No. 29

Prepared by:

Ben E. James, Jr.

September 1983

Water and Sanitation for Health Project
Contract No. AID/DSPE-C-0080, Project No. 931-1176
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Washington, DC 20523

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EXECUTIVE SUMMARY

The Government of Honduras (GOH) included in its five-year plan for 1979-1983 the improvement of water supply and sanitation for up to 75 percent of its rural population. The USAID Mission in Honduras, in keeping with a long history of U.S. assistance in Honduran water and sanitation projects, executed a loan agreement with the GOH to undertake the Rural Water and Sanitation Project, PRASAR.

Among many other water and sanitation improvements, PRASAR was to install 3,000 handpumps on existing and new dug, hand-drilled, or driven wells. The PRASAR project paper had called for the purchase of U.S.-made Dempster handpumps, but it was later decided that locally manufactured pumps should be considered for this project. Accordingly, the PRASAR loan agreement included a provision for AID to assist the GOH by developing the capability to manufacture a reliable, community-level handpump in Honduras.

In the beginning of the project the GOH ordered 1,120 Dempster handpumps in order not to delay project implementation while waiting for the local pump to be developed. At the same time it requested the AID Mission, and the Mission in turn requested AID in Washington, to undertake a program of technical assistance to develop local handpump manufacturing capability and conduct comparative testing of several handpumps so that the GOH would have reasonably objective criteria on which to base its selection when it placed its second order for pumps.

AID/Washington responded to the request in February 1981 by issuing Order of Technical Direction (OTD) No. 29 to Camp Dresser and McKee, Inc. (CDM), an environmental engineering company that operates AID's centrally-funded Water and Sanitation for Health (WASH) Project. CDM, in turn, authorized its subcontractor, the Engineering Experiment Station at the Georgia Institute of Technology, to undertake the work. Georgia Tech has extensive experience in this work with the AID-design handpump in several developing countries.

In accordance with the Mission's request, the work was carried out in two phases. The Phase I work was carried out under OTD 29. It consisted of selecting local manufacturers for the AID-design handpump and roboscreen (a PVC well screen), providing them with technical assistance, and purchasing from them 150 pumps and 200 feet of well screen. The work also involved selecting sites to field test various handpumps and to purchase the other pumps and materials needed for the field test. The Dempster Model 210F handpump and the Sanpar handpump, a locally-manufactured pump with which the GOH had experienced problems, were the other pumps to be compared with the AID-design pump.

This report describes the Phase I work carried out under OTD 29.

The Phase II work is being carried out under WASH OTD 85. It consists of installing the three types of pumps in the field, monitoring and maintaining them, and providing performance data to the GOH, the USAID Mission, and, in the case of the AID pump, to the manufacturer of the AID pump, Fundicion y Maquinado (FUNYMAQ), in San Pedro Sula.

The entire Phase I work program was carried out successfully, and local capability was developed to manufacture a reliable multi-family handpump and an inexpensive plastic well screen. In the course of the work several lessons were learned and conclusions drawn. Based on these lessons and conclusions several recommendations are made for future projects of this nature. They include suggested methods for improving the handpump technology transfer process as well as overall planning, coordination, and execution of programs involving the local manufacture and installation of handpumps. The conclusions and recommendations are included in Chapter 4 of this report.

As a result of the success of Phase I work, Phase II was initiated in February 1982 and is now nearing completion. A separate report is being prepared for that activity.

ACKNOWLEDGEMENTS

Georgia Tech extends its appreciation to Richard Dudley, William Smith, and Ing. Edmundo Madrid of the AID Mission in Honduras for their assistance in carrying out the work under OTD 29. Georgia Tech also acknowledges the assistance of Ing. Efrain Giron, Director of the Ministry of Health (MOH) component of the PRASAR Project, and all of the MOH staff that assisted in this work.

Georgia Tech enjoyed working with Ricardo Mata, owner and manager of FUNYMAQ. His enthusiasm, cooperation, and conscientiousness contributed to a very successful technology transfer effort.

Finally, Georgia Tech acknowledges the assistance of Ing. Porfirio Sanchez of ICAITI and the ICAITI organization for the assistance they provided.

Chapter 1

INTRODUCTION

1.1 Water and Sanitation Improvements in Honduras

In view of the high mortality and morbidity rates in the rural areas of Honduras, much of which is due to inadequate water supplies and poor sanitation, the Government of Honduras (GOH) included in its five-year plan for 1979-1983 the improvement of water supply for 75 percent of the rural population and the improvement of sanitation for 38 percent of this population. Given present coverage and population growth, these goals involve a target group of approximately 1,200,000 people needing new water and sanitation systems, and an estimated additional 170,000 needing their present water systems repaired or improved during this period.*

1.2 Honduran Government Agency Activity in Water and Sanitation

At present, the GOH implements its water and sanitation programs primarily through three government agencies: the Ministry of Health (MOH) Basic Sanitation Program (PROSABA), the National Autonomous Water and Sewer Agency (SANAA), and the Municipal Development Bank (BANMA).

PROSABA was established in 1974 to administer and promote rural environmental sanitation outreach programs. Its main activities have been the installation of handpumped wells and the promotion and construction of latrines in dispersed rural communities with populations of less than 200 inhabitants. These activities are coordinated by the MOH at the central level and implemented by rural health promoters working at the village and municipal level. Each promoter assigned to work with the villages is from the area and, therefore, is expected to be knowledgeable about local customs and beliefs. Through the promoter's efforts, community participation is stimulated and organized to develop the potential for self-help which exists in each locality.

SANAA was created in 1961 to respond to the needs for piped water systems and sewers. SANAA's rural activity mainly has been directed to the construction of gravity flow aqueduct systems in rural communities having populations of more than 200 inhabitants. Its responsibility includes project financing, design, construction supervision, and maintenance of completed systems. Community volunteer labor is required for all unspecialized work during the construction of the selected system. SANAA is also gradually applying user fees to support rehabilitation of existing nonfunctional rural systems which, upon upgrading, will be incorporated into SANAA's maintenance program. Chlorination treatment units are being installed on all systems. Filtration units are being considered for those systems that need filtration. With external financial assistance, SANAA is constructing or supervising the installation of approximately 100 rural gravity flow aqueduct systems annually.

*Honduras Project Paper - Rural Water and Sanitation Project 522-0166

BANMA provides loans to municipalities to finance infrastructure and municipal services, including water systems. The municipalities then operate and maintain the systems and repay BANMA from the user charges for the water system or from other revenues. Since 1975, systems have been built or repaired in medium sized communities, the smallest of which had a population of 6,000. This activity is expected to continue as viable opportunities for BANMA financing present themselves.

1.3 U.S. Government Assistance in Water and Sanitation in Honduras

Since 1942 the United States Government has been active in supporting Honduran water supply activities by financing the installation of rural systems. Through the services of the Institute for Inter-American Affairs (IIAA) and successor agencies, these programs have concentrated on construction and installation of gravity flow aqueducts. While exact figures are not available, it is estimated, for example, that between 1942 and 1959 over 125 rural aqueducts were constructed under these programs. From 1964 through 1967, the United States Agency for International Development (USAID) worked with SANAA on a $1.1 million Rural Water Pilot Project (Loan 522-T-008) that financed the construction of 62 gravity flow aqueduct systems benefitting some 13,000 rural inhabitants. A USAID Nutrition Project (Loan 522-T-029) included $1.5 million for PROSABA to promote the construction and use of latrines, low cost wells, and a few gravity flow aqueduct systems. A USAID Fund for Special Development Activities project has given priority to financing construction materials required to complete rural aqueduct systems at a rate of approximately 10 per year through SANAA. The most recent rural water and sanitation project being funded by USAID/Honduras, PRASAR (Project No. 522-0166) is an $18.2 million project, of which $10.5 million is U.S. financing, that consists of "providing rural families with access to safe water and human waste disposal systems primarily by means of the self-help construction of multi-family wells, gravity-flow aqueducts and latrines, and a health education program designed to reinforce the impact of the construction program by teaching rural Hondurans the importance of good hygienic practices."*

*Honduras Project Paper - Rural Water and Sanitation Project 522-0166

Chapter 2

PROJECT BACKGROUND

2.1 Events Leading to the OTD

During the planning of the PRASAR Project, AID Honduras requested assistance from the Georgia Institute of Technology concerning the handpumps that would be used in the project. In the early part of 1977 and 1978 and in December 1979 a representative of Georgia Tech met with Mission staff in Honduras to help them in planning the handpump aspects of the project. Georgia Tech had assisted AID in several other countries in developing in-country capability to manufacture the AID-design, multi-family handpump.

In the fall of 1979, a project paper for the Honduras Rural Water and Sanitation Project (PRASAR) was completed. As part of the procurement procedures of this project paper it was recommended that the Dempster handpump be used exclusively on this project. The Dempster handpump is manufactured in the U.S. and has been used widely for rural water supply there and in other countries. Apparently it was decided to use this pump in order to expedite project implementation and avoid the initial delay that would be involved if local manufacturing capability was to be developed for the AID pump. During the review of this project paper AID in Washington questioned the proposed exclusive use of the Dempster pump. It was thought that, despite the initial delays involved, it would be worth waiting for the local manufacturing capability to be developed because, in the long run, the availability of a reliable local pump could save time in delivery of pumps, facilitate procurement of spare parts, and ease the burden on Honduras' foreign exchange capacity.

After discussions between AID/Washington and the Mission in Honduras, the capital development officer agreed to consider locally manufactured pumps, provided that their price, quality, and performance were equal to or better than those of the Dempster pump.

During the summer of 1980, a feasibility study was conducted for USAID/Washington to determine the manufacturing capability in Honduras of the AID design handpump as well as a PVC well screen (roboscreen). A copy of the study is included in Appendix C. The results of this feasibility study indicated that there was manufacturing capability in Honduras for both the AID design handpump and well screen.

The PRASAR loan agreement between AID and the GOH, therefore, included provision for development of the capability to manufacture in Honduras a robust, low-cost, multi-family handpump. Because of its experience in several countries in developing such local manufacturing capability and because the GOH had experienced some problems with an existing locally manufactured handpump, the Sanpar pump, AID and the GOH decided to use the AID-design handpump in this technology transfer and manufacturing development activity. It was hoped that the introduction of a new model pump would stimulate competition and, thus, result in better quality handpumps at competitive prices in Honduras.

AID was very much interested in assisting local manufacturers in developing and improving locally-manufactured handpumps. To do this it decided to conduct comparison testing of several pumps, including a model of its own AID-design handpump to be manufactured in Honduras. Although the Sanpar pump, had experience in manufacturing handpumps, the 1980 feasibility study found that it did not have the foundry or what was considered to be adequate machine shop facilities needed to produce the AID pump. Another Honduran manufacturer, therefore, was selected to manufacture the AID pump.

Due to the fact that developing the local capability to manufacture the AID handpump was expected to take some time at the beginning of the PRASAR project, the GOH purchased 1,120 Dempster handpumps in the U.S. in order to get started with the PRASAR handpump component right away and not wait until the AID-design pumps were completed. It was estimated that it would take up to two years to develop the manufacturing capability and field-test the AID-design pump, activities that experience showed had to be done before the large number of pumps needed for the PRASAR project could be produced.

The 1,120 pumps which were purchased under the PRASAR project were similar to Dempster model 226F. This model was a relatively light design generally intended for single family usage. Dempster also produced a model 210F which was a heavier design generally intended for multi-family usage. Although OTD 29 specified the use of the heavier model 210F pump in the comparison testing described below, it was decided to use the lighter model 226F because it had already been purchased and the MOH claimed satisfaction with it.

AID/Honduras and the GOH decided that, in order to select pumps for the PRASAR project in the future, they should obtain reliable performance data on the pumps that would be considered for future orders. In order to carry out the development of local manufacturing capability and to obtain comparative performance data, AID/Honduras requested technical assistance from the AID Bureau of Science and Technology, Office of Health, Division of Water and Sanitation (AID S&T/H/WS) in Washington, D.C. in January 1981. In response to this request S&T/H/WS issued Order of Techical Direction (OTD) No. 29 to Camp Dresser and McKee, Inc. (CDM), the contractor for AID's centrally-funded Water and Sanitation for Health (WASH) Project in February 1981 (see Appendix A). After clarifying with AID the scope of work of the OTD, CDM, in turn, authorized the Georgia Institute of Technology, its subcontractor under the WASH Project, to carry out the work under OTD 29 in May 1981. The cable from the Mission requesting assistance is in Appendix A. During the work, AID/Washington issued several amendments to modify the scope and level of effort (Appendix A).

The Mission's request for assistance and the OTD reflected a decision which had been made by the Mission's capital development officer and the AID Office of Health to conduct this program of technical assistance in two phases.

The first of these phases would be to develop local manufacturing capability of handpumps and well screen by first selecting suitable manufacturers and then providing technical assistance to these manufacturers until it was felt that quality handpumps and quality well screens could be produced. In addition to developing manufacturing capability, Phase I included providing assistance to the MOH in identifying specific well locations for the installation of test pumps and screen. Phase I was to be carried out under OTD 29.

Phase II of this program would be to provide technical assistance to MOH technicians and engineers in methods of proper installation of AID pumps, locally manufactured Sanpar pumps, the Dempster pump, and well screens. Technical assistance was also to be provided to instruct MOH technicians in proper water sanitation tecnniques including testing and disinfection. Finally, Phase II was to provide a monitoring and evaluation program for these test pumps and then feed this information back to the MOH for its use in the ultimate determination of which handpump would be used in the PRASAR Project. Phase II was to be carried out under OTD 85 which was issued to WASH in February 1982.

The basic, overall purpose of the work was to develop information needed by the GOH to decide which handpump to select when it placed its second order of pumps for the PRASAR project.

The objectives of OTD 29 were to:

1. Develop in Honduras the capability of producing the AID-design handpump and the roboscreen;

2. Establish good working relationships with counterpart organizations in Honduras; and

3. Investigate and select sites suitable for field testing not only the AID handpump but also other locally manufactured and imported handpumps.

2.2 Scope of Work

The scope of work for OTD 29 was included in the cable from the Mission requesting assistance and was modified by the AID Office of Health in the OTD and its amendments (see Appendix A). The final scope of work was as follows:

A. Select suitable manufacturers in Honduras and provide technical assistance for producing:

   1. AID-design handpumps
   2. PVC roboscreen (2" diameter)

B. Award contracts for or purchase:

   1. 150 AID-design handpumps
   2. 200 feet of 2" diameter roboscreen
   3. 35 Dempster model 210F handpumps
   4. 50 Sanpar handpumps
   5. 10 Moyno deep-well handpumps
   6. Plunger rod, drop pipe, and expendable supplies necessary for Phase II program.

C. Assist GOH identify and characterize pump test sites readily accessible on a year-round basis and clustered as much as practical to facilitate monitoring.

D. Inspect, test, and accept finished AID handpumps and roboscreen prior to release by manufacturers for installation in the field.

The principal change made by AID/Washington in the scope of work submitted by the Mission was inclusion of 10 Moyno pumps for comparative field testing. This pump was added because it is considered one of the most maintenance-free handpumps on the market; and since maintenance is a major element in handpump programs it seemed worthwhile to obtain some performance data for such a pump during the field testing.

2.3 Organization of the Report

The next chapter discusses the approach, activities, and significant events involved in carrying out this technical assistance and technology transfer effort. While some details are included in this chapter, others are presented and illustrated in the appendices. Chapter 4 presents the conclusions drawn from this work and includes several recommendations for subsequent work on the PRASAR project and for AID's technology transfer activities.

While the report describes the work done in Honduras under OTD 29, an attempt has been made to extract from the specific experience of working there lessons that would most likely be helpful for similar activities in other countries.

Chapter 3

PHASE I ACTIVITIES: MANUFACTURE OF AID HANDPUMP AND ROBOSCREEN IN HONDURAS

3.1 The AID-Design Handpump and Implementation Program

Before discussing the specific work carried out under OTD 29, it will be helpful to describe the AID handpump and to give an idea of the range of concerns involved in a handpump program in general.

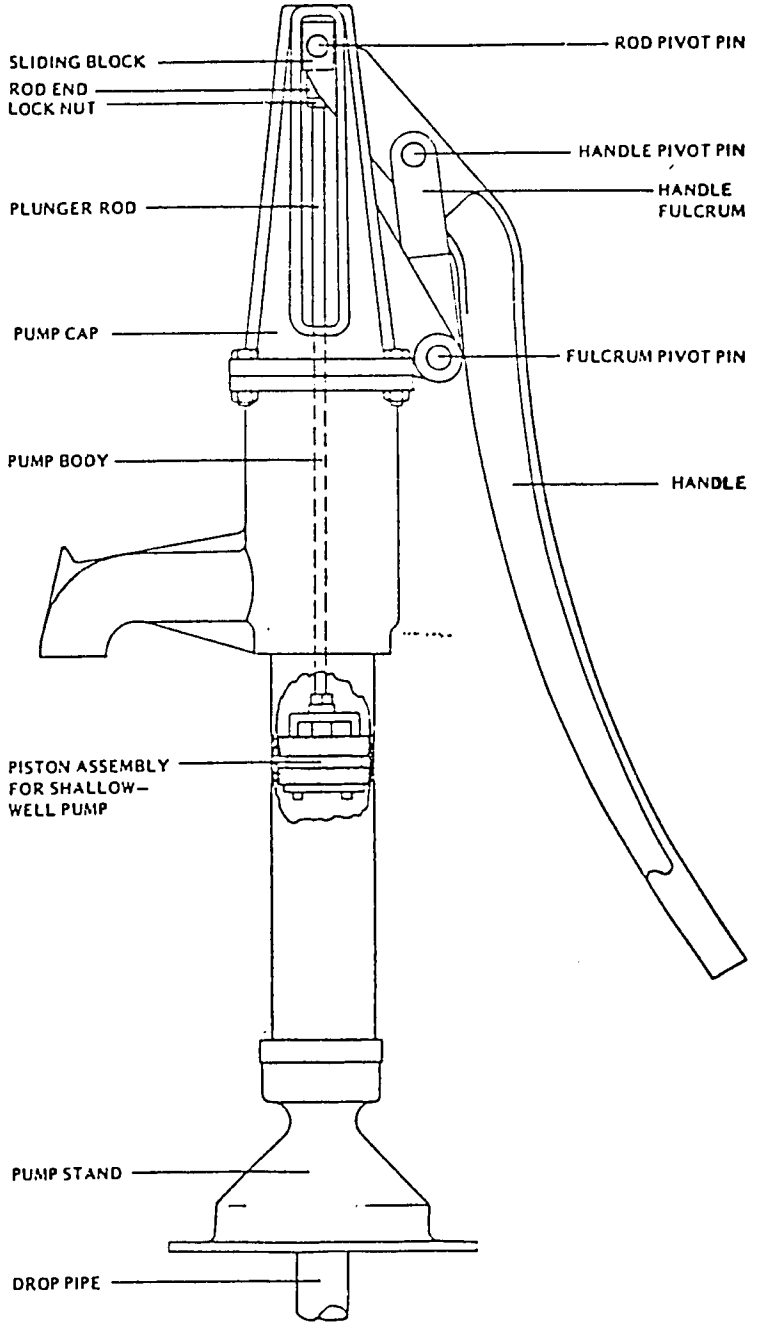
The AID-design handpump (see Figures 2 and 3) is a single-acting, positive-displacement piston pump for community or multi-family use consisting of an above ground pump stand made of cast iron and galvanized steel, a drop pipe, and a PVC or PVC-lined pump cylinder containing a steel and brass piston or plunger assembly with leather cup seals. It can be mounted on tube wells or on a platform built over dug wells. The pump has been found to provide a reliable water supply for 50 to 100 families per pump. Its average pumping capacity is approximately five gallons per minute (gpm) and it can pump from depths of up to 100 feet. The pump produces approximately one half liter of water per stroke of the handle. The pump has not been in use long enough to determine its average useful life before replacement, but some have estimated its useful life to be 10 years. It is most likely that, rather than replacing an entire worn-out pump, its component parts would gradually be replaced as needed, and it may be that after 10 years of use the pump would no longer contain any of its original parts.

The pump comes in two models, one for shallow wells and another for deep wells. The shallow well pump lifts water by suction from wells in which the lowest water level is no more than eight meters (approximately 26 feet) below the ground. The pump cylinder in this model is in the pump stand above the ground.

The pump cylinder in the deep-well pump is located down the well. It either pushes water up to the surface from below the water level or, if the pump cylinder is set above the water level, it lifts water by suction just as the shallow-well model does. In the latter case the cylinder must be no more than eight meters above the static water level.

