

# Use and Care Instructions for your new



## Low Head Micro-hydroelectric Generator



Models: MHG-200LH

MHG-500LH

MHG-1000LH

Asian Phoenix Resources Ltd., Canada

## READ THIS FIRST

This manual contains important information concerning your new PowerPal low head micro-hydroelectric generator. It covers Models MHG-200LH, MHG-500LH and MHG-1000LH. You should read this manual before installing PowerPal or allow a trained technician from your local PowerPal Service Center to install it for you.

Your PowerPal generator is designed to be simple to operate and easy to maintain. If used in accordance with these instructions your PowerPal will give you many years of service. PowerPal is also designed with safety in mind, but any electric device can be dangerous if not used correctly. At several points in this manual, instructions requiring special attention that must be followed are shown as:



*Warning symbol - beware of hazards or unsafe practices that may cause injury or death.*



*Caution symbol – beware of hazards or unsafe practices that may damage the product.*

## SAFETY FIRST



*While electricity improves your life, it can also be dangerous if simple precautions are not followed:*

- Never allow electrical contacts to become wet. Beware of electrocution.
- Never attempt to cut electrical wires or open appliances for repair if the generator is working. Unplug the main cable first.
- Inform children of the dangers of electrocution. Never allow them to play with electrical connections.
- Keep fingers away from the moving propeller. If partly blocked with debris, remove the generator from the canal before cleaning.
- If you have any questions about safety, please ask your PowerPal Service Center.
- Product should be earth bonded (grounded).

## OPERATING CAUTIONS



*Your PowerPal generator is designed for simple operation and low maintenance. However, the following operating cautions must be followed to ensure a long life for PowerPal:*

- Under conditions of higher water flow rates than given for each model in this manual, PowerPal is able to generate higher power outputs than rated. This is a bonus, but only up to a limit. If maximum power consumption listed in this manual is exceeded then the copper coils in PowerPal may be irreparably damaged and require total rewiring. See the section on ‘Technical Specifications’.

PowerPal MHG units are designed to supply mainly resistive loads. For other types of loads, especially reactive loads (battery chargers, low voltage lighting transformers or similar), a cooling kit for the generator may be required.

Technical background: Reactive loads need reactive power as a surplus to the effective power. This surplus of reactive power can make the stator of the generator much warmer than acceptable. The temperature can rise above the curie-point of the rotor magnets and make them lose strength. When the windings of the stator become warmer than 120°C, the insulation will fail and short circuits can occur within the windings.

- Do not forget to grease the bearing at the recommended times. Failure to do this will result in excessive wear on the bearings and shorten their life. Always ensure that the Electronic Load Controller is set at approximately 110 or 220V, depending on your country. Otherwise, the life of lights and appliances may be reduced.
- Low frequencies will result if the generator rotor is rotating slower than usual. Low frequencies may prevent proper functioning of appliances such as televisions and will harm electric motors. PowerPal is designed to stop working if the rotor speed becomes too low, as the drag on the rotor becomes too great to sustain its rotation. This in-built mechanism is there to avoid problems associated with low frequencies. High frequencies will occur if the rotor is rotating faster than usual. This is due to either a high water flow rate or the use of a small load. It can be corrected by adjusting the flow gate, or by turning on another appliance to increase the load. High frequencies do not normally damage electric motors or affect television picture quality. Light bulbs are not affected by frequency but are affected by voltage.

## **POWERPAL COMPONENTS**

Inside your PowerPal box you will find:

- 1 x generator-turbine assembly
- 1 x electronic load controller
- 1 x spare lower bearing
- 1 x Guarantee Card
- 1 x this instruction manual.

Please advise immediately if any parts are missing. Complete your Guarantee Card and have it signed by your PowerPal dealer.

