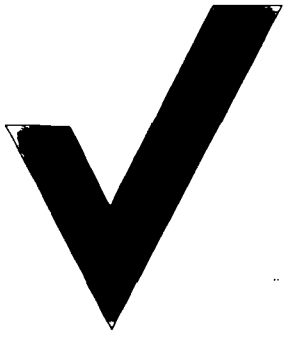
CA TESTING AND RESEARCH

TEST PROCEDURES
for
TESTING and DEVELOPMENT
of HANDPUMPS



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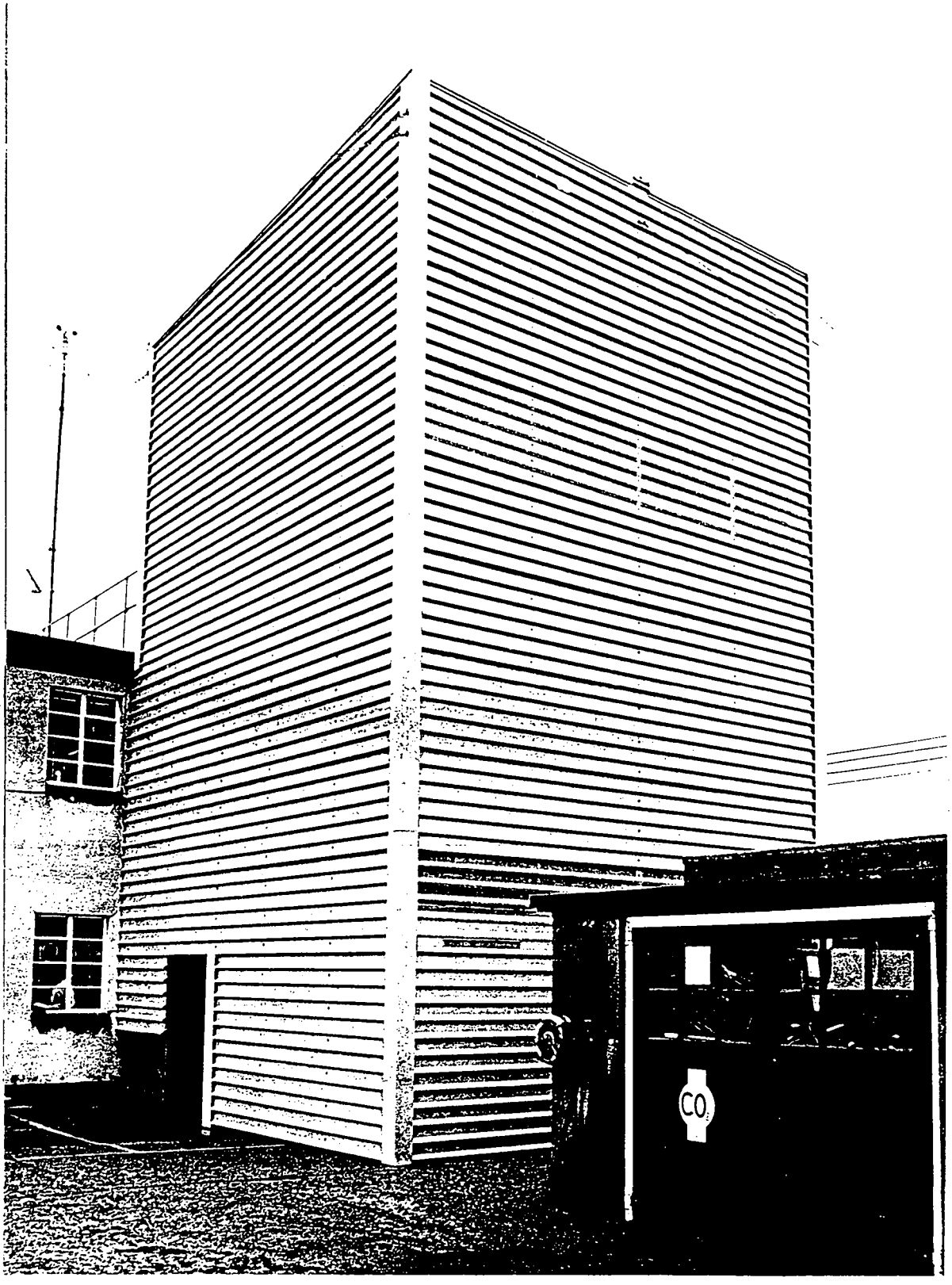
TEST PROCEDURES for TESTING and DEVELOPMENT of HANDPUMPS