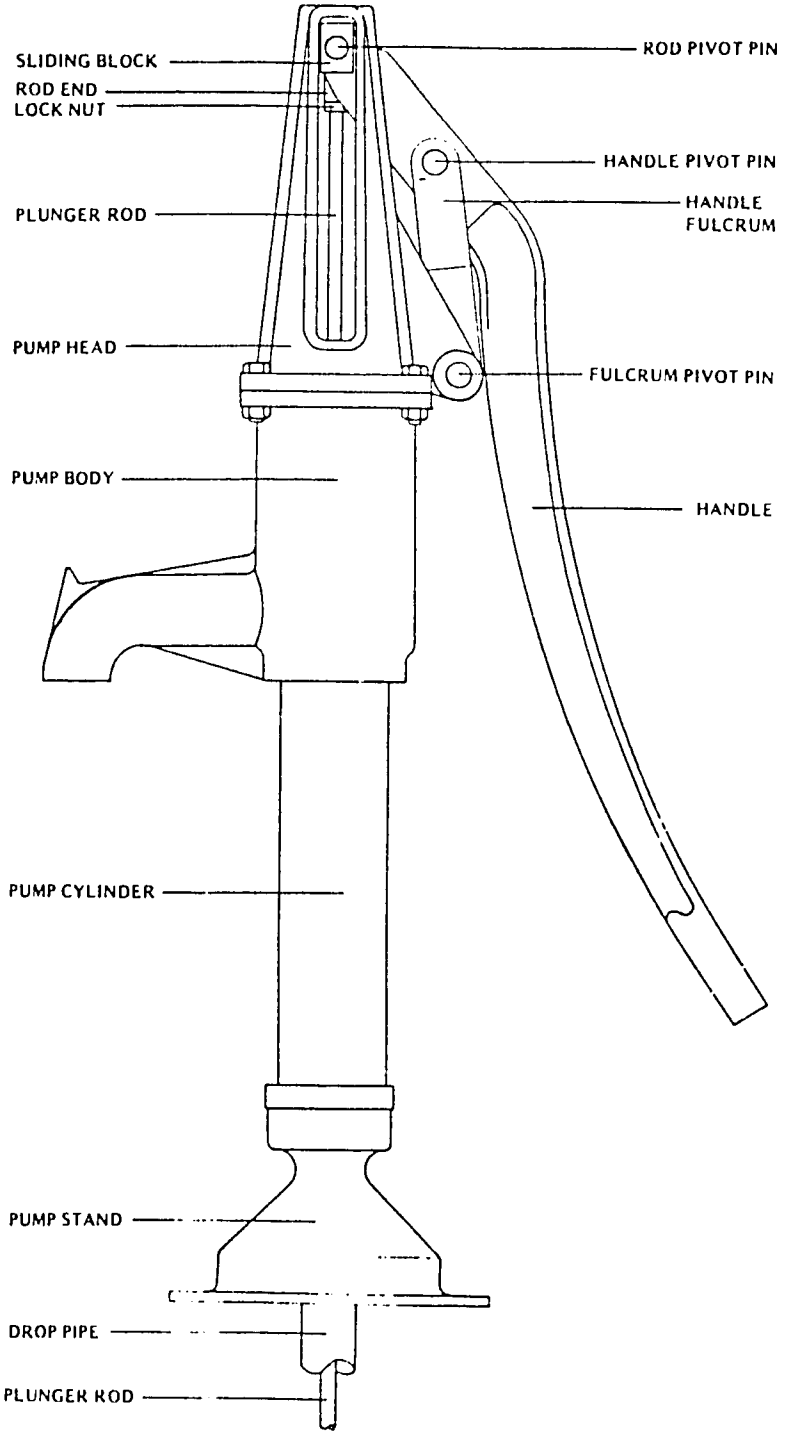
The pump is operated by moving the handle manually. If the pump is to lift water by suction, it must be primed initially. If it is to push water up from below the surface of the water it does not require priming. When the handle is lifted, the piston or plunger moves down and water pushes up through a poppet valve in its assembly. A foot valve at the bottom of the pump cylinder is closed during this action and prevents the column of water from draining out the bottom of the cylinder. When the pump handle is lowered, the piston or plunger moves up. The poppet valve closes and the piston or plunger assembly pushes water upward. The upward motion sucks open the foot valve and water passes up into the pump cylinder below the piston or plunger. Repeated operation of the handle brings water to the pump spout.

FIGURE 2
AID-DESIGN SHALLOW-WELL PUMP

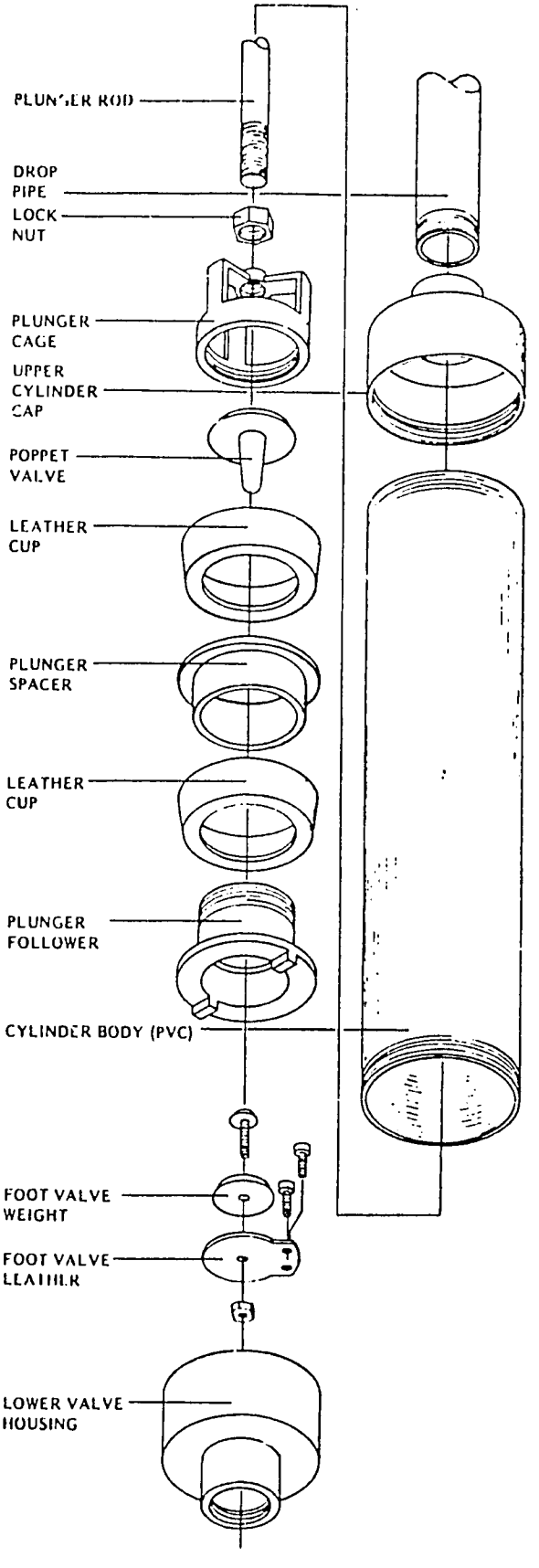


PUMP STAND

FIGURE 3
AID-DESIGN DEEP-WELL PUMP



PUMP STAND



COMPONENTS OF PUMP CYLINDER

Like all mechanical devices, the AID pump requires maintenance and repair. The most frequent maintenance item is lubricating the pins at the three mechanical linkages in the pump cap and the guides for the sliding blocks. This should be done once a week. It is expected that persons from the community where the pump is located could be trained to do this. The next most frequent maintenance item is replacing worn leather cups. This may have to be done as often as every six months or as infrequently as every two years. This is a relatively simple task for the shallow-well pump but is very laborious for the deep-well pump because it requires removing the pump cylinder from down in the well. In the latter case, therefore, a regional maintenance crew may have to do this work.

Parenthetically it is important to note that various design changes have been suggested, and some tried in the field, to improve the serviceability and maintainability of the AID pump. One such change was attempted in the Dominican Republic and Tunisia to allow the piston to be removed from the deep well pump without removing the pump body and drop pipe. The change consisted of using a two-inch-diameter PVC drop pipe which served as the pump cylinder for a two-inch-diameter pump piston. It was found that more development work was necessary, however, to improve the connection of the PVC drop pipe to the cost iron pump base and especially to be sure that the pump installation crews are adequately trained to install the pump properly. The intent of the work done under OTD 29 was to compare the standard design AID handpump with other pumps, so no design changes were made.

In any case, regional crews would have to be established to do more difficult maintenance and repair work. These crews would have to be supported by a national infrastructure capable of managing this operation. The principal management concerns would include the logistics of providing spare parts, tools, materials, fuel, and supplies, maintaining vehicles, scheduling work, personnel administration and training, and budgeting and financing. Experience in many countries has shown that, if such an infrastructure does not exist or cannot be developed, a handpump program will not remain viable for very long.

In order to be effective in reducing water-related diseases, a program involving handpumps should include an element of user education so that people will use clean containers to obtain water at the pump, will store it in clean containers in the home, and will be careful to use water in a sanitary manner. The well site should be drained so as to prevent water from pooling, and the users should keep the site clean and free from mud.

3.2 General Approach to Technical Assistance

In carrying out technology transfer programs involving the AID handpump, the Georgia Institute of Technology follows a sequence of activities that is outlined below:

1. Georgia Tech assesses the pump production capability of several manufacturers and recommends one or more of these manufacturers for selection by AID to furnish this pump for host country use.

2. Georgia Tech provides mechanical drawings and a prototype pump to the selected manufacturer(s) and discusses in detail the manufacturing of each pump component and the assembly and finishing of the pump.

3. The manufacturer fabricates the pump. This process involves casting and machining iron and brass components and procurement or fabrication of other materials and parts. The machining involves cutting, grinding, turning on a lathe, milling, drilling, and threading. The fabrication process also involves hardening and tempering steel pins and bushings for the pump's mechanical linkages.

   As the manufacturer completes some initial pumps, Georgia Tech personnel inspect them very carefully, using this opportunity to orient and train the manufacturer in quality control, product inspection, and testing.

4. Based on inspection of the initial pumps, Georgia Tech personnel identify the principal difficulties encountered by the manufacturer, determine the reasons for the difficulties, and work out a mutually-acceptable program of intensive technical assistance. Executing this specific technical assistance element is the major component of Georgia Tech's program and is the most time consuming.

5. The manufacturer completes the order of pumps, and Georgia Tech personnel conduct final inspection and acceptance testing. Again, Georgia Tech uses this opportunity to train the manufacturer in these last but critical steps in the pump production process.

6. If a host-country agency is purchasing the pumps, Georgia Tech trains the agency's personnel in the pump acceptance procedure so that they will be able to carry out this first step in ensuring that only reliable pumps reach the field. The agency's personnel will be the ones responsible for accepting or rejecting the pumps and approving or holding back payment to the manufacturer.

   If Georgia Tech is purchasing the pumps on behalf of AID, Georgia Tech personnel may be called in at a later date to train agency personnel when the host country agency places its own order for pumps.

7. In order to obtain information on the performance of the locally manufactured pump and the acceptance and use of the pump by the local people, Georgia Tech personnel assist host country personnel in selecting field-test sites and in installing the pumps. This involves a sanitary survey, site selection and characterization, constructing a slab (for dug wells) or an apron (for tube wells), installing the pump and disinfecting the well. The occasion of carrying out these activities is used as an opportunity to train host country personnel.

8. Together with host-country personnel, Georgia Tech maintains and monitors the field test sites and provides feedback on the pump's performance, acceptability and maintainability to the AID Mission, the host country agency, and the pump manufacturer.

9. If necessary, additional technical assistance is provided to the manufacturer or in-country personnel based on any difficulties revealed by the field testing.

10. Finally, Georgia Tech prepares a report documenting its activities and, drawing from the experience, formulates conclusions which are either

specific to the activity and/or are applicable to AID's overall handpump technology transfer program. Recommendations are made concerning both the specific country's water supply programs and future activities under AID's technology transfer program.

The initial program of technial assistance is usually a pilot program in that a relatively small number of pumps is involved and its purpose is as much for demonstration and data collection as it is for developing local manufacturing capability. A follow-up program of technical assistance is sometimes recommended to help AID, the host country government, and the manufacturers not only with the same problems as those dealt with in the pilot program but also with problems associated with the increased size and complexity of large-scale, full-production programs that involve thousands of pumps.

3.3 Selection of Manufacturers and Provision of Technical Assistance in Honduras

3.3.1 AID Handpumps

Prior to initiating work under OTD 29, five of the most promising potential handpump manufacturers in Honduras were visited and evaluated as part of the 1980 feasibility study (Appendix C). The manufacturers that were evaluated were:

Berkling Industrial, San Pedro Sula
Fundidora del Norte, S.A., San Pedro Sula
Fundicion y Maquinado (FUNYMAQ), San Pedro Sula
Metalurgia de Mayab, Tegucigalpa
Industrias Asociados, S.A., Tegucigalpa

This evaluation was based on both objective and subjective observations and was made by experienced manufacturing people from the University of Maryland, Georgia Institute of Technology, and Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI). The major criteria for determining the suitability of these manufacturers were:

1. Apparent foundry capabilities,
2. Machine shop capabilities,
3. Quality of products currently in production,
4. Apparent skill level of employees, and
5. Apparent managerial capability of the ownership.

Also taken into consideration were the estimated production costs and selling prices for manufacturing the AID handpump.

Three of these manufacturers were found to be unsuitable from a standpoint of production capability. One was considered unsuitable because it was found that the foundry portion of the business had been dissolved. Upon visiting another manufacturer, the investigators noted that the foundry facilities had not been used for some time and were in a bad state of repair. It was felt by the investigators that this company would be unsuitable because it lacked quality foundry facilities. A third company was deemed unsuitable because the

management seemed to be incapable of handling large production orders. The remaining two foundries were found to be capable of producing acceptable castings as well as machining. One of these two foundries, however, indicated a lack of interest in manufacturing the handpump.

After OTD 29 was issued and Georgia Tech was authorized to start work, its personnel went to Honduras to meet with Mission and GOH staff to select manufacturers and initiate pump production.

In order to facilitate its work in Honduras, Georgia Tech contracted with ICAITI for consulting services. A copy of the contract between Georgia Tech and ICAITI is included in Appendix D. ICAITI, with headquarters in Gautemala City, Guatemala, had a field office headed by a Honduran engineer in Tegucigalpa, Honduras. It was felt that a Honduran representative not only would facilitate translations but would also expedite many facets of this project. ICAITI had the capability to provide technical assistance to the manufacturers during Georgia Tech's absence. ICAITI was also to make major purchases in Honduras (e.g., pumps, roboscreen, etc.) because its local office had purchasing and payment mechanisms already functioning.

In June 1981, Georgia Tech personnel and the ICAITI consultant discussed the selection process for the pump manufacturer with Richard Dudley, AID Engineer, and Edmundo Madrid, AID PRASAR Coordinator. The findings of the feasibility study still held true, and Ricardo Mata, owner and general manager of the recommended foundry, FUNYMAQ, confirmed that his quotation of $100 per pump and a one-time charge of $1,000 for foundry patterns was still valid. In light of the findings of the feasibility study and a review of the situation in June 1981, AID agreed that Georgia Tech should purchase the AID pumps from one manufacturer and provide him the necessary technical assistance to obtain a quality pump. Under instructions from AID and through its consultant, ICAITI, Georgia Tech ordered 100 shallow-well and 50 deep-well AID-design handpumps. A copy of the purchase agreement is included in Appendix E. At the end of the pump manufacturing effort FUNYMAQ found that the price it would have to charge for future pumps would be $250 per pump for orders of less than 1,000 pumps and $238 for orders of more than 1,000.

During the initial meetings with Sr. Mata, the design of the AID handpump was discussed thoroughly. Each of the design drawings was reviewed in detail, and a sample pump manufactured in Indonesia was left with the owner. This has been the usual procedure in AID handpump programs undertaken in other countries. After reviewing the drawings, Sr. Mata indicated that he fully understood them and would have no trouble in producing the pump. After the Georgia Tech field personnel returned to the United States, Sr. Mata proceeded to make one deep-well model prototype pump prior to beginning full production.

It was later discovered that Sr. Mata used the sample Indonesian pump as his guide in making the prototype pump rather than the mechanical drawings. The prototype pump, when inspected by Georgia Tech field personnel in September 1981, had several problems. Sr. Mata was informed of these problems and he was shown how to correct them. When Georgia Tech field personnel returned to Honduras in October 1981 they had been corrected. One of these deep-well prototype pumps was then installed on a well located near Tegucigalpa, Honduras, and functioned properly.

It appears to be common that foundries in developing countries have greater ability to duplicate already manufactured items than to fabricate items using mechanical drawings and written specifications. The latter approach requires a higher literacy level and more formal, sophisticated training than is commonly found among foundry workers in developing countries. It is principally because of this situation that Georgia Tech has found it necessary to rely so heavily on direct technical assistance to obtain a pump that conforms to the drawings.

Another important factor in technology transfer is, of course, the language barrier. Because of the difficulty of understanding and being understood Georgia Tech contracted with the local organization, ICAITI, but even that measure did not manage to overcome the communication difficulties seemingly intrinsic in such cross-cultural situations. Even though the language problem was resolved by using ICAITI's services, there was still the gap between the highly-trained engineer and the practical foundryman.

In November 1981 Georgia Tech field personnel again visited Honduras and discovered that FUNYMAQ had not yet obtained the special dimension PVC tubing needed for the shallow-well cylinder liner and the deep-well cylinder casing. Georgia Tech had verified during the feasibility study that this tubing was available in Honduras but found that the delay in FUNYMAQ's obtaining it was caused by its not being available locally in the limited quantities required for the small initial order of pumps for the pilot program. This tubing was subsequently located in the United States, purchased and shipped to Honduras. It was realized that purchasing this plastic tubing in the Untied States was going outside the "locally manufactured or procured" concept, which is an essential part of AID's technology transfer program. Since it had been determined during the initial feasibility study that the PVC pipe was obtainable in Honduras in production quantities, however, it was felt that this would not ultimately present any major problem.

During their November visit Georgia Tech personnel found that the manufacturer was continuing to have problems with several aspects of the manufacturing process. At this point intensive technical assistance to the manufacturer was initiated by Georgia Tech personnel to resolve these problems. This technical assistance involved the following specific areas:

- o machining of castings
- o heat treating
- o final assembly
- o testing
- o jig and fixture development

Assistance was given in the processes of generating flat surfaces, drilling and reaming in the machine shop. Some of these processes are illustrated in Appendix F. Later, information was provided and demonstrations were given on heat treating pins and bushings. Unfortunately, this company did not have production heat treating facilities, and no custom heat treating services were available in San Pedro Sula. Georgia Tech personnel then advised the company on the type of steel to use for the pins and bushings and how to heat treat the finished parts using an oxygen-acetylene welding outfit. If a large scale pump production program is undertaken, the manufacturer would need a production level heat treating furnace. Sr. Mata expressed interest in purchasing this furnace if he were to receive an order for a large number of pumps.

Later, extensive assistance was provided during the assembly process. As the manufacturer had made no provision for the design, fabrication, and use of jigs or fixtures during the machining and drilling of the castings for the first 140 pumps, assembly became a very complicated and time consuming process. Some of these problems are illustrated in Appendix H. Extensive redrilling, reaming, grinding and filing operations were required in order to get each of the pump's components to fit properly. Even then, interchangeability of component parts of the pumps was limited. Finally, assistance was provided on correct procedures for in-process testing and inspection and final testing and inspection. The details of the procedures are described and illustrated in Appendix M.

After instructing the factory owner and the factory personnel on basic pump manufacturing technology, jig and fixture concepts were developed and designs were prepared at Georgia Tech expense. The jigs and fixtures are illustrated in Appendix G. Maintaining dimensional tolerance limitations is absolutely essential for several components of the AID handpump. Examples of these are: (1) hole spacing in the handle, (2) hole spacing in the fulcrum, (3) hole dimensions in the pump cap, (4) hole dimensions in the pump body, and (5) hole pattern dimensions in the pump base. It is not only critical that these hole dimensions be maintained, it is also critical that the holes in the fulcrum and in the handle be absolutely parallel. Improper dimensions and alignment of these parts affects the articulation of the handle, fulcrum, pins, rod ends, and slider blocks and causes binding movement which can result in premature failure of the pump. Also, maintenance and repair are complicated because the parts would not be interchangeable. By using the jigs and fixtures, which were designed by Georgia Tech, the factory management was able to fabricate production tooling for critical manufacturing operations which would insure the interchangeability of pump components and also drastically reduce the pump assembly time and its associated cost. The final 10 pumps of the initial order were produced using the production tooling with an obvious improvement in pump quality and interchangeability of parts. Ultimately, approximately 75 pumps originally produced without this tooling were remachined using the tooling to improve their quality. Finally, the original patterns for pump component castings were re-worked in order to improve consistency in the castings and subsequently improve overall pump quality.

In order to assist the manufacturer to be prepared to handle the large number of pumps that the GOH would probably order eventually, although not necessarily from FUNYMAQ, Georgia Tech provided guidance to Sr. Mata on an objective, analytical approach to determine his production cost and a reasonable selling price for the pump. The specific costs used by FUNYMAQ are proprietary and, therefore, cannot be included in this report. The forms used in this procedure, however, are included in Appendix I. They show the principal items to be considered in the cost estimate and also show the approximate time needed to fabricate each of the pump's components.

3.3.2 Roboscreen

Roboscreen is a helically-slotted, internally-ribbed PVC well screen (strainer) developed at the International Rural Water Research Development Laboratory (IRWRDL) at the University of Maryland under World Bank sponsorship. It was developed by Professor Ron Sternberg and Mr. Bob Knight, hence

its name. Its principal advantage over other plastic well screens is its larger proportion of open area which permits more free movement of water and less clogging of the screen.

In the feasibility study (see Appendix C) the following three manufacturers of PVC tubing were evaluated:

Polymer, S.A., Comayaguela
Industrias Novatec, S.A., Tegucigalpa
Polyformas Plasticas, S.A., San Pedro Sula

Because of its previous experience in producing plastic well screen, it was recommended to the Mission that Industrias Novatec, S.A. be selected for manufacture of roboscreen. This recommendation was reviewed again when Georgia Tech undertook the OTD 29 assignment and there was no reason found to alter it, especially since Novatec was the only one that indicated real interest in manufacturing roboscreen.

Georgia Tech personnel met with the engineering manager of Novatec. Together they worked out a method of modifying the male tube extrusion die to produce the internally-ribbed tubing needed for the roboscreen. Novatec produced a five-foot sample of two-inch diameter internally-ribbed tubing according to the sketches and specifications provided by Georgia Tech (see Appendix J).

The original method of slotting PVC tubing to produce roboscreen was to use a circular saw mounted on a lathe tool post grinder, but this device was not readily available in Honduras. An alternate method was devised using equipment available at FUNYMAQ (see Appendix K for a detailed description of this method). Using this alternate method the sample tubing was slotted at FUNYMAQ and a satisfactory roboscreen was produced.

Based on these successful initial results, an order was placed with Novatec S.A. for 400 feet of 2-inch diameter internally-ribbed PVC tubing. The OTD called for 200 feet of roboscreen. The additional 200 feet of tubing were ordered to allow for the waste that is normal in developing production capability for any new item. The special tooling designed by Georgia Tech for slotting the tube was slightly modified by FUNYMAQ. Novatec ultimately delivered the 400 feet of 2-inch diameter internally-ribbed tubing to FUNYMAQ. FUNYMAQ, utilizing the experience gained during the developmental stage, was able to produce 200 feet of acceptable roboscreen with no problems.

