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March 25, 1974

Mr. A. Dale Swisher, P.E.
Office of Health
Technical Assistance Bureau
Agency for International Development
Washington, D. C. 20523

Dear Mr. Swisher:

Eleventh Quarterly Progress Report on
Phase III "Field Research and Testing
of a Water Hand Pump for Use in Develop-
ing Countries"
AID/csd - 3305
January 1 through March 31, 1974

Since the first of the year, a meeting was held at Battelle to discuss the progress of the program and additional reporting has been received from Bangladesh and Nigeria.

Battelle Meeting

Because of the absence of field data and because of some feeling that perhaps the objectives of the program are not being achieved, it was believed that the total program should be reviewed in detail. A review was also in order because of the recent visits of Mr. Worthington to Thailand and Mr. Swisher to Nigeria.

A meeting was held in Columbus on February 22, 1974, during which the program was discussed in detail, as well as comments made and pictures shown of the recent visits. Much time could be spent reiterating the lack of enthusiasm for a new pump in Thailand, or their ready acceptance of PVC plastic pipe cylinders, or the poor machining done in Nigeria, but the most important factor discussed was the lack of resident program responsibility in the trial areas. Although the program was introduced with plans, samples, tooling, technical assistance, critical materials, and test forms; no

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AID official was given responsibility to monitor the program and none remained in the area long enough to follow up the local activities. Consequently, sufficient pumps have not been tested nor regular reporting made. In spite of this deficiency, significant data has been collected. The modified deep-well pump cap is a result of this information. It is hoped that this new design will generate further interest in the selected areas, that additional pumps with the new cap will be made and placed on test, and with some appointed responsibility, additional test results will be forthcoming. To realize this goal, a program extension is necessary.

The need for information dissemination was also discussed during the meeting and it was again agreed that a packet of some sort should be prepared that would answer most of the questions being asked.

Only one more month remains in the current program and any decisions regarding additional data and/or information dissemination must be made soon.

Report From Bangladesh

The latest report from the UNICEF program in Bangladesh (see Attachment #1) discusses mostly a redesigned pump incorporating the features of the Battelle-AID pump. As we had indicated to UNICEF, the complaints dealt mostly with:

- Too short a handle length increasing the pumping effort
- Too short a stroke decreasing the amount of water pumped, particularly with the deeper wells.

An additional complaint was directed toward the poor seal made by the poppet valve. Since this problem seemingly does not exist with the "Battelle" pump, it may lie in the valve design of the lighter weight pump. We at Battelle see the need for a pump design of less weight, especially when iron is difficult to obtain; however, care must be exercised to retain all of the advantages of the original design. Battelle also believes that only one design instead of two mentioned in the report would be more economical in the long run. These additional comments will be made to UNICEF.

Report From Nigeria

The report from Nigeria was more simple than that from Bangladesh. The only adverse comment recorded concerned the change from flapper valves to poppet valves to maintain a prime condition. This comment is just opposite from that reported by personnel in Bangladesh. It should be noted, however, that the pumps in Nigeria are of the deep-well type and the pumps in Bangladesh are of the shallow-well type. This may or may not be of significance. What is significant is that in both cases, Nigeria and Bangladesh (and in

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Thailand as well) premature wear of the cups is no longer the primary cause of failure and in fact, this improvement greatly extends the useful life of rural hand pumps in all test countries.

Costs

Program costs have increased over the original estimate significantly. To begin with, the program started in June, 1971, but it was March, 1972, before the first country (Thailand) was found. During this time, \$9,280 was spent.

About half of this was spent on updating drawings and making patterns and pump samples, but the other half was spent for unanticipated staff effort directed toward identifying three countries or areas to test our pump. This problem does not exist now, as shown by the many inquiries, but certainly existed in 1971. In addition, significant increases in cost have been incurred simply because of inflation. Battelle's costs alone have increased some 5.2 percent per year since the program began. This does not reflect higher increases of many suppliers. We estimate a \$8,700 increase in appropriation is required to complete the program, particularly if the program is extended 9 months. (This is the time lost at the beginning of the program.) It should be noted that AID assistance will be required in the test areas.