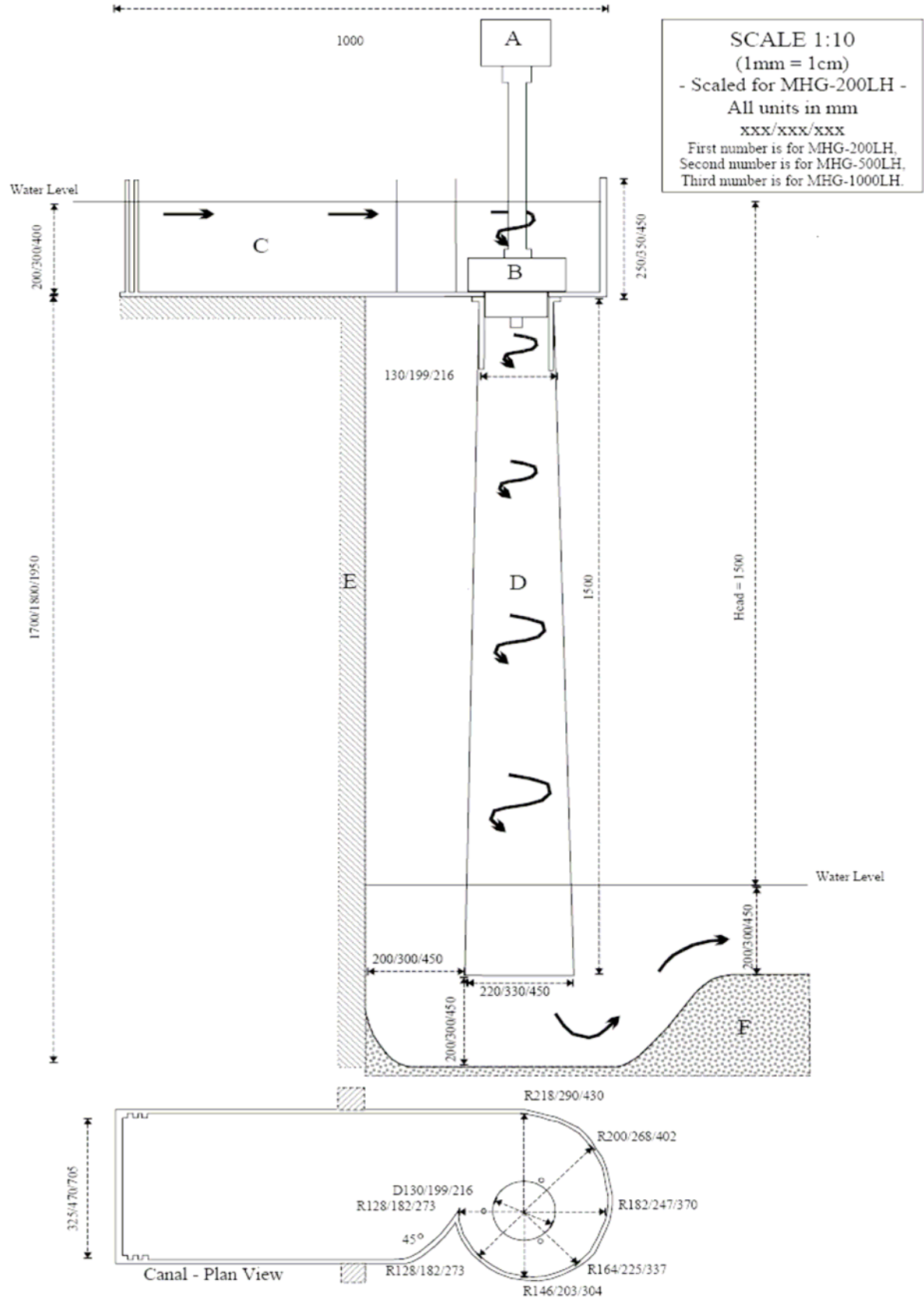
The PowerPal system consists of two major components – a hydroelectric generator and an electronic load controller. Other components are necessary and these can be manufactured locally. The water intake canal can be made from tin plate, wood, fiberglass or concrete. The water outlet pipe is usually made from tinplate. Your PowerPal dealer can advise you about this.

Therefore, other parts which are not included in the box but which are required to make PowerPal work are:

- 1 x water intake canal
- 1 x water outlet pipe
- electrical wire from generator to house. See the section on ‘Technical Specifications’ for the correct size wire.
- household wiring.

These are available from your dealer or local electrical store.

## SYSTEM DIAGRAM



This diagram shows how the non-electrical components fit together. Further reading of this manual will provide the necessary explanations. The components are:

- A. Alternator / generator
- B. Turbine
- C. Water intake canal
- D. Water outlet pipe
- E. Waterfall, dam wall, or cutting
- F. Stream bed.

The various measurements show how to properly construct and set up your system. The lower diagram (Canal – Plan View) shows the precise internal measurements in order to construct the water intake canal.

### SELECTING A SITE

PowerPal is designed for use in a wide range of locations. The most critical factor is sufficient water flow. Water flow is the amount of water that passes through the turbine at any instant, measured in liters per second (*l/sec*). The second important factor is head (see below). The following table shows the minimum flow rate and head to achieve the quoted power output for each model:

	MGH-200LH	MHG500LH	MHG-1000LH
Flow ( <i>l/sec</i> )	35	70	130
Head ( <i>m</i> )	1.5	1.5	1.5

### Measuring Flow

Flow can be calculated approximately by knowing the water speed. This speed, multiplied by the cross-sectional area of the intake canal will give you an idea of the flow rate. Minimum water flow *speeds* for each model are:

MHG-200LH: 0.54 m/sec.

MHG-500LH: 0.50 m/sec.

MHG-1000LH: 0.41 m/sec.

As a rule, say half a meter per second, or 5 meters in 10 seconds. Drop a leaf upstream and read the time it takes to travel the measured distance. Note that this method is only a guide and you will need a sufficient volume of water flowing at this rate to make the larger models work.

### Measuring Head

The head is the height from the water surface flowing into the turbine down to the water surface in the stream below. It is shown in the System Diagram.