3.4 Purchase of Equipment, Materials, and Supplies and Awarding of Contracts

3.4.1 AID Handpumps

Georgia Tech placed a verbal order with FUNYMAQ in early June 1981 for the AID handpump patterns and set a July 1981 inspection date. In late June a formal contract was executed between ICAITI and FUNYMAQ for the purchase of the pumps. A copy of the contract is included in Appendix E. Its principal provisions were:

1. 100 shallow-well and 50 deep-well pumps to be manufactured.

2. Foundry patterns to cost $1,000 and pumps to cost $100 each.

3. Two pump prototypes to be ready by August 17, 1981, for inspection prior to approval of full production.

4. Patterns to remain the property of AID.

5. All work to be approved by Georgia Tech and ICAITI field personnel prior to final acceptance and installation in the field.

3.4.2 Roboscreen

Two hundred feet of 2-inch diameter roboscreen were ordered in February 1982 and accepted in April 1982 (see 3.3.2).

3.4.3 Dempster Handpumps

The Dempster handpump, like the AID-design handpump, is a single-acting, positive-displacement piston pump. The basic design concept of this pump is almost identical with that of the AID handpump. Thirty-five Dempster Model 210F handpumps were delivered in Honduras in May 1982. These handpumps were purchased in anticipation of Phase II of this project. Thirty of these pumps were to be installed on the test sites in order to get comparative performance data along with the locally manufactured handpumps.

3.4.4 Sanpar Handpumps

The Sanpar handpump is also a single-acting, positive-displacement piston pump. However, it is fabricated from steel and is assembled to a great extent by welding. It is considerably lighter in weight than the AID design and the Dempster handpumps.

OTD 29 called for the purchase of 50 Sanpar handpumps and the selection of sites to install 35 of them. As with the Dempster handpumps, this was to obtain comparative performance data. There was an overlap between the completion of Phase I under OTD 29 and the beginning of Phase II under OTD 85. OTD 85 authorized field testing 10 Sanpar pumps, whereas OTD 29 called for site selection to field test 35 of them. Because of the reduced number of Sanpar pumps needed for Phase II and because at least 10 of them were available from the MOH's inventory, AID agreed that they should not be purchased under OTD 29. The MOH supplied the 10 Sanpar pumps for Phase II.

3.4.5 Moyno Handpumps

The Moyno handpump is a rotary, progressing cavity pump manufactured in the U.S. It is operated by turning crank handles on the above-ground pump stand. A sealed gear box transmits the rotation to a stainless steel rotor which turns in a hard-rubber, helical stator in the pump cylinder which is set below the

water level in the well. Water is gradually pushed upward from one cavity to the next as the rotor turns in the helical stator and then on up the drop pipe to the pump spout. The initial cost of the pump is two to three times that of most lever-operated handpumps, but the Moyno is considered to be one of the most maintenance-free pumps available. Because of the difficulties of maintaining pumps in rural areas, AID thought it would be worthwhile to include this pump in the Phase II testing.

In June 1982, Camp Dresser & McKee authorized Georgia Tech to purchase 10 Moyno pumps based on verbal instructions by S&T/H/WS. Amendment No. 3 of OTD 29, issued in August 1982, formally authorized this purchase in writing (see Appendix A).

Because of severe production problems, however, the sole manufacturer, Robbins and Meyers, was not able to meet several promised shipping dates. As a result, the order was canceled in October 1982 under instructions from S&T/H/WS.

3.4.6 Drop Pipe, Plunger Rod and Other Supplies

Drop pipe, plunger rod, and other supplies were purchased in anticipation of the Phase II installations. These supplies were readily available in Honduras at reasonable prices. It was expected that additional supplies would have to be purchased, however, as Phase II progressed.

3.5 Identification and Characterization of Wells for Pump Test Sites

3.5.1 General Procedure

There are five principal steps involved in field testing the handpumps. They presuppose the existence of wells or a program to install them. If this presupposition is not valid, then a well-construction step would have to be added. In each of the steps, host-country personnel are involved not only to facilitate the work in rural communities but also for training so that they can eventually carry out the work on their own. The steps are:

1. Site selection
2. Site characterization
3. Pump installation
4. Monitoring and maintenance
5. Data processing and feedback

The first two steps were done under Phase I (OTD 29), and the last three were to be done under Phase II (OTD 85).

Site selection involves surveying existing well sites to investigate both technical and social-cultural conditions that determine the suitability of the site for field testing. Based on this procedure a certain number of potential test sites are selected.

Site characterization involves a detailed examination of each of the selected sites in order to determine the resources of time, money, personnel, mate rials, and equipment needed to prepare the site for testing. The characteristics investigated include well type (see Table 1), condition of existing superstructure, reported seasonal water levels, number of users, and location of possible sources of contamination.

Table 1 - Types of Wells

Well Type	Characteristics
Driven	Access to groundwater is made by driving the complete well point/screen/drop pipe assembly into the water bearing strata. This method is expeditious in time and materials where groundwater table is shallow and soils do not permit tube or open well construction.
Tube	"Drilled," "borehole," or "tube" wells generally have small diameters ranging from 1 inch to 10 inches. They are drilled using a hand or motor-driven augers or impact tools and are usually cased with metal or PVC pipe. They require relatively sophisticated skills and close supervision.
Hand Dug	"Hand dug" or "open" wells have diameters much larger than tube wells and are constructed when well-drilling skills and/or materials are limited, the water table is relatively shallow, and/or the recharge rate is too low to permit adequate flow from tube wells. This method is much more labor intensive than driven or tube wells. If physical conditions are right, it is a good method to use where community participation is strong or ways are being sought to develop it.

3.5.2 Site Selection

Georgia Tech and ICAITI began discussions with the MOH in the fall of 1981 concerning the identification of suitable pump installation sites for carrying out the field testing component (Phase II) of the overall project. Initially, Georgia Tech attempted to identify a minimum of 100 sites so that characterization could begin (see site selection criteria in Appendix L). By late 1981, however, only 10 sites had been designated as possible test sites. Georgia Tech was informed that the MOH health promoters who were to make the initial identifications had been on strike and, consequently, the work was delayed.

In early February 1982, Georgia Tech representatives again met with Ing. Giron and other MOH officials in a further attempt to designate pump test sites. As a result of this meeting it was decided that four areas would be used for the field tests. These areas were Bajamar, Travesia, La Lima (all near San Pedro Sula and having only shallow, driven wells), and Comayagua (near Tegucigalpa and having deep, dug wells). Ing. Giron reported that Ing. Jorge Flores, Chief Engineer of the San Pedro Sula district, would, along with his staff, provide assistance in test site selection and later would provide any assistance required in pump installation and site improvements. Later in the month, sites were investigated in Bajamar, Travesia, and La Lima. During March, these three areas were revisited and 42 specific sites were designated for Phase II testing. Also during this period, Comayagua was visited and six specific sites there were also designated for Phase II testing.

3.5.3 Site Characterization

Site characterization was begun in March and was completed in May 1982. Georgia Tech field engineers were able to make assessments of site improvement costs, technical skills required, approximate well recharge rates, and other information related to the technical capabilities of the site. By reviewing non-technical information such as site location, accessibility, type of users, location of other sources of water, local interest, and capability of the pumps being locally maintained, Georgia Tech field engineers were better able to group or cluster sites to reduce transport and time costs both for installation and for monitoring and maintenance. An assessment could also be made on how the pump program would be received by the local communities involved.

3.5.4 Test Site Areas

Bajamar/Travesia

Bajamar and Travesia are two neighboring coastal fishing villages near Puerto Cortes (approximately one hour's drive north of San Pedro Sula). It was found that up to 24 shallow-well pumps could be utilized in this area. The pumps, however, would have to be retrofitted to existing driven wells which currently had a wide variety of working and non-working pumps previously supplied by the GOH. Local officials agreed to the removal of some of the existing non-functioning pumps and the utilization of other wells which already had functioning pumps in order to conduct a program of comparison pump monitoring.

There already were village caretakers for these well sites, and they were to be used for the Phase II pump installation and monitoring. It was estimated that the average cost for site preparation in this area would be approximately $200 per site.

La Lima

La Lima is a new rural development area near the airport and about 30 minutes from San Pedro Sula. This area was also being served by an MOH program and would provide good comparison monitoring data. Twelve to 24 shallow-well installations could be accommodated here as newly developed tube wells. Including labor and materials, it was estimated that an AID pump could be installed for $400-500 per site.

La Lima provided ideal testing sites for the AID handpump since enthusiasm for handpumps was high in this area. The area also provided good comparison monitoring data for both local and imported pumps presently being used by MOH programs. The wells were closely clustered and were near San Pedro Sula for convenient access for monitoring.

Comayagua

For potential deep-well installations, the MOH personnel and ICAITI recommended that the program focus on the development of sites at Comayagua (approximately one hour's drive north of Tegucigalpa). Many adequate deep-well sites were reported to be available in this area. Investigations, however, showed that only 10 deep, dug wells were available which would be suitable for paired installations. Such installations would provide comparison data on two different pumps at the same well site. No deep dug wells were available or suitable for pairing in the other two test areas.

3.6 Inspection, Testing, and Acceptance of Equipment, Materials, and Supplies

3.6.1 AID Handpumps

During the manufacture of the first 50 pumps, factory technicians were instructed and trained by Georgia Tech field engineers in proper acceptance inspection and test procedures. The inspection insured conformance to drawings and specifications. The functional testing insured that the handpump would pump water at the rate of five gallons per minute (gpm). These first 50 pumps underwent 100 percent inspection and 100 percent functional testing. For the first 50 pumps produced by FUNYMAQ, the final inspection involved the following steps:

1. The articulation of the handle, fulcrum, pins, rod end, and slider blocks was checked for alignment and non-binding movement with reference to the pump cap.

2. The piston assembly was disassembled and checked for pump leather cup quality, surface finish on underside of poppet and top of piston plunger follower, and thread engagement on pump rod.

3. Thread engagement was checked on pump stand to pump head as well as pump stand to pump base.

4. Alignment and quality of the leather check valve was observed.

5. PVC cylinders were inspected for surface quality and, on shallow-well pumps, looseness between cylinder and steel pipe jacket was checked.

6. A hardness test was performed on randomly selected, representative pins. The bushings had already been pressed into the iron castings and could not be tested at this time. However, since the hardness of the bushings had been tested during the manufacturing process, it was felt safe to eliminate this test during final inspection. If this procedure of bushing testing proves inadequate, a revised procedure should be initiated involving pressing several representative bushings out of the castings and measuring their hardness.

7. A function test was performed by attaching a short length of drop pipe to the pump base and placing the pump assembly over a concrete water tank. The pump was primed and operated until a consistent flow was obtained. While the pump was operated at approximately 50 strokes per minute, the output water was collected in a 2.5-gallon bucket and the time to fill the bucket was recorded. If the bucket was filled in 30 seconds or less, the pump was considered acceptable.

After these 50 pumps were 100 percent inspected, an acceptance inspection plan was devised for the remaining 100 pumps to be produced. The acceptance plan is included in Appendix M.

By April 1982, 140 AID handpumps had been inspected and accepted by Georgia Tech field engineers. In June 1982, the remaining 10 were accepted. These pumps were stored at FUNYMAQ where complete records were kept on withdrawals and destinations. The pumps have subsequently been moved to the AID Mission.

The pumps were purchased by Georgia Tech on behalf of AID. GOH personnel, therefore, were not involved in the final acceptance process at this time. If and when the GOH places an order for pumps, technical assistance should be provided to train its personnel in performance testing and final acceptance procedures.

3.6.2 Roboscreen

In late April 1982, the 200 feet of finished Roboscreen were sampled, inspected, and accepted by Georgia Tech field engineers. The roboscreen had been produced in 2-foot lengths. Ten pieces of the 100-piece lot were randomly selected and inspected for slot quality and excessive machining flash and debris. No imperfections were observed in the sample, so the entire lot was accepted.

3.7 Sequel

At the time the final draft of this report was written (i.e., in the spring of 1983) the Phase II activities under OTD 85 were nearing completion. A separate report was prepared for Phase II.

The PRASAR project, however, has encountered hydrogeological, institutional and administrative difficulties in installing the Dempster handpumps that were ordered at the beginning of the project. As a result, it may be some time before the work done under OTD's 29 and 85 yields practical results in influencing pump selection when future orders are placed. The GOH and AID Mission are taking positive steps to overcome these difficulties, and it is hoped that it will not be too long before the Phase I and II work will be put to practical, long-term use as these difficulties are resolved. The problems which the GOH has encountered, along with suggestions for dealing with them, are documented in WASH Field Reports 65 (for OTD 115), 69 (for OTD 101) and 81 (for OTD 135).

The number of pumps expected to be installed under the PRASAR project has been reduced from 3,000 to 1,600. Rather than ordering 1,880 handpumps to complement the 1,120 Dempster pumps already purchased, it now appears that the MOH will need only about 350 to 400 additional pumps, taking into account the AID pumps already produced by FUNYMAQ.

Chapter 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

All of the items in the scope of work for OTD 29 were successfully completed. Specifically, a handpump manufacturer (FUNYMAQ) was selected and provided with technical assistance. This technical assistance enabled the FUNYMAQ Company not only to manufacture and deliver 150 high-quality AID-design handpumps, but also to manufacture and deliver 200 feet of acceptable roboscreen. The Novatec Company was provided with technical assistance which enabled them to produce 400 feet of acceptable internally-ribbed PVC tubing, which was used in the manufacture of roboscreen.

The manufacturing capability established in Honduras included not only all of the manufacturing processes, but included technical assistance for in-process quality control systems as well as final acceptance testing.

The technology transfer provided to FUNYMAQ produced several spin-offs. One of these spin-offs involved the design and fabrication of production jigs and fixtures. As the FUNYMAQ Company became more proficient in precision, machining and layout, they were able to provide production jigs and fixtures for two companies involved in an AID handpump project in Ecuador. This enabled these two Ecuadorian foundry and machine shops to produce high-quality handpumps in much less time than is normally required.

Another benefit from this technology transfer was the forced improvement in product design and quality by other local handpump manufacturers. Prior to the introduction of new processes and inspection techniques which resulted in the high-quality FUNYMAQ pump, other pump manufacturers in Honduras were producing products of marginal quality. With the widespread local acceptance of the AID handpump produced by FUNYMAQ, a new norm for acceptable quality of handpumps was established in Honduras.

Materials and equipment were obtained for the Phase II field testing. In addition to the AID handpumps and roboscreen these materials and equipment consisted of 35 Dempster Model 210F handpumps, 10 Sanpar handpumps and drop pipe, plunger rod and miscellaneous supplies.

Good working relationships were developed with MOH personnel at all levels and with AID Mission personnel. Many joint meetings were held with MOH ranging from Ing. Giron, the Director of the MOH component of the PRASAR project, to the health promoters in the field. MOH and AID personnel were kept involved and informed, and their suggestions were solicited during all phases of the work under OTD 29. On several occasions they were brought into the factory to observe the pump manufacturing process and their ideas were solicited on how the pump could be improved. They were also involved in a principal role in selecting sites for Phase II field testing.

Several locations in the PRASAR project area were considered as possibilities for pump test sites. During meetings with MOH and Mission personnel four geographic areas were selected for pump test sites. Ultimately, 48 potential pump test sites were identified and characterized.

Inspection and testing procedures were developed which led to the ultimate acceptance of 150 AID-design handpumps and 200 feet of 2-inch roboscreen.

4.2 Recommendations

4.2.1 Recommendation No. 1

Background

During the acquisition of handpumps from the FUNYMAQ Company, initial contacts were made, drawings were given to the company, and a model pump was given to them for reference. Georgia Tech field engineers allowed the company to proceed with the initial manufacturing of the pumps with only a minimal amount of technical assistance. In a very short while, it became apparent that many mistakes were being made and that the manufacturer, in good faith, had been following his old procedures and processes which were not adequate to produce a high-quality pump. Fortunately, this was caught in time to take the necessary steps to correct the situation and ultimately produce 150 high-quality pumps.

Recommendation

It is recommended that, for future projects of this type, technical assistance activities should be intensified during the initial phase of manufacturing. For example, common practice dictates that a purchaser pay for production patterns when ordering castings. This same procedure should be followed for production tooling such as jigs and fixtures. This intensive technical assistance should include designing and building this tooling as the very first step in the manufacturing process. Furthermore, the construction of production patterns for castings and production tooling for machining the castings should be closely coordinated to insure compatibility.

4.2.2 Recommendation No. 2

Background

During the initial discussions with the FUNYMAQ Company, a complete set of drawings was provided, as well as a model of an AID handpump made in another country. Using the model only for reference, Georgia Tech field engineers discussed each drawing carefully with Sr. Mata of the FUNYMAQ Company. Sr. Mata gave every indication of understanding the drawings and being willing to comply with the specifications outlined by the Georgia Tech personnel. It was later found, however, that Sr. Mata had very little skill in reading and

interpreting mechanical drawings. The machinists and technicians in his factory had even less skill in this area. This problem was identified early and necessary corrections were made so that the quality of the final product was not adversely affected.

There is no question that the long-term interest of technology transfer would be better served if foundry workers could be trained to read drawings and specificiations, because they would then be able to fabricate original products. Such training, however, could only be accomplished over a period of several years because it requires not only literacy training, which itself takes a lot of time, but also development of drawing interpretation skills which require a long period of supervised practice and repetition.

In light of these limitations, planners and managers of water supply programs must decide whether or not they want to set aside enough time up front so that in-country manufacturers can be trained to read drawings and specifications and thus be able to supply the program with whatever manufactured items are required without relying on outside technical assistance. If a decision is made not to undertake such a training effort, for example, because of the pressure to get a program started, then provision should be made for outside technical assistance to help the manufacturers produce the items needed for the program.

Recommendation

It is recommended that a factory owner and his technical staff's ability to work with and interpret mechanical drawings be a critical item in the initial selection of an in-country manufacturer. It is also recommended that mechanical drawings be translated into the language of the country and converted to the standard drawing practices currently used in that country. If it is impossible to find manufacturers with the ability to interpret mechanical drawings, model pumps which conform to the drawings and specifications in every detail should be provided to the manufacturers to be used as guides for casting patterns, production tooling and, ultimately, production.

Furthermore, if long lead time (e.g., two or three years) can be built into the design of rural water programs that will use locally-manufactured handpumps, it would be beneficial in the long run to train local manufacturers to work from mechanical drawings and written specifications rather than duplicate a prototype pump.

4.2.3 Recommendation No. 3

Background

During the initial feasibility study in Honduras, many of the manufacturers of supplies and materials, such as PVC tubing, hardenable steel, nuts, bolts, and so forth indicated that they would be able to supply the items necessary to fabricate the handpump. However, after the fabrication of the handpump had begun, some of the manufacturers were reluctant to supply the limited quantity of materials required for the pilot program of initial pump manufacturing.

Recommendation

It is recommended that, during the feasibility study, firm quotations (which include prices, minimum order quantities, delivery dates and so forth) be obtained from suppliers of all critical materials necessary to fabricate the handpump.

4.2.4 Recommendation No. 4

Background

When the field work under OTD 29 first began Mission personnel reviewed the MOH administrative structure with Georgia Tech personnel and identified the MOH person who was responsible for the handpump aspects of the PRASAR Project. Shortly after the work under OTD 29 started, however, there were national elections, and a slight change occurred in the power structure within the MOH. Also, during the period of trying to identify well sites which could be used as field test sites for the pump under OTD 85, it was found that it was impossible to obtain information about potential sites because of labor problems on the technician level in the MOH. It was also discovered at a later date that the responsible person in charge of this project at the MOH did not have line authority over the field engineers and the MOH promoters at the local level. This meant that agreements made with MOH managers in Tegucigalpa would not necessarily be honored at the local level in San Pedro Sula. This caused misunderstandings between the Georgia Tech field engineers and the local MOH technicians.

Recommendation

It is recommended that, in any project of this nature, the AID Mission provide the contractor with as much information as possible to provide insights into the power structures of the local governmental organizations and the political climate in which the contractor will work. It is recommended that this be done not only at the beginning of the project but on a continuing basis throughout the project.

4.2.5 Recommendation No. 5

Background

During the site-selection process it became apparent that MOH personnel on the local level were not aware of the purpose of the project or of the overall plans of the MOH personnel in Tegucigalpa. This caused misunderstandings and wasted a lot of time.

Recommendation

This experience suggests that at the beginning of similar projects a plan of action be developed jointly by personnel contracting to conduct the work program, AID Mission staff, and AID Washington staff. It is essential that host-country personnel responsible for the project have principal responsibility for the development and final approval of this initial plan of action.

4.2.6 Recommendation No. 6

Background

The AID deep-well cylinder does not fit in a four-inch diameter well casing whereas the Dempster cylinder does. The AID pump, therefore, has difficulty competing with the Dempster pump. It has also been found that 1/2-inch diameter pump rod is more readily available than the 7/16-inch rod used in the AID pump.

Recommendation

Consider modifying the design of the AID pump so that the deep-well cylinder will fit in a four-inch well casing and so that a 1/2-inch pump rod can be used.

4.2.7 Recommendations for Future Action

Background

Once it became clear late in 1981 that FUNYMAQ would produce a high-quality pump, it was recommended to begin Phase II of the technical assistance program which the Mission had requested. Phase II included the installation and testing of AID, Sanpar and Dempster handpumps for comparative evaluation. It also included providing instruction on maintenance and repair of these pumps. Finally, it was to provide monitoring and evaluation of the various handpumps with feedback to the manufacturer for quality improvement and to the Honduran MOH for use in future handpump selection. Phase II was initiated under WASH Project OTD 85 before the completion of work under OTD 29.

The foundry that received technical assistance under the OTD 29 pilot program was selected by AID, the MOH, and Georgia Tech on the basis of an objective and subjective assessment of its capability to manufacture a high-quality AID handpump. If and when the GOH places a future order for a large number of handpumps, the foundry-selection process will most likely be based on a review of bids from several manufacturers.

Recommendation

If and when the GOH places a future order for handpumps, technical assistance should be sought in the preparation of bid documents (drawings, specifications, proposal, and contract) and in evaluation of the bids. Technical assistance should also be sought for the selected manufacturer(s) to insure that they understand their contractual obligations and can produce a high quality pump. Finally, assistance should be sought to train GOH personnel in procedures for performance testing and final acceptance of the handpumps, roboscreen, and any other related items that must be purchased.