HAND PUMP TESTING AND DEVELOPMENT

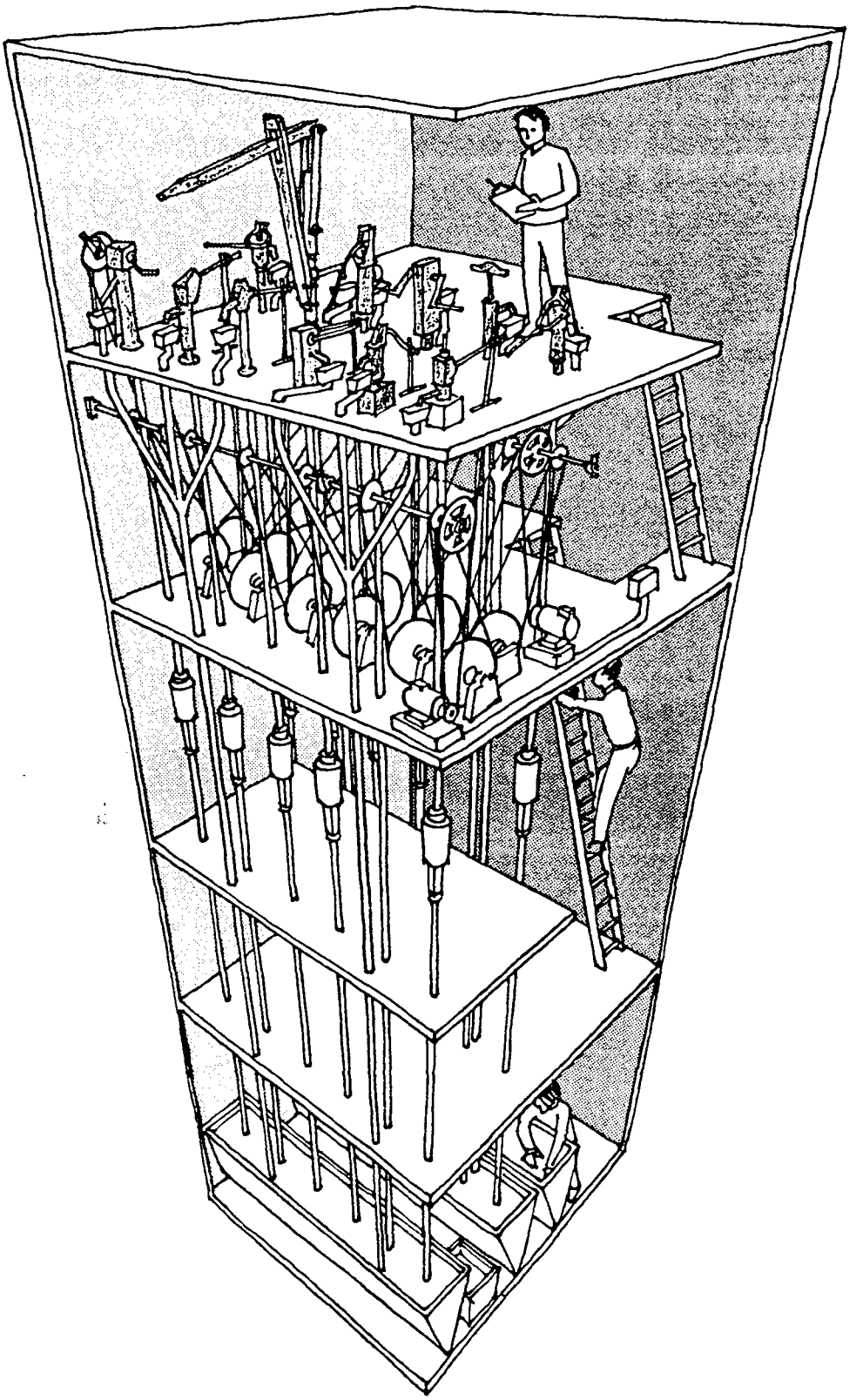
Consumers' Association Testing & Research have been involved with hand pump testing and development since 1977. Our unique approach to this activity reflects over 20 years of experience in the field of comparative testing of a very wide range of products.