Future Work

Currently it is planned that a final report be written next month. It is suggested, however, that an extension in time and funds be considered to obtain additional data in the field, and respond to the increased interest in rural water suppliers. If the extension is reasonable, action must be taken in the remaining few days. Don Frink or I can be reached on Extension 2663 or 2681, respectively.

Any questions concerning this report or regarding particulars of an extension to work would be welcomed.

Sincerely,



Robert D. Fannon, Jr.
Equipment Development
Section
Research Engineer

RDF:ban

cc: Ms V. C. Perelli

UNITED NATIONS CHILDREN'S FUND (UNICEF)
DACCA, BANGLADESH

RURAL WATER SUPPLY PROGRAMME
HANDPUMP TESTING PROGRAMME REPORT NO. 3

28th February 1974

File : 310

This report is prepared to record some information on the performance of various types of pumps, under test. This is in continuation of previous reports, No. 2 dated 19 December 1973 and Report No. 1 dated 1st October, 1973.

As of 21 January 1974, the following pumps have been put under test in areas of concentrated population:

Sl. No.	Type of pump	Location Installed	Date Installed	Status	Type of usage	Stroke length inches	Mechanical advantage in the handle	Type of check valve
1.	Economy	Kataban mosque old Dacca	19.9.73	20.12.73 removed	heavy	6"	1:4	Poppet valve
2.	Modified No. 4	Kataban near old Jinnah hall (slum)	15.11.73	Running OK	"	4"	1:5	"
3.	"	Thatari bazar old Dacca	23.11.73	"	"	"	1:5	"
4.	"	Joydebpur bazar (W)	23.11.73	"	"	"	1:5	"
5.	"	Kaoran bazar Triangle	4.12.73	18.12.73 removed	medium	"	1:5	"
6.	"	Kataban middle (slum)	4.12.73	Running OK	"	"	1:5	"
7.	"	Kaoran bazar middle of old Rlway track	17.12.73	"	"	"	1:5	Flapper valve on No. 6 base
8.	"	UNICEF office compound	25.1.74	"	Test only	5"	1:5	Flapper valve & poppet valve alternately

Modifications on No. 4 DPHE Pump

1. A PVC liner 3" ID 10" long inserted in the pump cylinder.
2. The total height of the pump barrel is reduced by 3".
3. The headcover is modified a little bit so that 3 Nos. $\frac{1}{2}$ " dia. nut bolts could be fitted.
4. The handle is designed as T section instead of I section.
5. The stroke length is reduced to 4" in place of $5\frac{3}{4}$ ". (In a later version increased to 5")
6. The base is the same as the No. 6 pump, because the overall diameter of the pump barrel is the same as the No. 6 pump in order to include the PVC sleeve.
7. The base nuts and bolts are all $\frac{1}{2}$ " dia.

This modified pump is almost in between DPHE No. 4 and Battelle pump. It may be called a modified Battelle pump suitable for a family or few families. It may also be called a Family Pump.

Observed Performances

Economy pump Sl. No. 1

The pump was in operation for 94 days since 19 September to 20 December 1973. The pump had been functioning quite alright during the period with a complaint of needing priming every few hours. The pump was installed in a heavily populated area. As time went on, water table was going down and in mid-December, the measured water table was at 26'0" from pump base. Since the mechanical advantage was only (1/4) of the shortened handle, people, especially the women, could hardly pump it and as such the pump was removed as per request of the users and replaced with a Battelle pump.

Pump Sl. No. 2

The pump was installed 15 November 1973 in a heavily used area. The average discharge of the well is 4.5 gallons of water in 75 seconds by 55 strokes. During the 69 days of its operation no parts were replaced or repaired. It was in operation throughout the period. The bearing

surfaces and bucket have not worn out in measurable degree. The well is inspected once every week. Users (1000) express satisfaction but have only one complaint: it needs priming every morning. Poppet valve does not retain water. Water depth measured on 31.1.74 : 28 ft from pump base.

Pump Sl. No. 3

The pump was installed on 23 November 1973 in the heavily used area. The discharge is 4.5 gallons of water in 80 seconds by 50 strokes. During the period of 61 days no parts replaced or repaired but the plunger follower fell down twice because of bad threads. The poppet valve works well. Users complaints a) small discharge; b) plunger follower falling down.