APPENDIX A

MEMORANDUM

February 19, 1981

Water And Sanitation for Health Project
Order of Technical Direction (OTD) Number 29

TO: Mr. James Arbuthnot, P.E.
WASH Contract Project Director

FROM: DS/HEA, Victor W.R. Wehman, Jr., P.E., R.S.
AID WASH Project Manager

SUBJECT: Provision of Technical Assistance Under WASH Project to USAID/Honduras-Phase I

Refs: A) Tegucigalpa 00093 (7 Jan. 81)

1. WASH contractor requested to provide technical assistance to USAID/Honduras as per Ref. A scope of work (modified).

2. WASH contractor/sub-contractor/consultants authorized to expend up to 100 person days over a 6-month period to accomplish Phase I or Stage I (see Ref. A para 2, State 1) of the scope of work. Stage II activities, i.e., field installation, training monitoring and evaluation of Phase I Honduras locally manufactured prototypes will be ordered in a later OTD, based upon knowledge of field conditions and knowledge of availability of high quality Roboscreens and high quality locally produced AID handpumps.

3. As per Ref. A, para 4., a draft final report shall be prepared by the contractor describing Phase 1 activities. A final report will be provided the mission within 30 days of contractor leaving Honduras on pump acceptance of quality of prototype trip.

(tel) 011 504 326 668
324 458

4. Contractor to coordinate directly with USAID/Honduras, probably with Assistant Program Officer (Mr. Ray Baum). Inform LAC/DR/ENGR, LAC/DR/HN and Honduras desk officer of all important issues and coordination points. Make sure Ms. Brinneman, Dr. Mathews and Honduras desk officer receive copies of this order.

5. WASH contractor will use technical assistance personnel familiar with Honduras mission personnel, local manufacturing conditions and organizations and with local manufacturing quality control aspects of AID handpump and Roboscreen (broached).

6. WASH contractor authorized to allow consultants to make up to 6 round trips in and out of Tegucigalpa through Washington, if necessary, to his/her home base as appropriate during technical assistance effort.

7. Contractor will be required to provide detailed debriefing on Phase I activity in Washington for regional bureau personnel before authorization and approval of Phase II activity.

This OTD amended by V. Wehman in Washington, D.C. on March 3, 1981 to delete Honduras

8. Contractor authorized to purchase 150 AID handpumps, 35 Dempster 210 F handpumps, 50 Sandpar pumps, 200 feet of Roboscreen. No single order for equipment may exceed $20,000 in cost for that order.

9. Contractor will insure sincere, tough negotiation takes place to obtain all equipment involved for as low a unit price as is reasonable, in conjuntion with the quality of manufacture anticipated.

10. Contractor may purchase under Phase I activities those amounts of spare parts, drop rod, drop pipe, and expendable supplies necessary to have complete pump assemblies ready to go for Phase II. Contractor may not purchase these supplies until contractor is very sure that quality of AID Honduras handpump is reasonable to go into field trials.

11. Contractor may work with USAID and Honduras officials in identifying and characterizing test sites. Every attempt should be made to have all test sites (35 AID handpump, 35 Sandpar handpump), (30 Dempster 210F) identified before Phase II activities are started and readily accessible on a yearly basis. Contractor will not select sites that take extensive amounts of time to reach. Every effort shall be made to cluster handpump sites, if possible.

12. Each handpump shall be filled with a 2" diameter Roboscreen strainer for evaluation purposes of 0.018 inch cut about 8 inches long. These Roboscreens shall be evaluated with the handpumps on a regular basis in Phase II.

13. Mission should be contacted immediately and technical asistance initiated as soon as possible and convenient to USAID/Honduras.

14. Appreciate your prompt attention to this matter. Good luck.

DS/HEA:V.Wehman:ja:2/19/81

PAGE 01 TEGUCI 00033 01 OF 02 060026Z 050407 AIC5153
ACTION AID-35

ACTION OFFICE DSHE-01
INFO LACE-03 LADP-03 LADR-03 CHG-01 FM-02 AADS-01 CHGT-02
CTR-02 CHB-01 /019 A1 7

INFO LACE-03 AADS-01 CHGT-02 CTR-02 DSHE-01 ENGR-02 CHB-01
RELO-01 MAST-01 LACR-01 /015 A2 12

INFO OCT-01 /036 W

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UNCLAS SECTION 1 OF 2 TEGUCIGALPA 0033

ADM AID

FOR VIC WEHMAN DS/HEA/EH

SUBJECT: CONTRACT TO DEVELOP LOCAL CAPABILITY TO FABRICATE HAND PUMPS AND WELL SCREENS

1. MISSION REQUESTS AID/W TO NEGOTIATE A CONTRACT EITHER UNDER THE WASH PROGRAM OR DIRECTLY WITH GEORGIA INSTITUTE OF TECHNOLOGY AS APPROPRIATE TO PROVIDE TECHNICAL ASSISTANCE FOR THE LOCAL MANUFACTURE OF THE AID HAND PUMP AND THE ROBOSCREEN.

2. SCOPE OF WORK WILL BE IN 2 STAGES OVER 24 MONTHS AND THE CONTRACTOR WILL PERFORM THE FOLLOWING TASKS:

STATE 1: (10 MONTHS). IN CONSULTATION WITH USAID/HONDURAS SELECT SUITABLE MANUFACTURERS OF AID HAND PUMPS AND ROBOSCREEN AND AWARD CONTRACTS TO THE SELECTED FOUNDRIES. DURING THIS MANUFACTURING PHASE, THE CONTRACTOR WILL BE RESPONSIBLE TO:

(A) ORDER FROM LOCAL FOUNDRIES AND MACHINE SHOP:

150 AID HAND PUMPS

50 SANPAR HAND PUMPS

100 FEET OF ROBOSCREEN

(B) PROVIDE WORKING DRAWINGS, PROTOTYPES AND TECHNICAL ASSISTANCE INCLUDING DIES, JIGS, PATTERNS, ETC. FOR PRODUCTION OF ABOVE TO FOUNDRIES AND MACHINE SHOPS.

(C) INSPECT, TEST AND ACCEPT FINISHED PRODUCTS PRIOR TO RELEASE BY MANUFACTURERS FOR INSTALLATION IN THE FIELD.

(D) ASSIST GOH IDENTIFY SPECIFIC LOCATIONS FOR INSTALLATION OF TEST PUMPS AND SCREEN.

STAGE II: INSTALLATION AND TESTING OF PUMPS AND ROBOSCREENS (14 MONTHS). CONTRACTOR WILL:

(A) DIRECT GOH HEALTH PROMOTERS IN METHODS OF PROPER INSTALLATION OF 30 AID PUMPS, 30 SANPAR PUMPS AND ROBOSCREENS. INSTRUCT THE SAME PROMOTERS HOW TO TEST AND WHERE REQUIRED DESINFECT THE WELLS FOR EACH TEST-SITE. PROVIDE INSTRUCTIONS ON MAINTENANCE AND PREVENTIVE MAINTENANCE AND REPAIR OF TEST PUMPS.

TEGUCI 00033 01 OF 02 060026Z 0501

(B) MONITOR AND EVALUATE THE AID AND SANPAR PUMPS AND ROBOSCREENS. PROVIDE FEEDBACK TO MANUFACTURERS FOR QUALITY CONTROL AND, IF NECESSARY, THE CORRECTION OF DEFECTIVE COMPONENTS.

(C) PROVIDE GOH MINISTRY OF HEALTH WITH PROGRESS DATA FOR SIMULTANEOUS EVALUATION OF HAND PUMPS INSTALLED IN TEST SITES.

3. BUDGET

STATE 1 (10 MONTHS)

SALARIES	$25,000
OVERHEAD	12,500
INSURANCE	1,000
TRAVEL (INTERNATIONAL)	2,500
PER DIEM	6,000
DIRECT MIS. (REPRODUCTION) TELE, ETC.)	1,500
SUB TOTAL	$48,500
EQUIPMENT (CONTRACTED) AND DIES JIGS, ETC.	35,500
STAGE I TOTAL	$84,000

STAGE II (14 CALENDAR MONTHS)

SALARIES	40,000
OVERHEAD	20,000
INSURANCE	1,500
TRAVEL (INTERNATIONAL)	2,500
TRAVEL (IN-COUNTRY)	3,000
PER DIEM	15,000
DIRECT MISC. (REPRODUCTION, TELE, ETC.)	3,000
SUB TOTAL	85,000
EQUIPMENT (DROP PIPE, PLUNGER ROD, CEMENT, ETC.)	18,000
STAGE II TOTAL	$103,000
TOTAL STAGE I AND II	$187,000

Department of State

INCOMING TELEGRAM

PAGE 01 TEGUCI 00093 02 OF 02 080024Z M207 4884 AID5142
ACTION AID-35

INFO SECT-01 /001 A1 11

INFO OCT-01 /036 W

R 071533Z JAN 81
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TO SECSTATE WASHDC 1344

UNCLAS SECTION 2 OF 2 TEGUCIGALPA 0093

ADM AID

FOR VIC WEHMAN DS/HEA/EH

NOTE ALL ITEMS WITH EXCEPTION OF SALARY AND OVERHEAD WOULD BE COST REIMBURSABLE IN ACCORDANCE WITH APPLICABLE AID REGULATIONS;

4. REPORTS: A REPORT SHALL BE PREPARED BY THE CONTRACTOR AT THE END OF STAGE I OUTLINING THE PROJECT, CONCLUSIONS, AND RECOMMENDATIONS; A SECOND REPORT SHALL BE PREPARED AT THE END OF STAGE II WHICH SUMMARIZES THE WHOLE PROJECT AND PROVIDES THE RESULTS OF THE TESTS AND THE RECEPTION AND REACTION OF GOH PERSONNEL TO THE PROJECT.

5. AS AGREED WITH WEHMAN AT DAEC, CONTRACT WILL BE FUNDED ENTIRELY FROM AID/W SOURCES SINCE FUNDS ARE NOT AVAILABLE FOR THIS ASSISTANCE FROM THE RURAL WATER AND SANITATION PROJECT (522-0166) NOR IN ANY OTHER AID HONDURAS PROJECT.

6. CONTRACTOR SHOULD BE MADE AWARE THAT THE PROJECT AUTHORIZATION FOR 522-0165 GIVES MISSION AUTHORITY TO ALLOW PROPIETORY PROCUREMENT OF DEMPSTER BRAND HAND PUMPS AND THAT THE PUMPS DEVELOPED LOCALLY WILL BE IN COMPETITION, AS FAR AS PRICE AND QUALITY ARE CONCERNED, WITH THE DEMPSTER PUMPS. WHEN THE SECOND GROUP OF 2,000 PUMPS IS ORDERED, DEMPSTER INDUSTRIES INC. WILL BE ALLOWED TO QUOTE A PRICE AND THE GOH WILL SELECT THE APPROPRIATE HAND PUMP BASED ON THE LOWEST UNIT COST, LOCALLY MANUFACTURED OR DEMPSTER (WHICH HAS ALREADY BEEN SELECTED AS THE STANDARIZATION MODEL).
BINNS

Sect #2

AMLW

December 10, 1981

AMENDMENT #1, OTD #29
VWW

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Manager

SUBJECT: Provision of Technical Assistance Under WASH Project to USAID/Honduras - Phase I

REFS: Tegucigalpa 0093 (7 Jan 81)

1. Para. 2 of subject OTD #29 amended to read as follows:

"WASH contractor/subcontractor/consultants authorized to expend up to 130 person days over a 15 month period to accomplish Phase I or Stage I (see Ref. a, para. 2, state 1) of the scope of work. Stage II activities, i.e., field installation, training, monitoring and evaluation of Phase I Honduras locally manufactured prototypes will be ordered in a later OTD, based on knowledge of field conditions and knowledge of availability of high quality Roboscreens and high quality locally produced AID handpumps."

2. Para. 6 of subject OTD #29 amended to read as follows:

"WASH contractor authorized to allow consultants or subcontractors to make up to 10 round trips from their home base through Washington (if necessary) to Tegucigalpa and return to their home base as appropriate during technical assistance effort."

3. Nothing follows.

VWW:ja

Annex

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTON (OTD) NUMBER 29
Amendment Number 2
January 21, 1982

TO: Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Victor W.R. Wehman, Jr., P.E. R.S.
A.I.D./WASH Project Manager
A.I.D./S&T/HEA/WS

SUBJECT: Provision of Technical Assistance Under WASH Project to U.S. A.I.D./ Honduras-Phase I

REFS:
A) Tegucigalpa 93, January 7, 1981
B) Potts (GIT)/Howard (WASH CIC) letter, January 5, 1982
C) OTD #29, February 19, 1981
D) Amendment #1 to OTD #29, December 10, 1981
E) Tegucigalpa 9598, December 30, 1981

1. Paragraph 2 of subject OTD #29 cancelled as written in paragraph 2 of original OTD #29 and cancelled in paragraph 2 of amendment #1 to original OTD #29. Paragraph 2 of OTD #29 is now to read as follows:

"WASH contractor/subcontractor/consultants authorized to expend up to one hundred and ninety-five (195) person days over a fifteen (15) month period to accomplish Phase I or Stage I (see reference A, paragraph 2, state 1) of the scope of work. Stage II activities, i.e., field installation, training, monitoring and evaluation of Phase I Honduras locally manufactured prototypes will be ordered in a later OTD, based on knowledge of field conditions and knowledge of availability of high quality roboscreens and high quality locally produced A.I.D. handpumps."

2. New paragraph 2A to OTD #29 to read as follows:

"Contractor authorized up to one hundred and sixty-five (165) person days total of international/domestic per diem to accomplish this technical assistance effort."

3. Paragraph 6 of OTD #29 (Amendment #1, dated December 10, 1981) is cancelled. Paragraph 6 of original OTD #29, dated February 19, 1981 is now to read as follows:

"WASH contractor authorized to allow subcontractor/consultants/ subcontractors to make up to eleven (11) trips in and out of Tegucigalpa, Honduras through Washington if necessary, to his/her home base as appropriate during technical assistance effort. Local travel authorized in Honduras as necessary and appropriate for purposes of identification of possible Phase II testing sites, work

with local manufacturer, and other activities necessary to complete scope of work. Contractor authorized car rental (car and driver) as necessary to accomplish scope of work, however, if Mission or local government organizations offer vehicles or support, contractor authorized to utilize U.S. or Honduras government vehicles."

4. Nothing follows.

Amend #3

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 29
AMENDMENT NUMBER 3
August 12, 1982

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Mr. Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Manager
AID/ST/H/WS

SUBJECT: Provision of Technical Assistance Under WASH Project to USAID/Honduras - Phase I

1. Para. 8 of subject OTD #29 (Feb 19, 1981) is cancelled New para. 8 of subject OTD #29 is now to read as follows:

"8. Contractor authorized to purchase 150 AID handpumps from local manufacturer in Honduras, 35 Dempster 210F handpumps, 25 Sandpar pumps, 10 Moyno deep well rotary handpumps (Robbins and Meyers - Sole Source), and 200 feet of Roboscreen locally manufactured in Honduras, (Sole Source). No single order for equipment may exceed $20,000 in cost for that order."

2. Para. 2 of subject OTD #29 (Feb 19, 1981), and all amendments to para. 2 are now cancelled. New para. 2 of subject OTD #29 is now to read as follows:

2. "WASH contractor/subcontractor/consultants authorized to expend up to one hundred and ninety-five (195) person days of effort over a nineteen (19) month period to accomplish Phase I or Stage I (see reference A, para. 2, state 1) of the Scope of Work. State II activities, i.e., field installation, training, monitoring, and evaluation of Phase I Honduras locally manufactured prototypes and other purchased handpumps identified and ordered in para. 8 of OTD #29 will be initiated in a later OTD (OTD #85) based upon knowledge of field conditions and knowledge of availability of high quality roboscreens and high quality locally produced A.I.D. handpumps."

3. Nothing follows.

AMEND #4

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 29
AMENDMENT No. 4
November 02, 1982

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Mr. Victor W.R. Wehman, Jr., P.E., R.S. VWW
A.I.D. WASH Project Manager
A.I.D./S&T/HEA/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Honduras - Phase I

REFERENCES: A) OTD #29, dated 19 Feb 81

1. Para. 2 of subject OTD #29 (Ref. A) is cancelled. New para. 2 of subject OTD #29 is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to two hundred and twenty-nine (229) person days of effort over a 24 month period to accomplish Phase I or Stage I (see Ref. A, para. 2, Stage 1) of the Scope of Work. Stage II activities, i.e., field installation, training, monitoring and evaluation of Phase I Honduras locally manufactured prototypes and other purchased handpumps identified and ordered in para. 8 of OTD #29 will be initiated in a later OTD (OTD #85) based on knowledge of field conditions and knowledge of availability of high quality roboscreens and high quality locally produced A.I.D. design handpumps."

2. Nothing follows:

AMEND. #5

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 29
AMENDMENT NUMBER 5
April 13, 1983

TO: Dr. Dennis Warner, P.E.
WASH Contract Project Director

FROM: Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Manager
AID/ST/H/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Honduras - Phase I

REFERENCE: A) OTD #29, date 19 Feb 81

1. Para. 2 of subject OTD #29 (Ref. A) is cancelled. New para. 2 of subject OTD #29 is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to two hundred and twenty-nine (229) person days of effort over a 29 month period to accomplish Phase I or Stage I (see Ref. A, para. 2, Stage 1) of the Scope of Work. Stage II activities, i.e., field installation, training, monitoring and evaluation of Phase I Honduras locally manufactured prototypes and other purchased handpumps identified and ordered in para. 8 of OTD #29 will be initiated in a later OTD (OTD #85) based on knowledge of field conditions and knowledge of availability of high quality roboscreens and high quality locally produced AID design hand pumps."

2. Nothing follows.

CHW/ddc

APPENDIX B

Itinerary

Travel To and From Honduras

By Georgia Tech Personnel

Georgia Tech Staff Person	To Honduras	From Honduras
POTTS	5-28-81	6-05-81
MONTGOMERY	5-28-81	6-05-81
HARPER	5-28-81	6-05-81
MONTGOMERY	7-26-81	7-28-81
MONTGOMERY	8-31-81	9-03-81
MONTGOMERY	10-13-81	10-16-81
JAMES	11-09-81	11-11-81
JAMES	12-07-81	12-10-81
MOY	2-01-82	2-19-82
MOY	3-15-82	4-02-82
JAMES	3-15-82	3-26-82

APPENDIX C

FEASIBILITY OF LOCALLY MANUFACTURING AID HAND-OPERATED WATER PUMPS AND ROBO DEVICES IN HONDURAS

Prepared by

Robert Knight
Project Designer
International Rural Water
Resources Development Laboratory
University of Maryland
College Park, Maryland 20742

Phillip W. Potts
Senior Research Scientist
International Programs Division
Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

Ing. Angel Porfirio Sanchez
Delegado en Honduras
Instituto Centroamericano de Investigation
y Tecnologia Industrial (ICAITI)
Apartado Postal No. 20-C
Tegucigalpa, D.C., Honduras

for

The United States Agency for International Development
Washington, D.C.

Contract No. AID/ta-C-1354

International Programs Division
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
August 1980

Table of Contents

Summary

The purpose of this report is to present the feasibility of locally manufacturing the AID hand-operated water pump, the Roboscreen (a plastic well screen/infiltration gallery filter), the Robovalve (a plastic faucet) and the Robometer (a user-activated water meter) in Honduras. Each of these devices has been designed as a cost-effective vehicle in improving water supplies in developing countries and should offer tremendous benefits through in-country manufacture (by generation of local employment, provision of more readily available spare parts, lower unit hand pump costs to users and reduction of foreign exchange outflow).

Secondary data alone indicates that the need for rural water supply programs (and associated hardware such as the AID hand pump and the Robo devices) is great in Honduras. For instance, among children, diarrheal disease is the main cause of hospitalization and is a leading cause of outpatient visits. It represents one of the first five causes of mortality in all age groups and, as reported in 1977 statistics, caused 12.4 percent of all deaths and 24.4 percent of infant deaths. Among the deaths due to diarrhea, 77 percent occurred in children under five years of age. While a safer more convenient source of water is not sufficient in itself to improve these statistics, certainly it is a necessary part of any overall health program that is to be successful.

Fortunately, there is considerable activity now underway or being planned by the Government of Honduras to help meet the need for rural water supply programs (primarily through three government agencies, the Ministry of Health's Basic Sanitation Program, PROSABA, the National Autonomous Water and Sewer Agency, SANAA, and the Municipal Development Bank, BANMA). Adequate foundries now exist in Honduras for manufacturing AID hand pumps which could play an important role in this activity; and therefore, it is recommended that two or three selected foundries manufacture trial orders of 50-75 AID hand pumps each. These pumps should then be installed in the field for monitoring and evaluation whereby any manufacturing defects would be detected and the data from such defects (if any) fed back to the foundries for tightening of any necessary quality control procedures. By the conclusion of the monitoring and evaluation period, lasting 12-16 months, the manufacturers should

be thoroughly knowledgeable in producing an AID hand pump, and it would then be available for inclusion into the Government's many rural water supply programs as a high-quality, sturdy, cost-effective hand pump (approximately $100 U.S. as per quote of FUNYMAQ foundry officials) to serve the needs of rural Hondurans.

If the above-recommended manufacturing and field testing program is carried out, it should also include a comparative field evaluation of the Sandpar hand pump that is now being manufactured in Honduras. The Sandpar pump sells for approximately $150 and is reported to be capable of pumping from well depths of 160-180 feet. This pump is being promoted by various MOH officials and acceptance of the AID hand pump will depend on how well the AID hand pump performs against the Sandpar pump (there is no existing field performance data on the Sandpar pump).

The manufacture of the Roboscreen is well within the capabilities of two plastics manufacturers, Polymer and, especially, Industrias Novatec (because of its prior experience in manufacturing slotted PVC well screen). Since the Roboscreen is a complimentary item to the AID hand pump (as a filter), it would be worthwhile from an economic development standpoint as well as spare parts availability and cost effectiveness to include producing the screen for inclusion into the recommended pilot hand pump manufacturing and field testing program.