This brochure shows some of the extensive facilities available for this work, and includes the Terms of Reference of the tests we undertake.

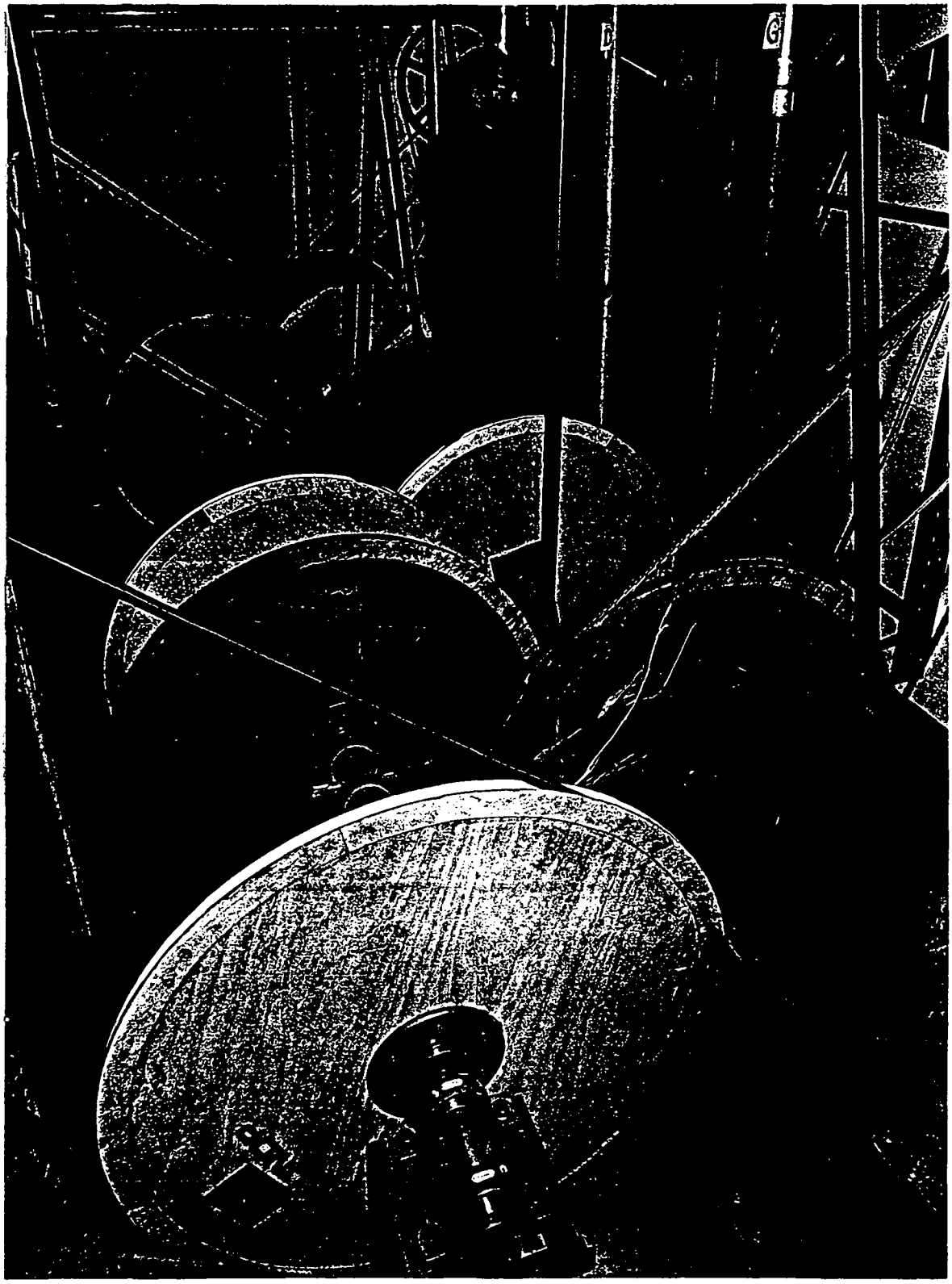
Please contact us for further information.



Pump Testing Tower, Gosfield Laboratory.