Pump Sl. No. 4

The pump was installed on 23 November 1973. The discharge is 4.5 gallons of water in 35 seconds by 42 strokes. No complaint, no repair, but the problem is that it needs priming every day in the morning but the users (1000) seem quite satisfied. Water depth as measured on 30.1.74 : 12 feet from pump base.

Pump Sl. No. 5

The pump was installed on 4 December 1973, but was removed by the users because of priming problem every now and then and also the plunger fell down several times. People did not like the pump due to the above reasons.

Pump Sl. No. 6

Working alright but discharge is small - about 1.5 gallons per minute.

Pump Sl. No. 7

The pump was installed about a month back on a No. 6 base having a flapper valve of leather. No complaint or problem except for small discharge of the well - 2 gallons per minute. For mechanical advantage the handle is extended by pushing a short piece of PVC pipe. People are not satisfied with the quantity of water. Water level measured on 31.1.74 is 23 feet from pump base.

Further test on modified pump No. 4

In the backyard of UNICEF office, a No. 4 modified pump was installed on a well whose water level was at 27 feet from base of the pump. This is considered an extreme case in terms of suction lift. The pump was tested with use of (a) poppet valve and (b) flapper valve system alternately.

Observations:

The poppet valve worked fine during and as long as the pump was in operation but failed to retain suction overnight.

The leather flapper valve worked better, produced more water and retained water overnight.

General Comments:

1. People in Bangladesh are mostly used to the No. 6 pump with $3\frac{1}{2}$ " piston diameter, average 6" stroke length. With the experimental well (modified No. 4) with 3" piston diameter and 4" stroke. at the very outset users expressed disappointment, because of a decrease in quantity of water per stroke. (In the No. 6 pump, the theoretical discharge is 0.25 U.S. gallons per stroke, No. 4 modified discharge is 0.125 U.S. gallons, i.e. 50% less per stroke.)

Users' reaction was being studied with the passage of time in all the 5 observation wells. In some cases, the users' dislike disappeared; perhaps because of one main reason: these wells did not have to be repaired during the period of their usage for about 2 months.

2. Observations on Battelle pumps:-

One of the Battelle pumps failed (Chawk Bazar mosque) due to very low water table - measured 31 feet from pump base. The pump was removed and the well capped.

Another Battelle pump failed at Jaydebpur (Dr. Jalal's house) because the plunger got separated from the piston rod. The same plunger was put back with jam nut. Other Battelle pumps are running O.K.

Additional Comments:

It has been generally agreed that the modified No. 4 pump is rugged, dependable and economical, using less than 50 pounds of pig iron. However, observation has shown that it will probably be desirable to revert to a 7" stroke if possible.

For this, there are two reasons. Firstly, a 7" stroke gives a greater output per stroke, especially in times of low water table. Secondly, and perhaps more important in the long run, a longer stroke will probably reduce the number of strokes per day on each pump, give a smoother pumping action, and combined with a longer piston rod, result in a smaller angle of deflection of the plunger, piston rod alignment.

All of this taken together should mean less wearing of moving parts. That is, by about an increase of 20-25% on the initial cost, the overall expenditure on spares during the life of the pump may be less, also the pump should give better performance. Thus the following line of action is being taken. Two prototypes are being developed. One a smaller, light-weight pump suitable for family use and areas with a dispersed population of smaller units, which calls for a relatively higher number of smaller capacity pump.

This prototype would be an off-take from the Maya No. 4 pump, but incorporating Battelle features such as PVC liner, 3" cup leather, 3/4" steel pins, cast iron rod end, jam nuts on piston rod, use of lockwashers on nuts and bolts for headcover and base plate, improved handle design and improved base plate design. It will have approximately a 5" stroke and weigh less than 50 pounds.

Another prototype based on the Maya No. 6 pump is being developed for the heavy duty community pump. It will have all the Battelle features as above. In addition it will have a stroke of 7"-8"; longer, heavier handle with higher ratio of mechanical advantage, and heavy duty flanges at top and bottom of the body to which the base and headcover will be held by four 2 1/2" x 1/2" nut-bolt and lockwashers. This pump will probably weigh about 65 pounds.