The introduction of local manufacture of the Robovalve, unfortunately, appears to be premature at this time since injection molding is beyond the present scope of the plastics industry in Honduras.

The Robometer is within the capabilities of Honduran industry, and it is estimated that local production could be attained at a cost of less than $50 per meter. However, the Robometer is still in development stages (optimization) and should not be introduced into Honduras until a more final design with more laboratory testing is completed. This further laboratory development (optimization) and laboratory testing is soon to start under the centrally funded AID/Washington (DS/HEA) Water and Sanitation for Health (WASH) project and should be accomplished within the next 12 months.

INTRODUCTION

The purpose of this report is to present the feasibility of locally manufacturing the AID hand-operated water pump, the Roboscreen (a plastic well screen/filter infiltration gallery), the Robovalve (a plastic water faucet) and the Robometer (a user-activated water meter) in Honduras. Each of these devices has been designed as a cost-effective vehicle in improving water supplies in developing countries and should offer tremendous benefits through in-country manufacture (by generation of local employment, provision of more readily available spare parts, lower unit hand pump cost to users and reduction of foreign exchange outflow, especially).

The AID hand pump consists of a shallow-well version (the plunger, or piston, and its cylinder located in the pump stand) and a deep-well version (the plunger, or piston, and its cylinder located below the water level of the well when the pump is installed). Both versions are single-action, reciprocating, positive displacement type pumps.

The AID hand pump was initially manufactured and field tested in Nicaragua and Costa Rica. Then, with recommended design changes resulting from the Nicaragua and Costa Rica field tests, it was successfully introduced into rural water supply programs in the Dominican Republic, Indonesia and Sri Lanka (similar programs should begin in Tunisia and Ecuador during the next several months). In each of these programs the AID hand pump has proven to be adaptable to local manufacture, easily maintained, low in cost when compared to imports (that also ordinarily require lengthy purchasing lead time) and very durable.

The Roboscreen was developed to fill the need for a low-cost plastic well screen which would yield a high percent open area and with local manufacture in developing countries in mind. It is basically an extruded PVC (poly vinyl chloride) pipe with equally spaced strengthening ribs running longitudinally in the bore and a continuous helical slot cut through the wall thickness along the entire length of the pipe (leaving the ribs to support what would otherwise be a plastic coil). This screen is now being manufactured in the Philippines for domestic use as well as export. Its commercial production will also begin during September of this year in Tunisia and Ecuador.

The Robovalve was designed as an answer to the need for a locally manufactureable, low-cost, self-closing plastic faucet. This valve (faucet) is a simple device with a float valve and a valve seat formed in the main body. There are no springs or washers to wear out as the Robovalve operates by making use of two basic principles, buoyancy and pressure differential. Field testing results are limited at this time, however, laboratory tests suggest that the valve should last for several trouble-free years which is a remarkable improvement over the usual brass faucets with rubber washers.

The Robometer is a user-activated water meter which was designed with the idea of the consumer paying for a predetermined volume of water before consumption. The concept behind this is that the consumer buys a small, special cartridge of compressed air which is used to activate the water meter (geared to allow only a certain volume of water to flow through it before automatically shutting off). When the predetermined volume of water has been used, the consumer must have on hand or must purchase another small gas cartridge before more water is obtainable through the meter. Thus, the consumer pays a small amount of money as he/she uses water rather than having to pay larger amounts over longer periods (the revenue from the sale of the cartridges of compressed air goes to the water agency in place of traditional collection revenue), and there is no need for costly meter reading, billing or additional revenue collection.

NEED FOR RURAL WATER SUPPLY IN HONDURAS[1/]

Honduras suffers from health conditions prevalent in poor, developing countries: high fertility and mortality; infections as the leading cause of death and illness; endemic malnutrition; poorer health conditions in rural areas and a greater morbidity/mortality rate in the mother-child groups. Infant mortality is 103/1000 per live births and roughly 80 percent of all children under five years of age suffer from some degree of malnutrition. Gastro-intestinal and respiratory infections account for 40 percent of all recorded deaths and are the most common causes of morbidity. A high prevalence of parasites in both adults and children exists; and, according to most estimates, second and third degree malnutrition affects about 35 percent of the children under the age of five. In addition to the continuing threat of gastro-intestinal and respiratory diseases, serious outbreaks of preventable diseases such as polio, measles and malaria are on the increase and are a mounting source of concern to health officials. In 1972 the general mortality rate was 16.5 per 1000 population for rural areas compared to nine per 1000 in urban areas, and there were 127 infant deaths per 1000 live births in rural areas compared with 85 infant deaths per 1000 live births in urban centers.

Despite the adoption of a policy of community-based primary health coverage by the government and a substantial investment in health facilities and training, Honduran health conditions leave much to be desired. Diarrheal disease, for instance, is a principal cause of morbidity, and diarrheal dehydration is an important contributor to the high rate of infant mortality. During 1978, the Ministry of Health recorded 110,393 cases of diarrhea (excluding amoebic and bacillary dysentary) giving an incidence of 3210 cases per 100,000 population (a figure most probably underreported, especially in rural areas; and, thus, fails to show the true magnitude of the problem).

[1/] Taken from USAID/Honduras "Honduras Project Paper, Rural Water and Sanitation," March 1980.

Among children, diarrheal disease is the main cause of hospitalization and is a leading cause of outpatient visits. It represents one of the first five causes of mortality in all age groups and, as reported in 1977 statistics, caused 12.4 percent of all deaths and 24.4 percent of infant deaths. Among the deaths due to diarrhea, 77 percent occurred in children under five years of age.

Under its five-year plan, 1979-83, the Government of Honduras hopes to provide easy access (community wells or better) to safe water for 75 percent of the rural population and some form of human waste disposal system to 38 percent, more than doubling its accomplishments to date. Given present coverage and population growth, these goals imply a target group of 1,200,000 for new water and sanitation systems and an additional 170,000 would need repaired water systems during this period.

At present, the Honduran Government implements its water and sanitation programs primarily through three government agencies: the Ministry of Health (MOH) Basic Sanitation Program (PROSABA), the National Autonomous Water and Sewer Agency (SANAA) and the Municipal Development Bank (BANMA).

PROSABA was established in 1974 to administer and promote rural environmental sanitation outreach programs. Its main activities have been directed toward the installation of hand pumped wells and the promotion and construction of latrines in dispersed rural communities with populations of less than 200 inhabitants. These activities are coordinated by the MOH at the central level and implemented by rural health promoters working at the village and municipal level. The promoter assigned to work with the villages is from the area and, therefore, is expected to be knowledgeable about local customs and beliefs. Through his efforts community participation is stimulated and organized to develop the potential for self-help which exists in each locality.

SANAA was created in 1961 to respond to the needs for piped water systems and sewers. SANAA's rural activity mainly has been directed to the construction of gravity flow aqueduct systems in rural communities having populations of more than 200 inhabitants. Its responsibility includes project financing, design, supervision of construction and maintaining the completed system. Community volunteer labor is required for all unspecialized work during the construction of the selected system. SANAA is also gradually applying user fees to support rehabilitation of existing nonfunctional rural systems which,

upon upgrading, will be incorporated into SANAA's maintenance program. Treatment units consisting of chlorination and/or filtration units are being installed for the systems which require them. With external financial assistance, SANAA is constructing or supervising the installation of approximately 100 rural gravity flow aqueduct systems annually.

BANMA provides loans to municipalities to finance infrastructure and municipal services, including water systems. The municipalities then operate and maintain the systems and repay BANMA from the user charges of the water system or from other revenues. Since 1975, eight systems have been built or repaired in medium sized communities, the smallest of which had a population of 6,000 inhabitants. This activity is expected to continue as viable opportunities for BANMA financing present themselves (AID, for instance, is currently financing a $5.0 million Municipal Development Loan through BANMA to assist the smaller municipalities with their development efforts).

Since 1942, the United States Government has been active in supporting Honduran water supply activities by financing the installation of rural systems. Through the services of the Institute for Inter-American Affairs (IIAA) and successor agencies, these programs have concentrated on construction and installation of gravity flow aqueducts. While exact figures are not available, it is estimated, for example, that between 1942 and 1959 over 125 rural aqueducts were constructed under these programs. From 1964 through 1967 USAID worked with SANAA on a $1.1 million Rural Water Pilot Project (Loan 522-T-008) that financed the construction of 62 gravity flow aqueduct systems benefitting over 13,00 rural inhabitants. A current USAID Nutrition Project (Loan 522-T-029) includes $1.5 million for PROSABA to promote the construction and use of latrines, low cost wells and a few gravity flow aqueduct systems. Another current USAID Fund for Special Development Activities project gives priority to financing construction materials required to complete rural aqueduct systems at a rate of approximately 10 per year through SANAA. A Rural Water and Sanitation Project due to begin soon consists of providing rural families with access to safe water and human waste disposal systems primarily by means of the self-help construction of multi-family wells, gravity-flow aqueducts and latrines, and a health education program designed to reinforce the impact of the construction program by teaching rural Hondurans the importance of good hygienic practices.

Other projects financed by international donors and administered by the Government of Honduras are as follows:

1. CARE/SANAA. In 1979 the Cooperative for American Relief Everywhere, Inc. (CARE), donated $0.2 million for the construction of rural gravity aqueduct sstems. The construction or expansion of 100 additional rural aqueducts nationwide is planned between 1980 and 1982 with CARE's financial input estimated at $1.2 million. CARE finances a portion of the construction materials and supervision, SANAA provides cement and transportation, and communities assist with the remainder. The CARE project does not address the issue of water quality, but merely taps a stream above the community to supply the village inhabitants water needs. When completed, the systems are turned over to the community for administration, operation and maintenance.

2. IDB/SANAA. The Inter-American Development Bank (IDB) lent $4.0 million in 1976 for the construction of 90 gravity flow rural aqueduct systems by SANAA to service approximately 87,000 rural inhabitants. IDB has recently signed a follow-up loan of $7.5 million for rural aqueducts to be constructed throughout Honduras for an estimated 150 rural communities which range in size of populations from 200 to 2,000 persons. Water quality will be tested, and where necessary, simple treatment units will be provided. The expected period of execution is 1980 through 1983.

3. EEC/MOH. The European Economic Community (EEC) is presently negotiating a grant of $4.0 million with the MOH for installing latrines, wells and rural aqueduct systems to cover 90 percent of the population for the Department of Olancho during the period 1980-1983.

4. CEDEN/SANAA. Comite Evangelico de Desarrollo y Emergencia Nacional (CEDEN) has recently started working under a contractual arrangement with SANAA to drill and install deep wells with motorized pumps to evaluate the possibility of SANAA's eventual involvement in this area of work.

5. PAHO. The Pan American Health Organization (PAHO) has been providing technical assistance and some training opportunities for many years.

PAHO's program has been oriented toward studying and developing recommendations for overcoming specific technical problems but without providing substantial implementation resources to assure that recommended improvements actually take place.

6. Others. Various international agencies, including the Swiss Government, Foster Parents Plan and the United Nations International Children's Emergency Fund (UNICEF) have contributed approximately $1.0 million since 1976 in grants and loans to the Ministry of Health to finance extension of small rural water systems, generally wells, in the southern region and in the area near the southern El Salvadoran border.

INVESTIGATION INTO POSSIBILITIES FOR LOCAL MANUFACTURE OF THE AID HAND PUMP

It is obvious that the need is great in Honduras for rural water supply programs and that the Government of Honduras is involved in considerable activity that could effectively utilize the AID hand pump as well as the various Robo devices. As a result, a number of plastics, foundry and metalworking establishments were visited by the authors of this report in the Tegucigalpa and San Pedro Sula areas (where the nation's industry is concentrated) to determine the level of in-country manufacturing capabilities.

The foundry and metal working organizations visited are as follows:

Name: Berkling Industrial

Address: Post Office Box 588
San Pedro Sula

Telephone: 52 37 51 or 52 37 54

Person Interviewed: Mrs. Ruth de Berkling

Berkling Industrial is a well-equipped foundry and machine shop establishment with a history of producing quality products, including two types of hand pumps (one a rotary type and the other reciprocating), agricultural machinery, gratings and grills. As an example of the size of this organization, its furnace capacity is capable of pouring up to 25 tons of molten metal daily; however, there is an important missing ingredient -- employees. It seems that Mr. Berkling, the owner and driving force behind the business, was killed in an airplane accident sometime ago, and the company's operations have steadily declined ever since. Because Mrs. Berkling was very interested in manufacturing the AID hand pump and felt that such a product might render the company solvent, it is felt that the use of this resource would be highly desirable from an economic development standpoint. To let the company fail, on the other hand, would surely present a negative impact on the Honduran economy.

Foundry No. 2

Name: Fundidora del Norte, S.A.

Address: Post Office Box 661
San Pedro Sula

Telephone: 52 30 28 or 54 21 41

This company was visited on several different occasions. The first visit was for the purpose of inspecting the plant, its machinery and equipment, and the quality of its casting presently being produced. The second visit was to leave an AID hand pump prototype with technical personnel for a cost estimate on producing 50-100 pumps.

Equipment and machinery observed is as follows:

- 4 cupola furnaces
- vibration equipment
- sand molding equipment
- 5 lathes
- 2 shapers
- 1 horizontal milling machine
- 1 large radial drilling machine
- 1 small drill press
- 1 disc cut-off machine

In general, this company appeared well organized and produces quality castings in brass, aluminum and iron (agricultural machinery, e.g., sugar mills and corn mills, and an attractive line of cast aluminum patio furniture). There was no in-house pattern making shops but this does not present a major problem as patterns can (and are) made by external firms for Fundidora del Norte. In conclusion, it is felt that the AID hand pump could be manufactured here at a very acceptable level of quality.

Note: The manager of Fundidora del Norte, Mr. Antonio Jacobo Saybe, was not available during visits to the company because of prior commitments; however, his technical staff was very impressive with its knowledge of foundry/metalworking practices and its ease in assuming responsibility during the absence of Mr. Saybe. Unfortunately, after two months of following up on a request for a cost estimate in manufacturing the AID hand pump, there has been no response and is indicative of a lack of interest.

Foundry No. 3

Name: Fundicion y Maquinado (FUNYMAQ)

Address: Carretera a Chamelecon
(Post Office Box 1094)
Km. No. 16
San Pedro Sula

Telephone: None

Person Interviewed: Mr. Ricardo Mata, Manager

This foundry/machine shop was also found to be quite acceptable for manufacturing the AID hand pump. It has had experience in producing pitcher pumps as well as a variety of agricultural machinery, is well organized in its plant layout and provides castings of excellent quality. There is sufficient pattern-making facilities, too.

In-plant equipment and machinery observed is as follows:

- 3 cupola furnaces (a new induction furnace is expected soon)
- 4 lathes
- 1 milling machine
- 2 drill presses
- 2 cut-off saws
- 1 hardness tester (Rockwell type)

After disassembling and inspecting an AID hand pump prototype, it was determined by FUNYMAQ management that an estimated cost for manufacture would be $100 per pump for an order of 50-100 pumps.

Foundry No. 4

Name: Metalurgia de Mayab

Address: Post office Box 249
Tegucigalpa

An appointment was made to meet with the manager of this company that reportedly had a foundry. However, the manager did not keep the appointment and, after further investigation, it was discovered that the foundry portion of the business had been dissolved. Therefore, the company was dropped from consideration in manufacturing the AID hand pump.

Foundry No. 5

Name: Industrias Asociadas, S.A.

Address: Km. 5 Carretera a Suyapa
(Post Office Box 216)
Tegucigalpa

Telephone: 32 51 57 or 32 59 44

Person Interviewed: Mr. Rolando Aplicano Molina, owner and manager

Office furniture and light structural steel frames for building purposes (trusses, A-frames, etc.) are fabricated by this company. There was a resemblance of a foundry present, but it obviously had not been used for quite some time. Further investigation showed that a previous owner (prior to Mr. Molina) had actually operated the foundry in the past while Mr. Molina would merely prefer to revitalize the activity if a sufficient volume of production could be found. Under these circumstances, it seems somewhat unwise to manufacture the AID hand pump, especially when foundries exist elsewhere that are quite capable.

Based on the above, it is recommended that two or three foundries (possibly FUNYMAQ, Berkling and Fundidora del Norte) be provided with technical assistance to manufacture 50-75 AID hand pumps each. The provision of technical assistance to more than one manufacturer will encourage competitive pricing and should raise and maintain a high level of quality through competition. A representative sample of these pumps could then be installed in the field for monitoring, evaluation and adaptation whereby any manufacturing defects would be detected and the data from such defects (if any) then fed back to the manufacturers for tightening of any necessary quality control procedures. By the conclusion of the monitoring, evaluation and adaptation period, lasting 12-16 months, the manufacturer should be thoroughly knowledgeable in producing a quality AID hand pump, and it (the AID hand pump) would be available for inclusion into the many rural water supply programs now underway or being planned for the future by a variety of different development agencies.

INVESTIGATION INTO POSSIBILITIES FOR LOCAL MANUFACTURE OF ROBO DEVICES

The following plastics manufacturers were investigated in Honduras:

Plastics Manufacturer No. 1

Name: Polymer, S.A.

Address: 2A Avenida, 14 Calle
Frente al Obelisco
Comayaguela
(Post Office Box 827)

Person Interviewed: Mr. Hector M. Zelaya, Manager

Polymer is one of two major plastics manufacturers in Honduras. It produces PVC pipe, mostly of the thin-wall variety, and wholesales a wide range of PVC pipe fittings made in Costa Rica. According to Mr. Zelaya, any injection-molded item found in Honduras is imported from Costa Rica as there are no in-country capabilities. As a result, it would be possible to produce the Roboscreen here but not the Robovalve.

Plastics Manufacturer No. 2

Name: Industrias Novatec, S.A.

Address: Antigua Colinia la Rosita
Tegucigalpa
(Post Office Box 164-C)

Telephone: 32 69 11

Person Interviewed: Mr. Edwin Handal, President

Industrias Novatec is the second of two major plastics manufacturers in Honduras. This company already produces PVC pipe, plastic well casing and screen (slotted in the conventional horizontal or vertical manner); therefore, the President, Mr. Handel, was very interested in the slotting process applied to the Roboscreen. Mr. Handal estimates his price for unslotted two-inch PVC Roboscreen (complete with ribs) would be an incredibly attractive price of $.42 (U.S.) per foot (slotting would add an estimated $.50 to the unit price).

Industrias Novatec management (Mr. Handal) claims to have injection-molding machinery, but it was not operative (nor was it available for inspection);

therefore, the Robovalve cannot be made here until the undeterminable time such machinery exists and/or is properly functioning.

Plastics Manufacturer No. 3

Name: Polyformas Plasticas, S.A.

Address: Carretera a Cortes - Choloma
San Pedro Sula
(Post Office Box 166)

Person Interviewed: Mr. Jose Handal

This company also produces thin-walled PVC pipe (nothing else) in sizes ranging from one-half to six inches. There is no injection molding capability, but, according to Mr. Handal, the Association of Plastics Manufacturers (in Honduras) has researched, in detail, the feasibility of entering into it (injection molding) and feels that the market potential is large because of the demand for pipe fittings. Nevertheless, until the time comes that injection molding facilities exist in Honduras, the Robovalve cannot be manufactured locally (the Roboscreen can be manufactured by Polyformas Plasticas' competitors, Polymer or Industrias Novatec).

CONCLUSIONS

There is an apparent need in Honduras for expansion of water supply programs, especially in rural areas, and considerable activity is underway or being planned by the Government of Honduras to meet this need. It seems logical that local manufacture, rather than importing, of as much as possible of the hardware needed for these programs should be stressed (for employment generation, more readily available spare parts, lower unit hand pump cost to users and reducing foreign exchange outflow).

In determining the potential market for the AID hand pump in Honduras, it is estimated by USAID/Honduras officials that there are over 1,200 villages with populations of between 200 and 500 inhabitants and over 18,000 communities of under 200 people without any form of water or waste disposal system. From field trips and discussions with government personnel, it is concluded that the majority of these villages are appropriate as sites for AID hand pumps to alleviate the necessity of traveling great distances for gathering water of questionable quality (under these circumstances, it is estimated that as many as 20,000 hand pumps are needed immediately to relieve the situation).

Where there is a need for hand pumps, it is reasonable to conclude that there is a corresponding need for Roboscreens. Where hand pumps are not appropriate and piped water systems appear to be the practical solution to the problem of supplying safer water to rural citizens, Robovalves and Robometers could have application, if accepted by local community users and if local country manufacturing quality can be maintained.

The manufacture of the AID hand pump in Honduras should not present any significant problems. FUNYMAQ, (one of several manufacturing possibilities) is more than capable of such manufacture and at an attractive price of $100 per pump. As a result, it is recommended that a pilot program be carried out that would allow the manufacture of approximately 150 AID hand pumps with technical assistance to selected manufacturers in proper production and quality control procedures. After manufacturing the pumps, they should be installed in the field for monitoring and evaluation whereby defects (if any) would be detected and the data fed back to the manufacturers for further tightening of quality control. At the conclusion of the program the manufacturer

should be thoroughly knowledgeable and capable of producing a high-quality, sturdy, cost-effective hand pump to serve the needs of rural Honduras.

If the above-recommended manufacturing and field testing program is carried out, there should also be included a comparative field evaluation of a previously unmentioned Sandpar hand pump that is now being manufactured in Honduras. The Sandpar pump sells for approximately $150 and is reported to be capable of pumping from well depths of 160-180 feet. This pump is being promoted by various MOH officials and acceptance of the AID hand pump will depend on how well the AID hand pump performs against the Sandpar pump (there is no existing field performance data on the Sandpar pump).

The manufacture of the Roboscreen is well within the capabilities of Polymer and, especially, Industrias Novatec (because of its prior experience in manufacturing well screen). Since the Roboscreen is a complimentary item to the AID hand pump (as a filter), it would be worthwhile from an economic development standpoint as well as spare parts availability and cost effectiveness to include producing the screen for inclusion into the previously recommended pilot hand pump manufacturing and field testing program.

The introduction of local manufacture of the Robovalve, unfortunately, appears to be premature at this time since injection molding is beyond the present scope of the plastics industry in Honduras.