HAND PUMP TESTING TOWER



Mechanical drive systems for endurance tests

Calibration of Head Simulation Valves

HANDPUMP EVALUATION

SUMMARY OF STANDARD TEST PROCEDURES

1. Description
   - 1.1 Manufacturer or Agency
   - 1.2 Pump model and type
   - 1.3 Cost

2. Inspection
   - 2.1 Condition of Pumps
   - 2.2 Literature

3. Weights and Measures
   - 3.1 Weights of principal components
   - 3.2 Principal dimensions - use manufacturers data
   - 3.3 Cylinder bores - diameter only. Comment if bore is bad.
   - 3.4 Ergonomic measurements

4. Pump Performance
   - 4.1 Volume flow, work input and efficiency
   - 4.2 Leakage

5. User Trial
   - 5.1 User Comments
   - 5.2 Observation of users

6. Endurance Test

   Two stages of 2000 hours each

   - 6.1 Stage 1 - clean, hard water, approx. 7.2 pH
   - 6.2 Stage 2 - hard water to which Kieselguhr, with a particle size of 7.5 um, and sharp quartz sand with a particle size between 75 and 500 um are added in the concentration 1 gram each per litre of water.

   For stage 2 the water is agitated.

   At the 2000 hour stage, the volume flow and leakage are checked.
   At 4000 hours a full performance test is carried out and pumps dismantled for inspection.

   - 6.3 Failure Report. At any failure an assessment is made of the probable cause

7. Abuse Tests
   - 7.1 Handle shock load test at the endurance stroke rate, where applicable:
     96,000 impacts for force pumps
     72,000 impacts for suction pumps
   - 7.2 Side impacts on pumpstand up to 500 Joules.
   - 7.3 Side impacts on handles up to 200 Joules.

8. Engineering Assessment

- 8.1 Materials, manufacturing methods, fitness for purpose
- 8.2 Suitability for manufacture in developing countries
- 8.3 Ease of installation, maintenance and repair
- 8.4 Resistance to contamination and abuse
- 8.5 Potential safety hazards
- 8.6 Suggested design improvements

9. Verdict

10. Reporting

- 10.1 Interim report with Data Checking Sheets sent to pump manufacturer
- 10.2 Further interim report(s) where necessary, describing problems encountered during endurance test
- 10.3 Final Technical Report

DETAILED DESCRIPTION OF STANDARD TEST PROCEDURES

1. **DESCRIPTION** The test samples should be representative of the manufacturer's normal output. Wherever possible, sample pumps should be obtained through independent procurement agencies.

1.1 Manufacturer or Agency

Name and address of pump manufacturer and/or supplying agency

1.2 Pump model and type

Manufacturer's model reference
Deep or shallow well type
Free discharge or delivery lift

1.3 Cost

FoB

2. **INSPECTION** 2.1 Condition of pumps

Whether in working order as received.
Summary of defects on delivery.

The pumps will be dismantled and inspected for any visible defects. Further defects may come to light in the course of testing the pumps.

2.2 Literature

Whether supplied with pump or obtained from other sources.
Assessment of clarity, accuracy and usefulness.

In our experience, few pumps are supplied with literature. This is regrettable, since even the simplest installation instructions can be very helpful. Literature should be more visual than verbal, to minimise difficulties of translation.

3. **WEIGHTS and MEASURES**

3.1 Weights of principal components

Pump stand
Cylinder
Drop pipe per metre length,
Pump rods per metre length,
including couplings

3.2 Principal dimensions

Nominal bore and stroke
Nominal volume per stroke
Usable cylinder length

3.3 Cylinder bore diameter - comment only if bore finish is unsatisfactory

3.4 Ergonomic measurements

Measurements of handle and spout heights, angular movement and velocity ratio of handle, and description of exit water pattern.

Where a pump is mounted on a plinth, some of the ergonomic measurements will depend on the height of the plinth.
When such information is available, pumps will be installed at their manufacturer's recommended height. When it is not, the pump will be installed so that the midpoint of handle operation is as close as possible to 0.9 metres from floor level, subject to a maximum spout height of 0.6 metres. These preferred heights were suggested by previous user tests of handpumps

4. **PUMP PERFORMANCE**

4.1 Volume flow, work input and efficiency

Measurements of volume flow, work input and the efficiency of the pump can be combined in a single test procedure. Strain gauges will be attached to the pump handle to measure the applied forces, and a rotary potentiometer fixed to the body of the pump will measure the angular movement.