In addition, the new flange arrangement hopefully will permit the use of four nuts and bolts to attach the headcover to the pump body, and more importantly, two of the bolts will be at the "heel" position, that is immediately on either side of the fulcrum, which is the most critical place to have the nuts and bolts.

The other advantage of flanges is that they are both easier to cast than collars, and are stronger. The old collars used to break off now and then, making it necessary to replace the whole body of the pump.

The old No. 6 design had only three bolts, placed at 9 o'clock, 12 o'clock and 3 o'clock, relative to the fulcrum at 6 o'clock position. This new nuts-bolts configuration is expected to give a much sturdier attachment.

Another attractive aspect of using the traditional No. 6 body, to which flanges are simply added instead of collars, is that the foundries can use all their old patterns and core boxes, with very slight adaptations. This should reduce the capital cost and make it easier to get foundries to produce the new pump.

Having available two prototypes, will introduce a certain amount of flexibility into the programme. There are areas in Bangladesh and other countries as well, where the No. 4 variety will be adequate, and where the extra expense on the No. 6 variety would not be justified.

It is expected that the No. 4 pump would be adequate for population clusters of up to 100 people. This model may also prove popular and economical for a family pump. Where more than 100 people would be serviced by a pump, it would probably be advisable to use the heavier duty pump.

One rather attractive aspect of the dual design approach, is that all the moving parts, that is flapper valve, cup leather, steel pins, are all interchangeable between the No. 6 and No. 4 version. This is an extremely important feature in a country where such pumps are being introduced because it will minimize the problem of the most fast moving spare parts.

Since these prototypes are still in a fluid stage of development, it is being considered to keep the programme rolling, purchasing some 25,000

No. 6 pumps with PVC liner and No. 4 bucket, improved base and handle, but otherwise the same as under previous purchases. In addition, some of the 750 tons of pig iron available to the programme would be used to make spare parts to continue repairing the existing pumps.

Also, the rate of progress of the programme is not quite as fast as expected. It has thus been decided to allow three to five months more to continue to develop the new prototypes in a thorough and systematic manner. After about one more month it is expected that something near to a "final" design prototype will be in hand. It is then planned to produce several hundred of both the No. 4 and No. 6 prototypes. These would then be placed throughout the country under a variety of conditions, under the watchful eyes of various DPHE engineers, voluntary agencies and UNICEF field staff. After getting feed back on the performance and acceptability of these pumps, this office will then be better prepared to prepare detailed drawings and call forward production of the new pumps.

NIGERIAN FOUNDRIES LIMITED.

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15th February 1974

Mr. R. D. Fannon (Jr)
Cattello Memorial Institute
505 King Avenue, Columbus,
Ohio 43201,
USA

Dear Robert,

As I promised in my last letter of 31st October 1973, I hereby write to put you in picture of the performance of the well pump.

1. Flapper Valves:- Although we have not been able to use nylon fabric impregnated with neoprene, in making the flapper valves, we have used various types of rubbers. Apart from one occasion when the flapper lasted for eight months, in all the other cases, the life of the rubber flapper varied between a few days to two months.

As a result of these failures, from now on, we have decided to use poppet valves with rubber gasket.

2. One of the most important of all the findings that may interest you to know was the examination of the first pump installed in mid April 1973 which worked till the end of December 1973 when it stopped due to a cracked flapper in the plunger.

The condition of the PVC Cylinder and Cups Plunger was excellent. Above all, the two leather cups showed no sign of wear inspite of the fact that particles of red sand and mud were found in the PVC cylinder and plunger when examined.

The pump worked over eight months in a hospital in a rural area from where the whole village (Yala, South Eastern State, Nigeria) was taking water at an estimated frequency of 100 to 150 times a day.

Besides the good quality of the leather cups, I may say that the use of PVC cylinder may be responsible for the good results.

There is no doubt that the use of rubber flapper gave a big setback in the good performance of the pump.

We are now making efforts to replace all the flappers in the pumps delivered so far by poppet valves.

I shall be very pleased to hear from you on the subject.

Yours truly,
NIGERIAN FOUNDRIES LIMITED.

R. V. BARRINGTON
DIRECTOR