The Robometer is within the capabilities of Honduran industry, and it is estimated that local production could be attained at a cost of less than $50 per meter. The Robometer is still in the process of being fully developed and could be introduced into Honduras when its final design is completed.

APPENDIX D

AGREEMENT FOR CONSULTING SERVICES

between

INTERNATIONAL DIVISION
TECHNOLOGY APPLICATIONS LABORATORY
ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY

and the

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY

The undersigned parties mutually agree to the following consulting arrangements between the International Division (hereinafter called ID) at the Georgia Institute of Technology and the Central American Research Institute for Industry (hereinafter called ICAITI) and enter into this agreement as of the date of the below signing.

1. ID wishes to utilize ICAITI to provide consulting services in conjunction with a rural potable water project in Honduras involving the local manufacture of AID water pumps and Robo devices. (Tasks as shown on attached scope of work, Stage I).

2. ICAITI's services will include technical assistance to ID, USAID and the Government of Honduras in assessing and evaluating the feasibility of the local manufacture of AID hand pumps, and Roboscreens. ICAITI's professional personnel will report to Mr. Phillip W. Potts, of the ID staff, who will serve as project director.

PWP

3. The project will have an effective date of May 29, 1981, and will terminate no later than November 30, 1981.

4. The estimated cost of ICAITI's services, to be performed including salaries and fringe benefits, overhead, travel and per diem, is $ 95 000, and this amount will not be exceeded without written authorization by the project director. Cost detail is as follows:

Professional services, including fringe benefits and overhead	$ 15 593
Travel and per diem	6 825
Telecommunications + supplies	2 582
Equipment and materials	70 000
	$ 95 000

5. ID will reimburse ICAITI for actual cost incurred upon presentation of monthly invoices.

IN WITNESS WHEREOF, the parties have executed this document.

GEORGIA INSTITUTE OF TECHNOLOGY

By: [illegible]

Title: Senior Research Associate & and project director, A-2774-000

Date: May 29, 1981

CENTRAL AMERICAN RESEARCH INSTITUTE FOR INDUSTRY

By: [illegible]

Title: May 29, 1981

Date: Director

APPENDIX E

Purchase Agreement Between FUNYMAQ AND ICAITI

CONTRATO DE CONSTRUCCION Y COMPRA-VENTA

El Instituto Centroamericano de Investigación y Tecnologia Industrial (en adelante denominado el "ICAITI"), entidad internacional con domicilio en Avenida de la Reforma 4-47, Zona 10 de la ciudad de Guatemala, República de Guatemala; y Fundición y Maquinado (en adelante denominada "FUNYMAQ"), empresa hondureña con domicilio en la Carretera a Chamelecón, kilómetro 6, Apartado Postal No.1094, dela ciudad de San Pedro Sula, Republica de Honduras; habiéndose acreditado mútuamente los poderes de los respectivos representantes legales que suscriben este documento, convienen en celebrar el CONTRATO DE CONSTRUCCION Y COMPRA-VENTA contenido en las siguientes cláusulas:

PRIMERA: FUNYMAQ se obliga a manufacturar ciento cincuenta (150) bombas de agua, con estricto apego a los diseños, especificaciones y planos proporcionados por el ICAITI, los cuales forman parte de este contrato, debiendo seguir los lineamientos siguientes:

a. FUNYMAQ fabricará los patrones y modelos en madera, los cuales deberán ser aprobados por el ICAITI;

b. Una vez que haya recibido la aprobacion de los patrones y modelos en madera, procederá a la fabricación de dc bombas prototipo, las cuales serán hechas de aluminio.

c. Una vez aprobados por el ICAITI los prototipos, procederá FUNYMAQ a manufacturar CIEN bombas para agua de pozo poco profundo y CINCUENTA bombas para pozo profundo.

SEGUNDA: Todos los trabajos convenidos en este contrato deberán quedar terminados el treinta y uno de diciembre de este año; y FUNYMAQ se obliga a entregar las bombas, modelos y patrones a más tardar el cinco de enero de mil novecientos ochenta y dos.

TERCERA: Los modelos y patrones quedarán en propiedad de la Agencia Internacional para el Desarrollo (AID) de Honduras; y los planos y diseños proporcionados quedarán en propiedad de FUNYMAQ.

CUARTA: El precio total de los trabajos, incluyendo el valor de los materiales, patrones, mano de obra, honorarios, prestaciones la' orales y gastos de cualquier otra naturaleza, asciende a la cantidad de DIEZ Y SEIS MIL DOLARES EXACTOS ($16,000.00).

QUINTA: El precio convenido se pagará en la siguiente forma: un anticipo de SEIS MIL DOLARES ($ 6 000.00) que el representante de FUNYMAQ ha recibido a su entera satisfacción; y luego, a medida que el ICAITI reciba y apruebe las unidades de bombas de agua fabricadas, pagará cien dolares ($100.00) por cada una.

..../

..../

SEXTA: En garantía del cumplimiento de las obligaciones que adquiere FUNYMAQ por este contrato, el ICAITI retendrá el diez por ciento (10%) de cada pago que le corresponda hacer, y el total así reunido lo entregará a FUNYMAQ a la terminación del presente contrato y una vez que hayan sido entregados los trabajos a entera satisfaccion del ICAITI.

SEPTIMA: Salvo el caso de fuerza mayor debidamente comprobada, FUNYMAQ se obliga a cubrir una multa de diez dolares ($10.00) diarios por el retraso en la entrega de las bombas en la fecha convenida. Esta multa se aplicará por un máximo de treinta días, a cuyo vencimiento el ICAITI podrá dar por vencido este contrato y ejercitar las acciones que procedan.

OCTAVA: Para los efectos de este contrato, FUNYMAQ renuncia al fuero de su domicilio, se somete expresamente a los tribunales que escoja el ICAITI y acepta desde ya como buenas y exactas las cuentas que éste le presente.

NOVENA: Ambas partes aceptan expresamente este contrato y se obligan a cumplirlo con absoluta buena fe.

Guatemala, junio 29, 1981

POR EL ICAITI:

Director

San Pedro Sula, junio , 1981

POR FUNYMAQ:

Gerente

FUNDICION Y MAQUINADO, S. A.
FUNDICION DE HIERRO BRONCE Y ALUMINIO
Carretera Chamelecón Km. 6
Apartado 1094

San Pedro Sula, 7 de Julio de 1981

Por L. 12,000.00

Recibi de "Haiti"

la suma de Doce mil Lempiras Lempiras

por concepto de anticipo por maquina de Sandas, pagado por # 10519 de Citibank por $ 6,000.00

Crédito Cuenta No.

i r 20bt 5 9 80

DISTRIBUCION	LEMPIRAS	
Saldo		
Su Abono		
Saldo		

NOTA: No es válido si contiene alteraciones o raspaduras.

RECIBO Nº 5730

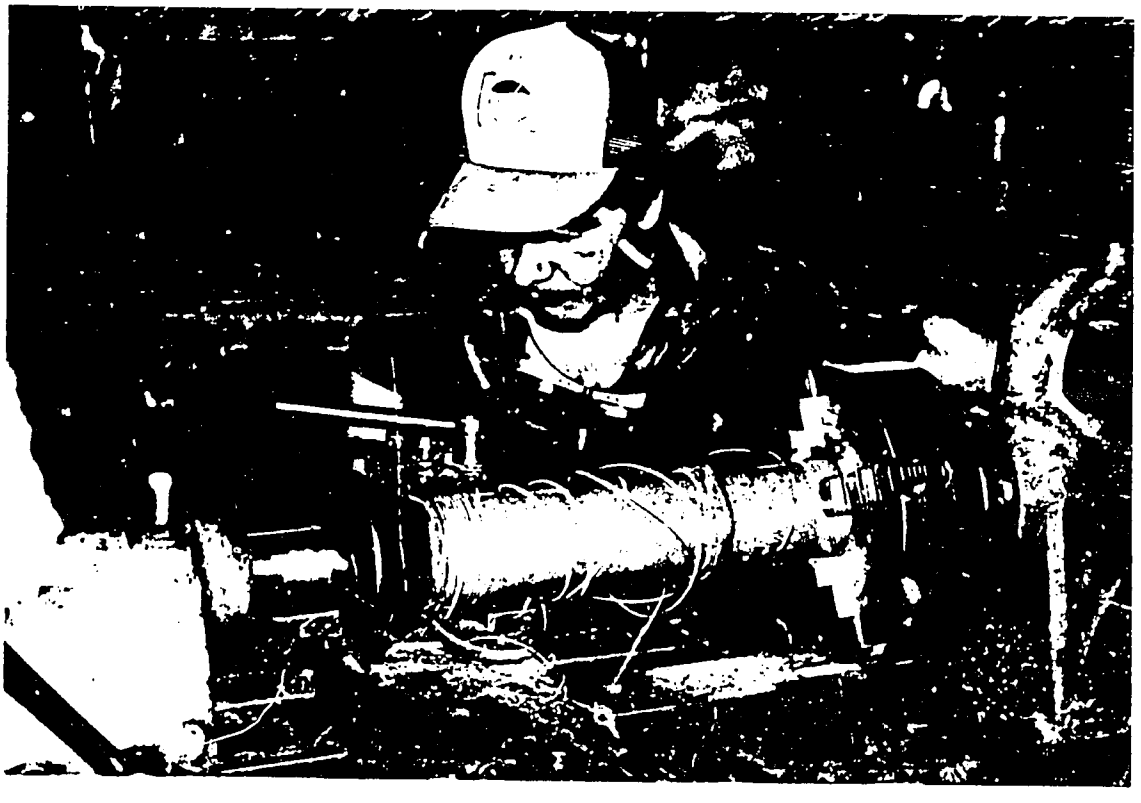
FUNDICION Y MAQUINADO

APPENDIX F

Photographs of
Foundry and Machine Shop Operations

POURING CAP CASTINGS

DURING THE POURING OF MOLTEN IRON INTO THE SAND MOLDS, EXTREME CARE MUST BE TAKEN IN ORDER TO PREVENT VOIDS AND POROSITY.

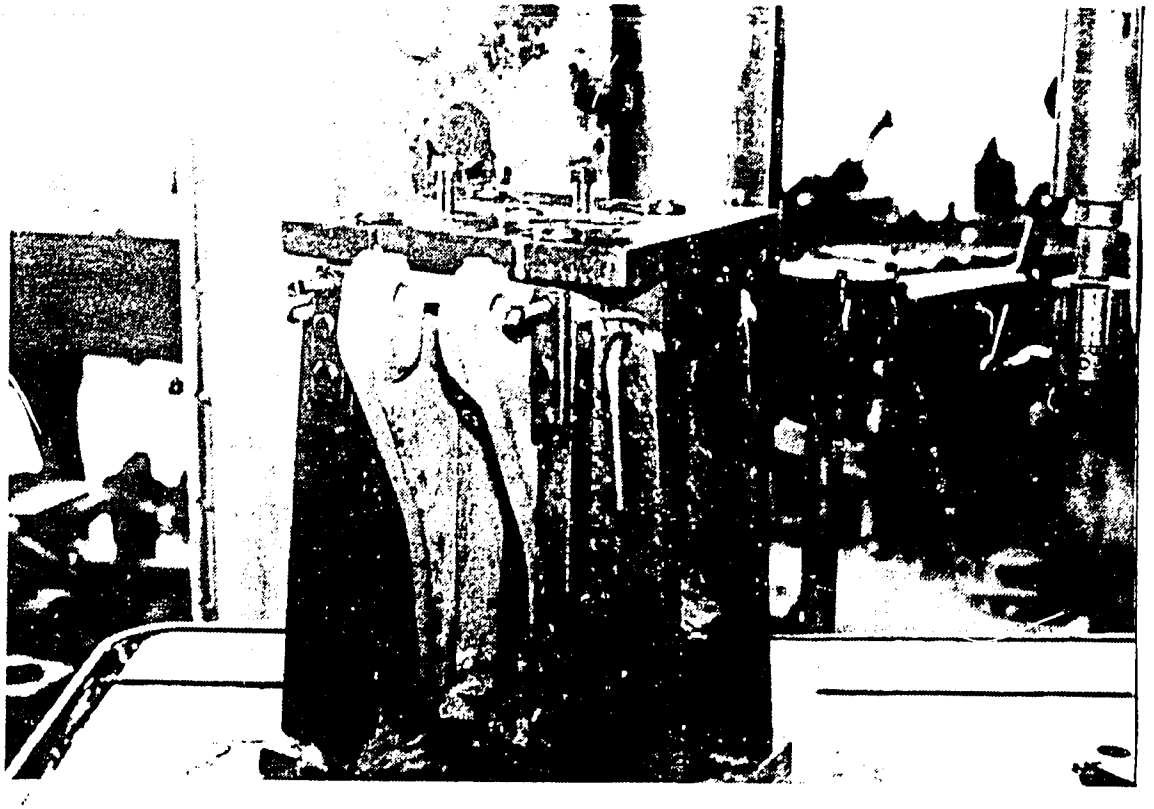


TURNING CYLINDER THREADS

THIS IS ONE OF THE CRITICAL OPERATIONS IN PUMP MANUFACTURING. IF IMPROPERLY DONE, THE MECHANICAL STRENGTH AND THE SEALING ABILITY OF THE THREADS CAN BE ADVERSELY AFFECTED.

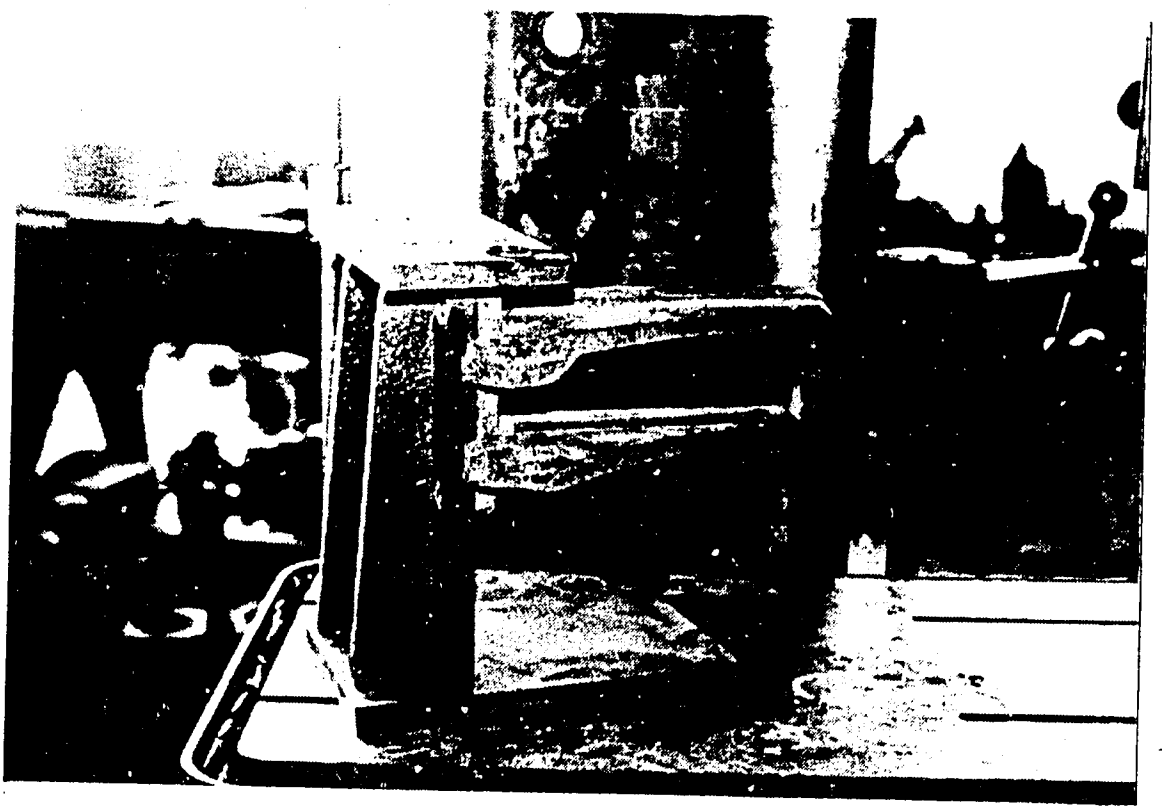
APPENDIX G

Photographs of
Production Tooling (Jigs and Fixtures)



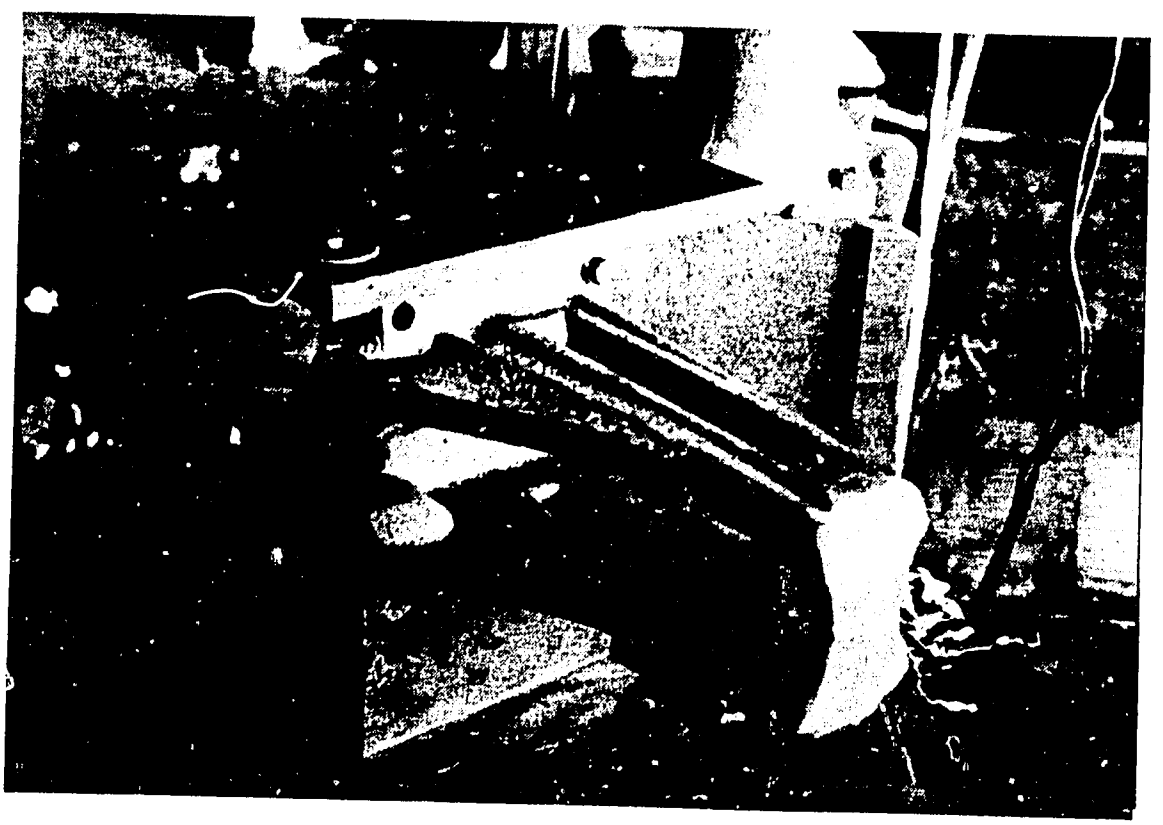
CAP AND BODY DRILLING FIXTURE

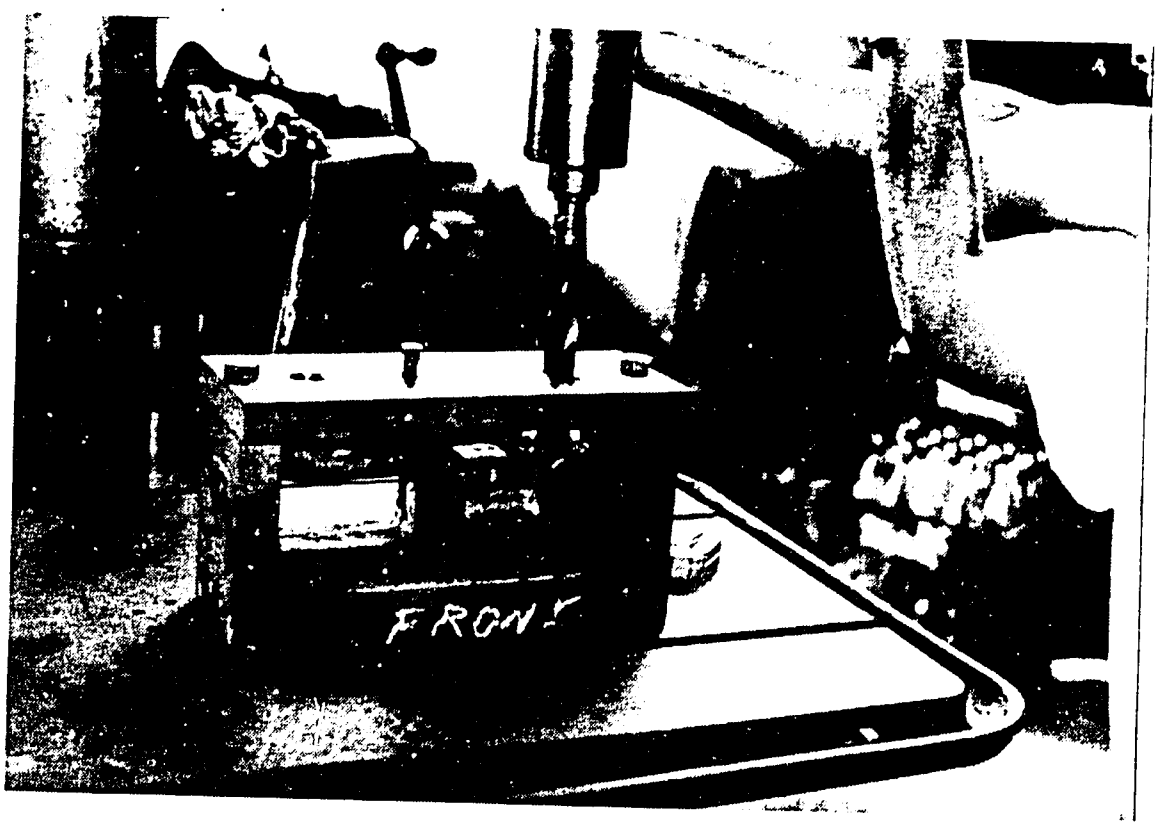
SHOWN IN THE CLOSED POSITION, THIS FIXTURE ACCURATELY LOCATES THE DRILLED HOLES TO INSURE THAT THE CAP CAN BE FITTED TO THE BODY IN ANY 90° POSITION. THE TOP OF THIS FIXTURE IS HINGED AND PINNED SO THAT, AFTER THE PART HAS BEEN DRILLED, THE TOP CAN BE SWUNG OUT OF POSITION AND THE PART REMOVED.