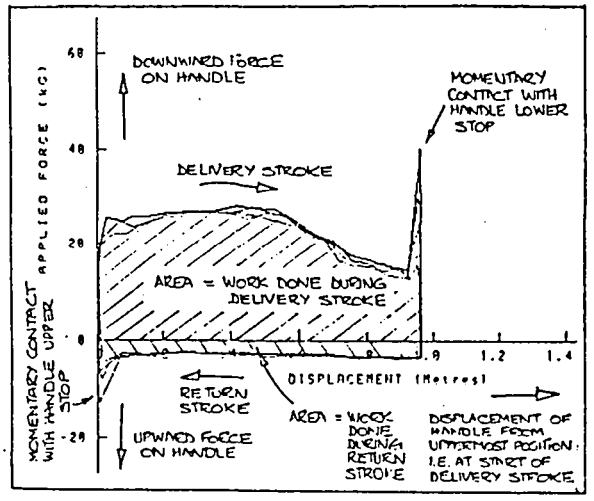
The outputs from the strain gauges and the potentiometer will be fed, via an interface unit, to a microcomputer. The computer is programmed to record the data and calculate the work done by the operator on the pump. The computer compares this work done on the pump with the work done by the pump in raising water (the product of the weight of water raised and the head) to calculate the efficiency of the pump. The strain gauges and potentiometer will be calibrated at the start of each test; the calibration procedure is built into the computer programme.

Shallow-well pumps will be tested at 7 metres head. Deep-well pumps will be tested at 3 heads - 7, 15, and 25 metres or 15, 25 and 45 metres, depending on the specification of the pump.

For each head, the pump will be tested at three operating speeds, normally 30, 40 and 50 strokes or revolutions per minute. Where 50 strokes/min would be impractical or unrealistic, 20, 30 and 40 strokes/minute will be used.

For each test, the computer will plot applied force on the handle against handle displacement. A typical result for a conventional reciprocating pump is illustrated.

Successive strokes retrace the force/displacement loop. The area inside the loop represents the work done on the pump.



4.2 Leakage

The volume of water leaking past the footvalve will be measured for the same heads as the tests of volume flow, work input and efficiency.

The leakage test will normally be carried out by removing the cylinder and one length of drop pipe. The cylinder will be filled with water and the open end of the drop pipe blocked off. The various heads will then be simulated by injecting compressed air above the cylinder.

5. **USER TRIAL**

A number of users will be recruited. Most will be women and children, of various heights and ages, with a small control group of adult men.

Each user will be given an opportunity to familiarise him/herself with the pump and to find their preferred method of operation. They will be asked to fill a 10 litre container in their own time. The number of strokes or revolutions and time taken will be noted. Deep-well pumps will normally be set at 20 metres depth.

5.1 User Comments.

Each user will be asked to fill out a short questionnaire to record their opinions of the ease of operation of the pump.

5.2 Observation of users.

Methodical observations of the relationships between pumps and people will be made, reinforced by selective video recordings.

6. **ENDURANCE TEST**

Two stages of 2000 hours each with a check test of volume flow after the first stage. The pumps will be mechanically driven, normally at 40 strokes or revolutions per minute, or the speed most appropriate to the pump design. The handles of the reciprocating pumps will be driven in simple harmonic motion imposing no shock loads. The simulated depth will be the maximum agreed with the manufacturer.

6.1 Stage 1 - clean hard water, approx. 7.2 pH.

6.2 Stage 2 - hard water with one gram per litre of Kieselguhr with particle size maximum 7.5 um and one gram per litre of fine sharp quartz sand of particle size between 75 and 500 um will be added.

For stage two the water will be agitated and daily checks made to ensure the correct concentration of contaminants is maintained.

6.3 Failure Report. Any failure is examined and an assessment made of the probable cause i.e. use of materials, design, bad quality control or manufacture. Arising from this failure suggestions for design improvements or manufacturing changes will be made.

7. **ABUSE TESTS**

7.1 Handle Shock Loading where applicable.

Controlled shocks will be applied to the handle stops using impacts determined by using a human operator where the handle is allowed to travel with the normal level of effort on to the stops.

Both deep-well and shallow-well pumps will be tested at a head of 7 metres, since for deep-well pumps the user is more likely to hit the handle on its stops when the pump is used at relatively shallow depths. The test will be carried out using the normal endurance stroke speed at a rate appropriate for the type of pump. The test will consist of 96,000 shocks for force pumps and 72,000 shocks for suction pumps, or until the pump fails.

7.2 Impacts on pumpstand

Using a pendulum, impacts in steps of 100 Joules to a maximum of 500 Joules, on the centre of the pumpstand.

7.3 Impacts on handle

Using a pendulum, impacts in steps of 50 Joules to a maximum of 200 Joules, on the centre of the pump handle.

8. ENGINEERING ASSESSMENT

The pumps will be dismantled. Each component will be examined and the material and method of manufacture assessed, together with the degree of skill demanded and the standard of workmanship. These together with the experience gained in installing and maintaining the pumps form the basis of the overall assessment of suitability for manufacture in developing countries.

8.1 Materials, manufacturing methods etc.

Identification of materials and manufacturing processes used for each component of the pump. Assessment of fitness for purpose of chosen materials and processes.

8.2 Suitability for manufacture in developing countries.

Summary of manufacturing processes required, with assessments of the degree of skill demanded for each process.

8.3 Ease of installation, maintenance and repair.

Assessment of techniques, skills and equipment required.

In assessing ease of installation, maintenance and repair, we will consider the degree of technical competence demanded by the design and construction of the pump, and whether it could be repaired using indigenous materials.

8.4 Resistance to contamination and abuse.

Assessment of sanitary sealing, of both pumpstand and wellhead.
Assessment of resistance to deliberate abuse, pilferage, impacts by domestic animals etc.

In assessing sanitary sealing, we consider the resistance of the pumpstand to accidental or deliberate contamination, and the likelihood of contamination of the well by surface water. Resistance to abuse includes both the likely susceptibility of the pump stand to impacts - from domestic animals, for example - and to pilferage or vandalism.

8.5 Potential safety hazards

Assessment of potential dangers of finger traps, insecure fastenings, projections etc. - to both pump users and bystanders.

8.6 Suggested design improvements

Suggestions for improvements in either pump design or manufacture, at minimal cost. We hope that these suggestions will stimulate a response from pump manufacturers.

9. **VERDICT**

A short summary of the main good and bad features of the pump and its performance. Comment on suitability for manufacture in developing country.

10. **REPORTING**

10.1 The first interim report will contain all information prior to the start of the endurance test - it will not be a comprehensive report, but rather will highlight the more important findings so far. It will include Data Checking Sheets, detailing the results for the particular pump This will give manufacturers an opportunity to comment on the testing to date, and to question any of the results relating to their pumps. We hope that this approach will encourage a dialogue with manufacturers.

10.2 Contacts will be made with the client as required where significant problems are encountered in endurance testing.

10.3 The final Technical Report will include full details of the pumps, test procedures, results, relevant drawings and photographs.

CONDITIONS OF ACCEPTANCE OF HANDPUMPS FOR TESTING OR EVALUATION BY CATR

Two options exist for submission of handpumps for testing or evaluation by the Consumers' Association Testing and Research Laboratories:

1. CONVENTIONAL TESTING.

The manufacturer or other sponsor of the test must agree in writing that the results will be available to the public, and may be published by the World Bank/UNDP Handpumps Project regardless of the test outcome. The manufacturer will be given an opportunity to comment prior to publication, especially in relation to design changes that will be made in response to the test results, but the inclusion of such comments in any published report will be at the discretion of CATR and the World Bank/UNDP Handpumps project. The manufacturer or other sponsor is required to pay a rental fee of £500 towards a CATR managed fund to offset costs of using the UNDP handpump testing tower. Other charges are to be agreed upon with CATR.

2. LABORATORY RESEARCH AND DEVELOPMENT.

For such work by CATR, the manufacturer or sponsor agree the research and development process, and the laboratory work does not constitute an independent standard test. The results will not be for public information and will not be published by the World Bank/UNDP Handpumps Project regardless of the outcome of any related testing, nor may CATR authorise others to publish the results. However, if and only if the manufacturer or sponsor approves, CATR will send a confidential report to the World Bank/UNDP Handpumps Project, which will not however be published. It is intended that such R & D will allow manufacturers to learn of and correct deficiencies in early products or prototypes, as well as more advanced products, without jeopardizing the reputation of a potentially good product.

KJM/EJW
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