CAP DRILLING FIXTURE

THIS FIXTURE INSURES THAT THE LOWER FULCRUM PIN HOLDS THE FULCRUM IN PROPER ALLIGNMENT WITH RESPECT TO THE HANDLE AND THAT THE LOWER FULCRUM PIN CAN BE INSERTED FREELY WITHOUT BINDING.



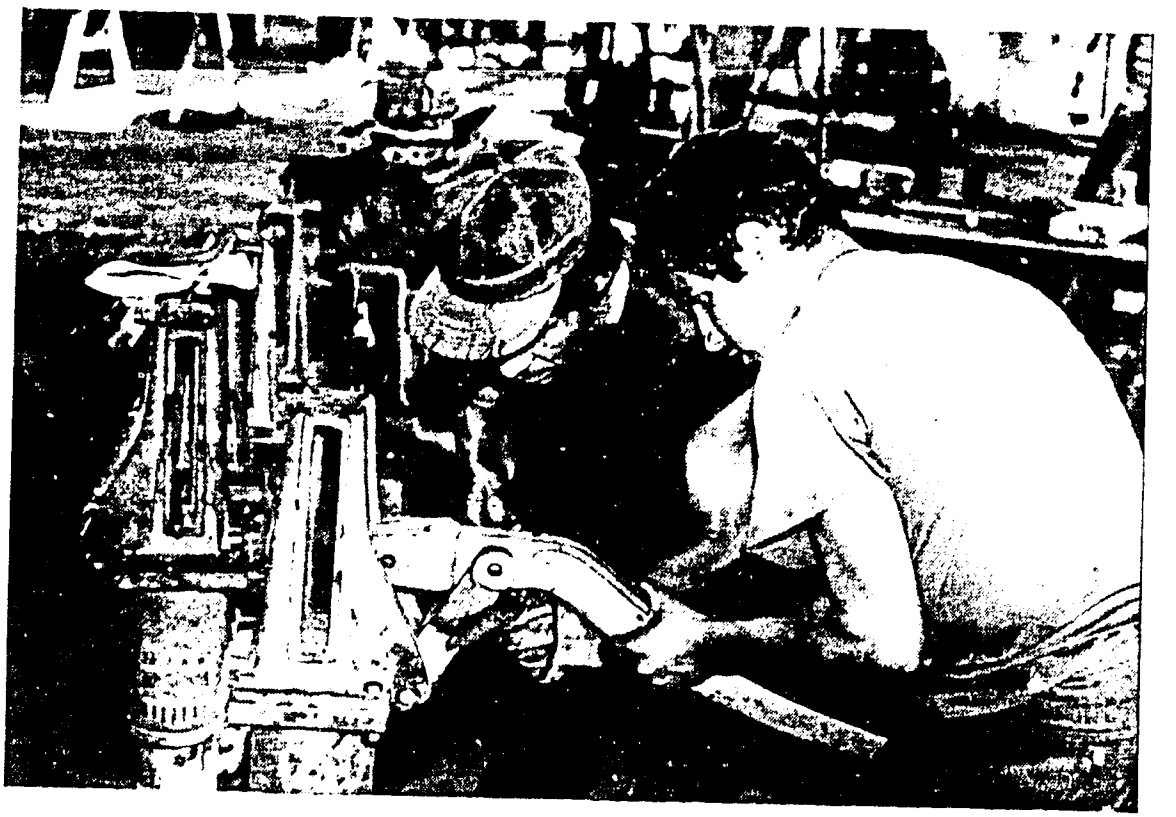


FULCRUM DRILLING FIXTURE

THIS FIXTURE INSURES THAT THE DRILLED HOLES IN THE FULCRUM ARE PROPERLY SPACED AND ABSOLUTELY PARALLEL.

APPENDIX H

Photographs of
Handpump Assembly



PUMP ASSEMBLY

MISALIGNMENT OF THE DRILLED HOLES IN THE CAP, HANDLE OR FULCRUM CAN MAKE THE PUMP ASSEMBLY OPERATION DIFFICULT OR EVEN IMPOSSIBLE.

CAP REAMING TO CORRECT MISALINGED DRILLED HOLES

A CONSIDERABLE AMOUNT OF TIME IS NECESSARY TO CORRECT MISTAKES THAT HAVE BEEN MADE IN EARLIER MACHINING OPERATIONS.

FUNDICION DE
HIERRO
BRONCE Y
ALUMINIO

FUNDICION Y MAQUINADO, S. A.
"FUNYMAQ"
CARRETERA A CHAMELECON KM 6
SAN PEDRO SULA HONDURAS, C. A.

APARTADO 1094
TELEFONO: 54-05-52
CABLE "FUNYMAQ"

Format for the Production
Cost Analysis and Sales Price Determination

DETALLE DE COSTO DE VENTA DE BOMBA

COSTO DE PRODUCCION		
COSTO DIRECTO		
Materia Prima	Lps. XXX	
Mano de Obra Directa	XXX	
Materiales y Accesorios	XXX	
		Lps. XXX
COSTO DE FABRICACION		
Materiales Indirectos	Lps. XXX	
Mano de Obra Indirecta	XXX	
Sueldos y Salarios	XXX	
Seguros y Infop	XXX	
		Lps. XXX
GASTOS INDIRECTOS		
Gastos de Administración	Lps. XXX	
Depreciaciones	XXX	
Mantenimiento	XXX	
Energía Eléctrica	XXX	
Combustible y Lubricantes	XXX	
Gastos Financieros	XXX	
		Lps. XXX
SUB-TOTAL		Lps. XXX
Utilidad		XXX
COSTO DE VENTA		Lps. XXX

DETALLE DE PIEZAS FUNDIDAS QUE COMPONEN UNA BOMBA

Pump Head,	Pieza fundida en hierro		Peso	27	Lbs.	Lps. XXX
Pump Body,	"	"	"	30	"	XXX
Pump Stand,	Pieza fundida en hierro		"	27	"	XXX
Handle,	Pieza fundida en hierro		"	14.5	"	XXX
Lower Valve Housing,	Pieza fundida en hierro		"	6	"	XXX
Foot Valve Weight,	"	"	" "	1/2	"	XXX
Plumger Follwer,	"	"	bronce "	2	"	XXX
Plumger Spacer,	"	"	" "	2.5	"	XXX
Peppet Valve,	"	"	" "	1/2	"	XXX
Plumger Coge,	"	"	" "	2	"	XXX
Ful Crum,	"	"	Hierro "	6	"	XXX
Rod End,	"	"	" "	2	"	XXX
Upper Cylinder Cap,	"	"	" "	7	"	XXX
						Lps. XXX

DETALLE DE MANO DE OBRA EN CADA DEPARTAMENTO

(Minutes of time required for machining components of the AID handpump)

	CORTADO (Cutting)	ESMERILADO (Grinding)	TORNEADO (Lathe)	FRESADO (Milling)	TALADRO (Drilling)	ROSCADO (Threading)	PRECIO
Pump Stand	5	15	60		20		L. XXX
Cylinder (PVC)	10		15			15	XXX
Pump Cylinder Galvanizado	10						XXX
Pump Body	10	15	60		15		XXX
Pump Head	10	15		60	15		XXX
Plumger Rod	5					15	XXX
Rod End	5	10	15		10	10	XXX
Slider Blck	5	5	15				XXX
Rod Pivot Pin	5	5	30		15		XXX
Handle Pivot Pin	5	5	30		15		XXX
Full Crum	5	5			10		XXX
Full Crom Pivot Pin	5	5	30		15		XXX
Andle	5	10			10		XXX
Plumger Cage	5	5	30			15	XXX
Poppet Valve	5	5	30				XXX
Plumger Spacer	5	5	30				XXX
Plumger Fellower	5	5	45			15	XXX
Foot Valve Weight					5		XXX
Lower Valve Housing	5	5	50			20	XXX
							L. XXX

DETALLE DE ACCESORIOS PARA ARMAR BOMBA

COMPRADOS AL COMERCIO

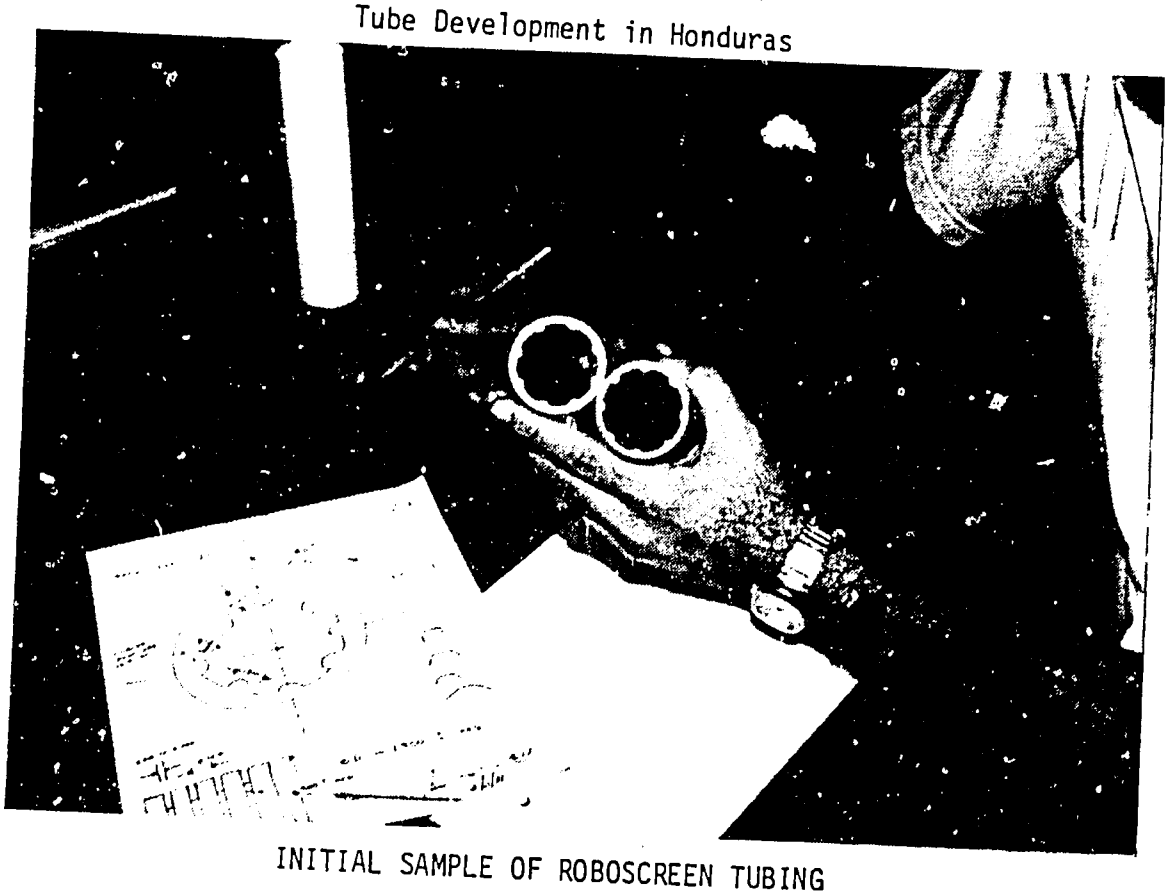
CANTIDAD	DETALLE	P/UNIDAD	TOTAL
3	Rod Pivot Pin de 5/8"	Lps. XX	Lps. XXX
1	Foot valve Leather	XX	XXX
2	Leather Cup	XX	XXX
1	Plumger rod inch de 20" X 7/16	XX	XXX
6	Chavetas	XX	XXX
4	Tornillos de 1/2 X 2	XX	XXX
2	" " 3/4 X 1/4	XX	XXX
1	" " 1/2 X 1/4	XX	XXX
2	Tuercas " 7/16	XX	XXX
1	Pump Cylinder de 14½ X 3	XX	XXX
1	Cylinder Body (PVC)	XX	XXX
10	Bushing de hierro dulce 10-40 endurecido a 60R	XX	XXX
	Lock nut	XX	XXX
1	Decimo de galón de pintura	XX	XXX
			Lps. XXX

OTROS GASTOS EN MANO DE OBRA

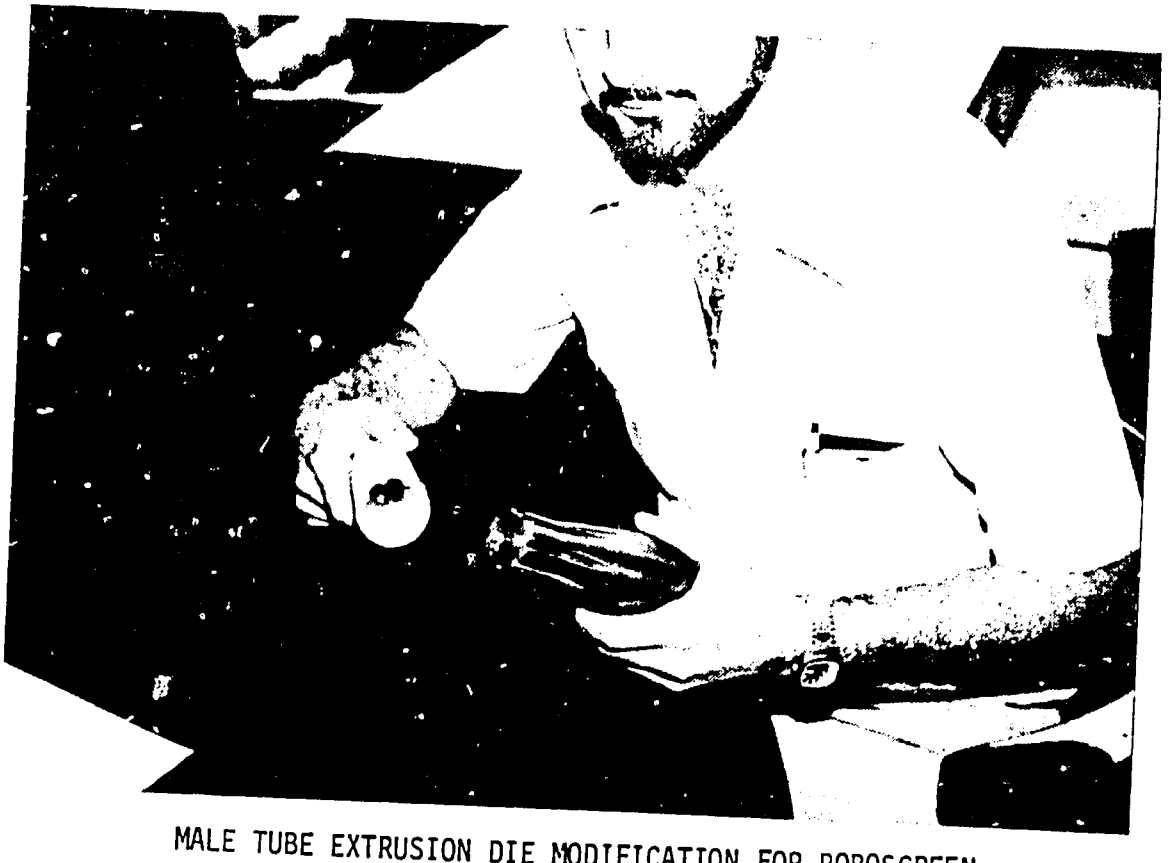
	(Minutes)	
Tiempo de armado de 1 bomba	25	L. XXX
Inspección y Prueba	10	XXX
Traslado de bomba al Dpto. de pintado y limpieza	10	XXX
Pintado de bomba	10	XXX
Inspección de acabado	5	XXX
		L. XXX

APPENDIX J

Photographs of Roboscreen
Tube Development in Honduras



INITIAL SAMPLE OF ROBOSCREEN TUBING

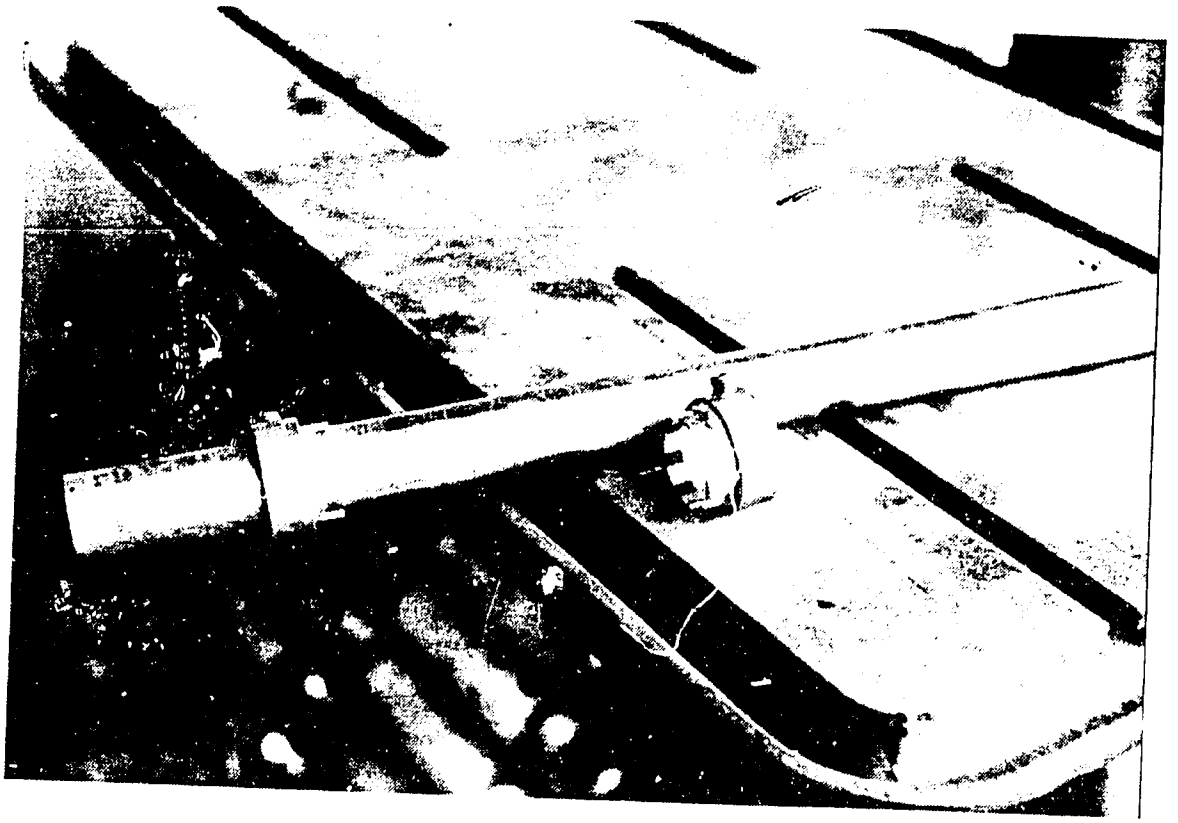


MALE TUBE EXTRUSION DIE MODIFICATION FOR ROBOSCREEN

APPENDIX K

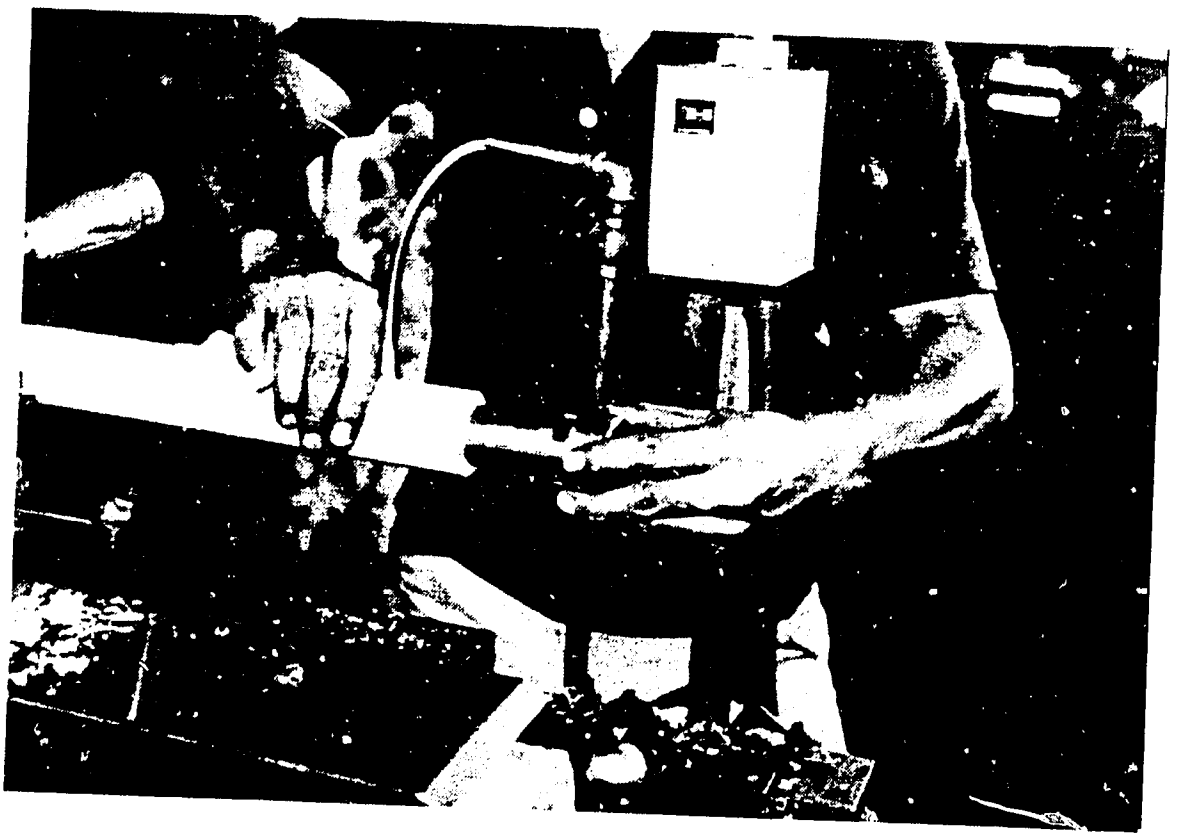
Photographs of Roboscreen Machining Development in Honduras

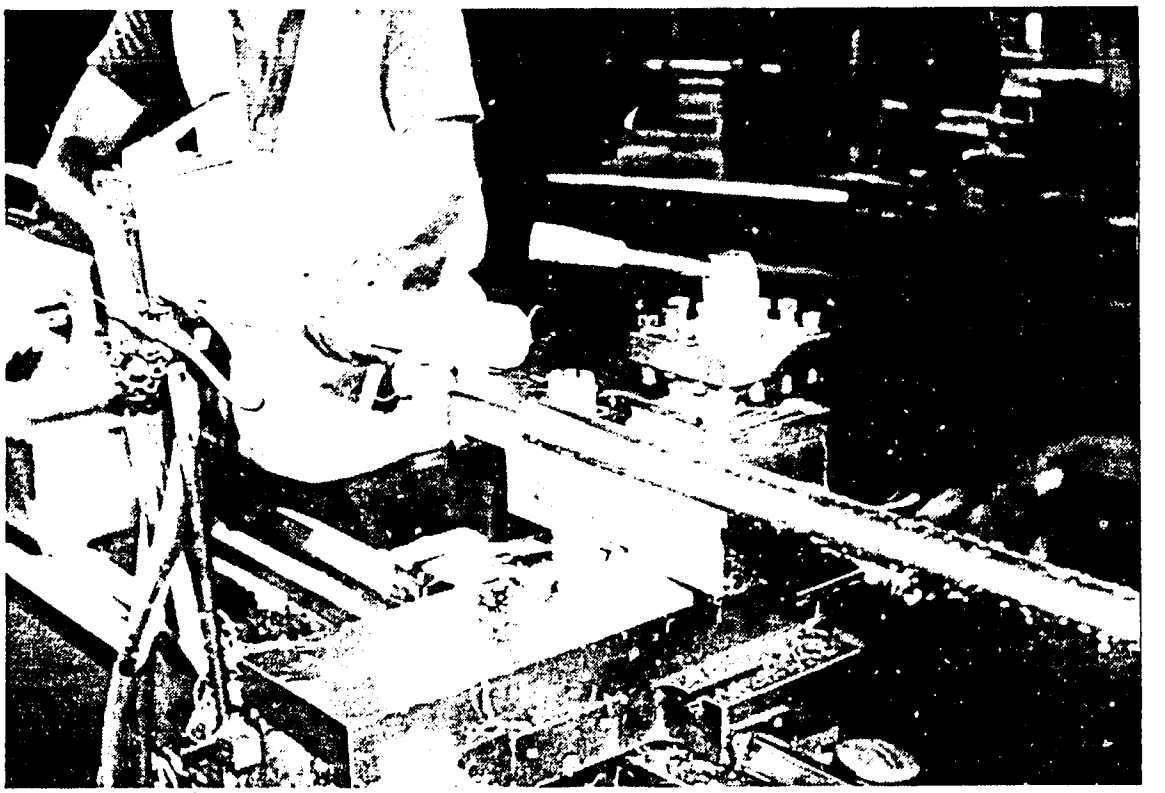
Due to the fact that a tool post grinder was not readily available in Honduras another acceptable slotting method was developed which required only a common engine lathe and very inexpensive, readily-available tooling. This alternative slotting process involved grinding a standard 3/8" square lathe tool blank so that the end was only .015-inch thick. A mandrel was then designed so that the PVC tubing could be slipped over it, holding it completely steady while the slots were being machined. The previously-ground tool bit was placed in the lathe tool holder, the PVC tubing was then slipped over the mandrel and, in manner similar to turning screw threads, the slotting process was begun. As the PVC tubing was rotated and as the tool bit cut into the PVC about 0.010 inch deep and moved along the tubing, a spiral groove was generated. Several passes were required, each pass removing about .010 inch or .015 inch thickness of material, before the tool broke through the interior surface of the PVC tubing. The tool was not allowed to cut into the ribbing in order to preserve the rigidity and strength of the Roboscreen. The slotted tube was then removed from the mandrel, and the interior was cleaned of flash and debris with a wire brush.



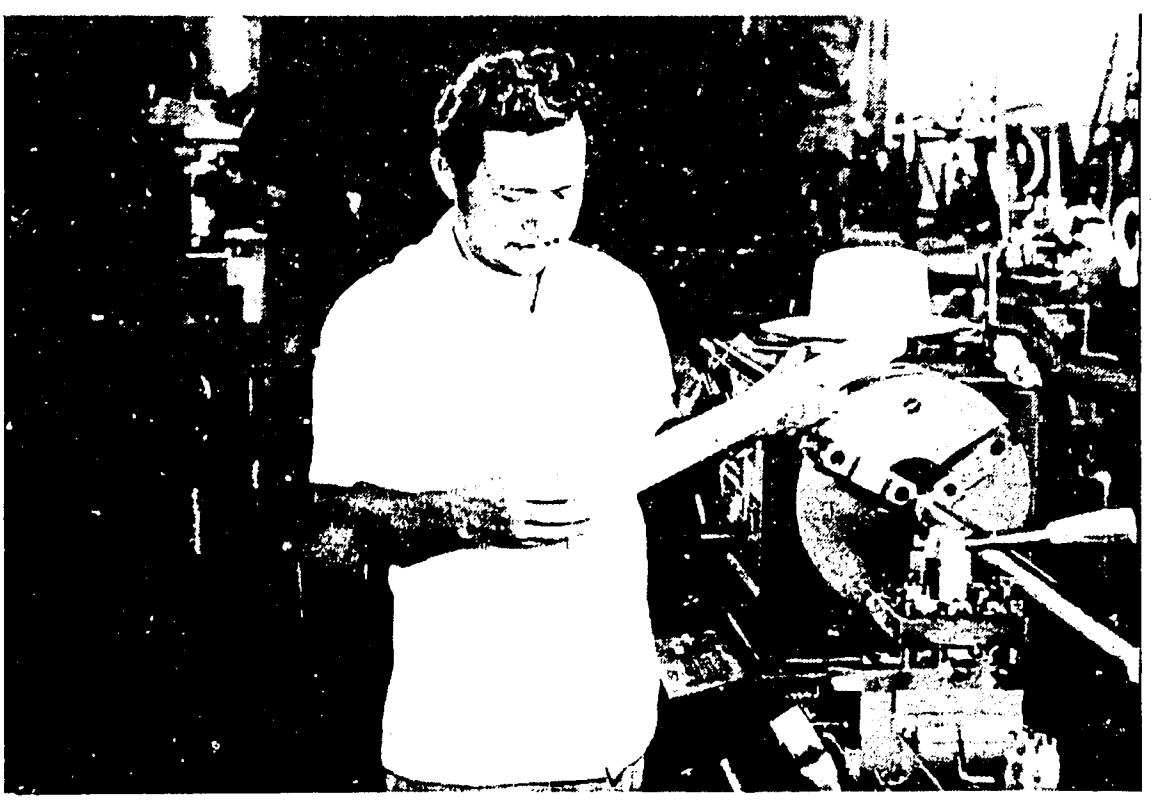
ROBOSCREEN SLOT MACHINING TOOLING
(Above and below)

THIS MANDREL AND CLAMPING COLLARS, WHEN SECURED IN A LATHE, INSURES THAT THE PVC TUBING IS HELD RIGIDLY DURING THE SLOTTING OPERATION.





ROBOSCREEN SLOT MACHINING SETUP



FINISHED ROBOSCREEN

APPENDIX L

Site Selection Criteria for Field Testing Handpumps

1. Acceptable to the local community.

2. All possible sources of groundwater contamination should be downhill and at least 50 feet (15 meters) from the well.

   These include:

   a) Any sanitary facilities (latrines, septic tanks)
   b) Bathing and washing wells
   c) Agricultural fields using insecticides and fertilizers
   d) Drainage canals, fish ponds, other water bodies

3. The site should provide year-round ground water (the well does not dry up).

4. The water should be of quality acceptable to the people, or within W.H.O. water quality standards.

5. The well should be a public well located on as high of a ground elevation as possible.

6. The well should be easily accessible for repair, cleaning, testing and, monitoring.

7. The well space should be suitable to the sinking methods available.

APPENDIX M

Acceptance Criteria and Inspection Plan
for AID Handpumps

1. Randomly select a sample consisting of 20% of the production lot or 5 pumps (whichever is greater)

2. Inspect the following quality characterisitcs:

CHARACTERISTIC	ACCEPTANCE CRITERIA
1. Examine motion of handle/fulcrum assembly	A. Smooth motion, no catching on burrs, etc. B. Fulcrum to limit motion of handle so that rod end does not contact cap
2. Examine surface finish of external parts and piston assembly	A. No burned sand adhering to casting, relatively smooth surface B. Parting line flash removed C. No obvious distortion of parts
3. Examine threads in base, stand and body	A. No voids or badly broken threads in threaded area B. No putty or filler evident

	C. 3" pipe section and 1 1/4" drop pipe must have 4 threads showing when hand-tightened into base or body
4. Rotate cap on body to check hole spacing	A. Cap must fit in all four positions
5. Check dimensions on anchor bolt holes in base	A. Using a standard base or a template, line up base holes
6. Inspect for porosity in critical areas	A. Must meet porosity criteria of casting criteria sheet
7. Inspect pins and bushings	A. Pins and bushings must be to hardness of 40-45 and 60-65 R_C respectively B. Bushings must be press fit in cast iron part C. Measure dimensions and warpage on gages D. Cotter pins must be easily removed from pins; cotter pins not to drag on cast iron parts

8. Inspect cylinder	A. No putty, voids, sealer in threads B. Cylinder ID smooth and without excessive ripple
9. Inspect plunger assembly	A. No holes, voids or porosity on valve contact surface of follower or underside of poppet valve B. No holes or excess porosity in plunger cage; no machined sharp corners inside cage C. All flash removed from brass parts D. Leather cups not ragged, torn or stretched; ID to just fit over follower E. Piston fits snugly into cylinder F. Plunger rod threads not misthreaded and do not protrude into cage
. Inspect foot valve	A. Valve seat has no holes or imperfections

	B. Rubber or leather on valve smooth
11. Wet test pump	A. Pump must fill 5 gal container in 18-25 strokes
	B. No leaks at base/stand/body connections
	C. Foot valve must not appear to leak over 5 minute period

3. If any of the 20% sample pumps has one of the quality characteristics fail, that entire pump will be rejected and that quality characteristic inspected on <u>every</u> pump in the entire lot. The inspector has <u>sole</u> authority to determine disposition of the failed part; he may order it scrapped or he may have it repaired.

4. Each pump in the lot will be numbered. All pumps in the lot to be inspected will have no paint or thread sealer or putty of any kind in evidence when inspected. After the lot has been accepted, the number will be painted or stenciled on the pump body in a color that contrasts with the finished color of the pump.

CASTING POROSITY CRITERIA

Acceptable:

holes less than 1 mm diameter

and

greater than 1 cm from each other

Not Acceptable:

1) In critical areas holes greater than 1 mm diameter but less than 3 mm diameter

and

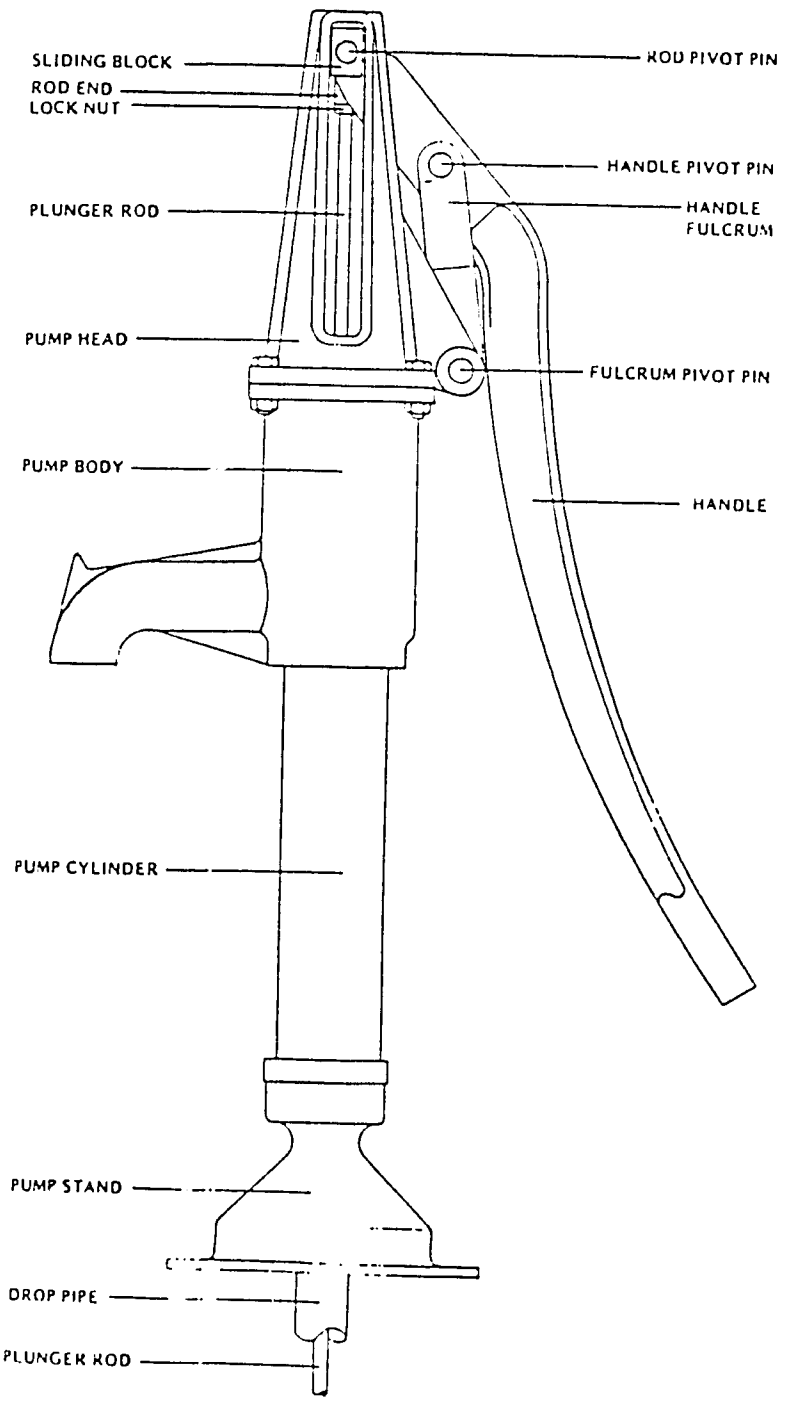
2) In critical areas holes greater than 3 mm diameter

3) Any holes in threads

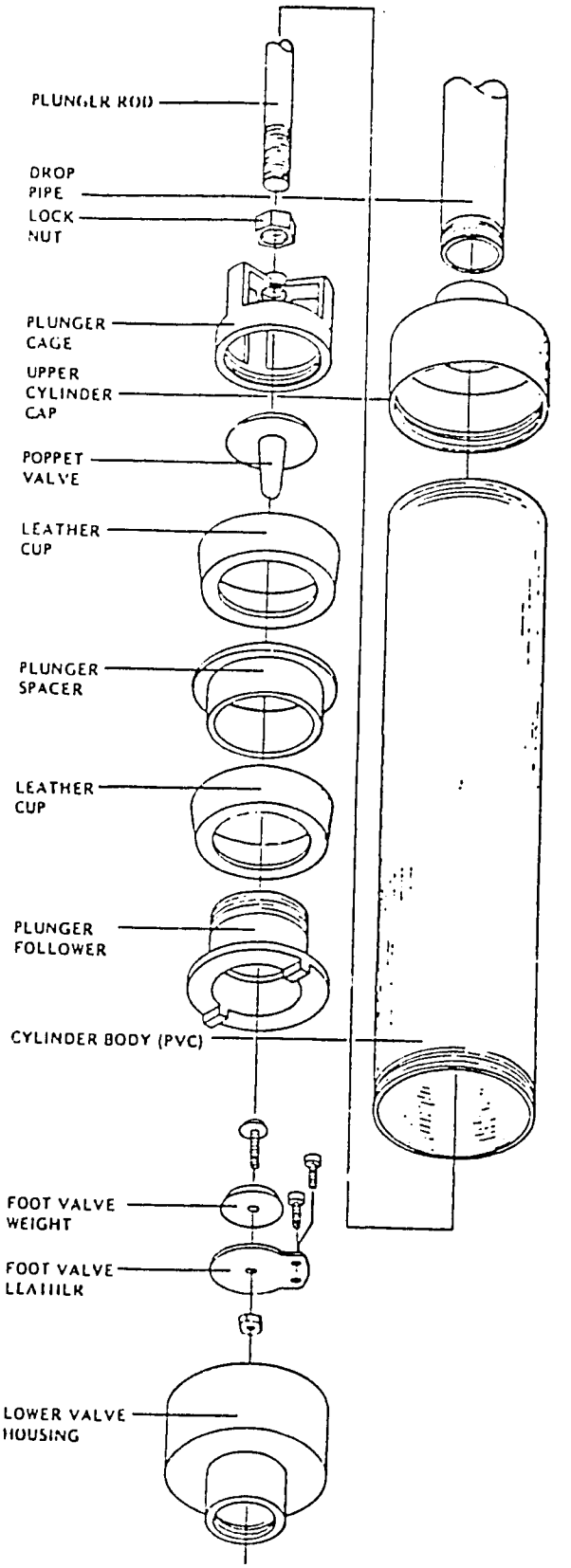
4) Any holes in valve seat

Critical Areas:

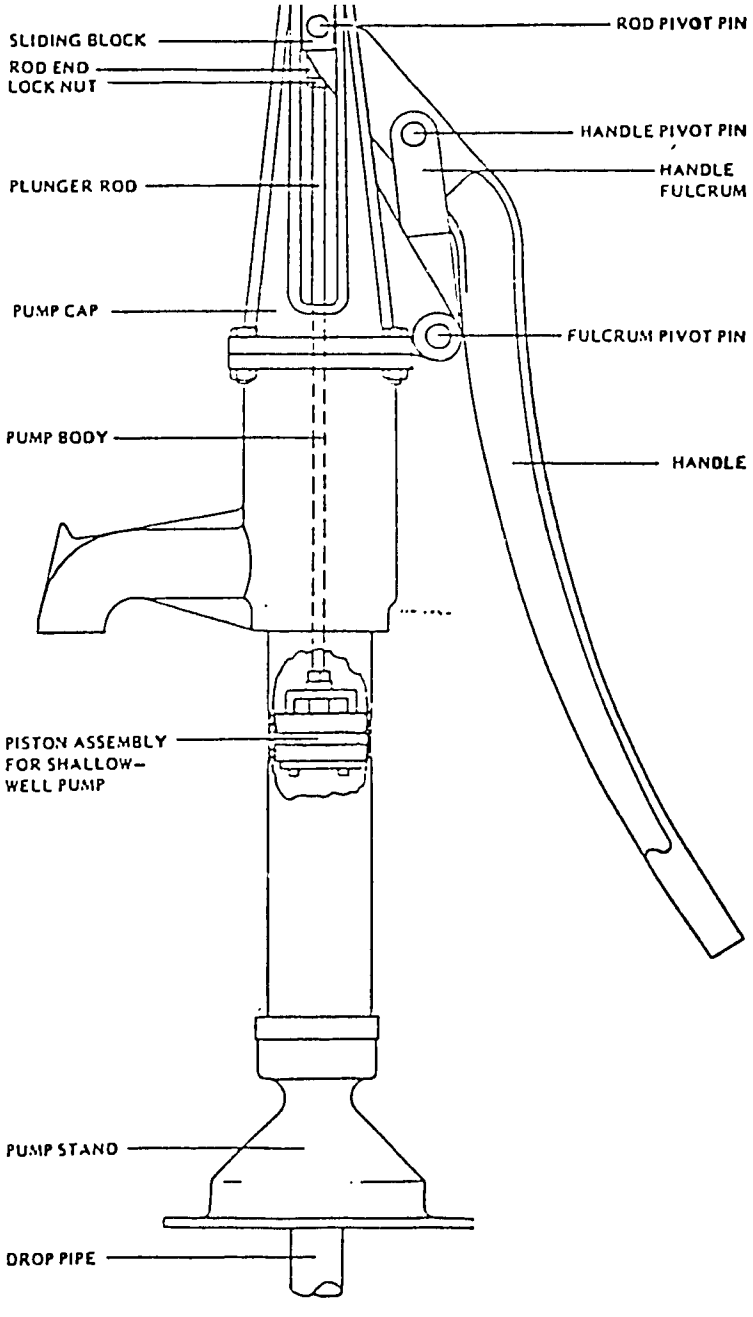
1) areas around every bushing
2) neck of base
3) forks of handle and fulcrum
4) tapering section of handle



PUMP STAND



COMPONENTS OF PUMP CYLINDER


SLIDING BLOCK
ROD END
LOCK NUT
PLUNGER ROD
PUMP CAP
PUMP BODY
PISTON ASSEMBLY
FOR SHALLOW-
WELL PUMP
PUMP STAND
DROP PIPE
ROD PIVOT PIN
HANDLE PIVOT PIN
HANDLE
FULCRUM
FULCRUM PIVOT PIN
HANDLE

PUMP STAND

IN-PROCESS INSPECTION

IN-PROCESS HANDPUMP INSPECTION IS PART OF THE OVERALL QUALITY PLAN TO INSURE CONFORMANCE TO SPECIFICATIONS AND DRAWINGS AND IS USUALLY DONE BY REPRESENTATIVES OF THE HANDPUMP MANUFACTURER.