This head should be 1.5 meters for all PowerPal models. If it is smaller then the power output will be reduced. If it is larger then your power output will be increased. While increased power output appears desirable, if the head is too large then the rotor will turn too fast and reduce the life of the bearings. Try to keep the head in the range of 1.4 meters to 1.6 meters.



*Do not attempt to exceed the recommended head height.*

## **SITE PREPARATION**

There are three basic situations that are suitable for installing PowerPal. They are:

### **1. Waterfall**

This is the simplest method. If your house is near a stream with a small waterfall around 1.5 meters high then you can use this as a platform. Minor modifications to channel the flow may be required.



Although this is the simplest method it is also the most affected by changes in stream flow. Rainstorms or dry periods may make site modifications necessary.

### **2. Dam**

If the stream is flat you may need to build a dam. It can be constructed from clay and river boulders, clay and bamboo (or other wood) or even concrete. The dam wall should be 1.75 meters high to allow for the head. If there is a waterfall less than 1.5 meters high it may be easy to use this as your dam site to keep the dam small. If, after constructing the dam the water flow rate is too high then a separate diversion channel will need to be cut into the dam wall to reduce the flow to the turbine.

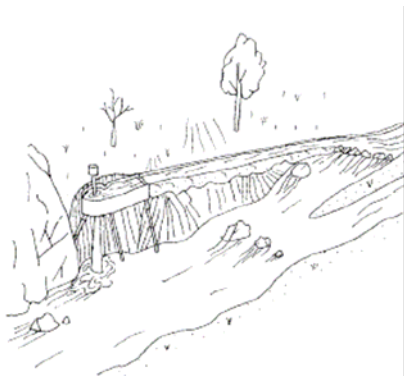


Dams have both advantages and dis-advantages. If used in a village setting they can provide additional uses as a fish pond and washing area. The dam wall may support a row of PowerPal generators so that several families can have access to electricity. If the village works together to build the dam the time and construction costs are lower. Dams are less likely to be effected by flooding if diversion channels are adequate, so PowerPal can be used effectively during the rainy season.

The flow rate is also much more stable than a waterfall set up. Disadvantages are the flooding of an area to make the lake, a land area that might be used otherwise. The more incised the stream, the smaller the lake.

### 3. Side Channel

This is an alternative to a dam and has the advantage of being simpler to construct while providing a good degree of stream flow control. It is suitable for incised streams with soil banks. Dig a trench along the bank parallel to the stream, starting at the upstream end where water can enter. The trench should follow the contour, i.e. be almost horizontal. Make the trench long enough so that when you have finished it is around 1.5 meters above the water surface in the stream below. Excavate this area so that the water can enter the trench, flow along it and exit back into the stream below. Some modifications may be required to achieve the required flow rate. Try inclining the trench floor in a downstream direction, or lining the trench with smooth material such as a plastic tarpaulin to reduce friction.

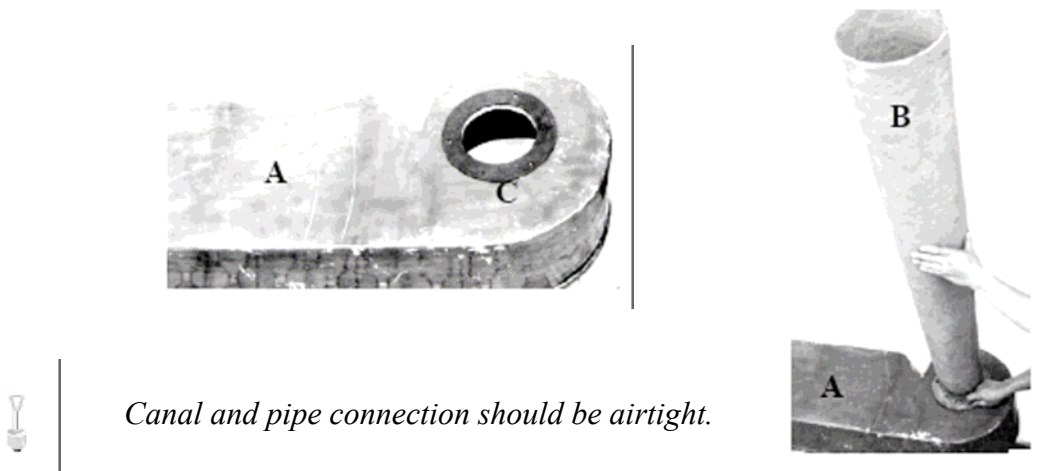


Simpler than a dam, it is most suitable for small villages or isolated houses. It also avoids the worst of flooding as most of the stream flow will follow the main stream channel.

## SYSTEM INSTALLATION

After locating a suitable site and completing the earthworks (if any), your PowerPal is ready for installation. To do this:

1. Connect the water intake canal (A) to the water outlet pipe (B). Insert the rubber seal (C) at the connection point. Bolt the canal and pipe together. Note that the connections should be airtight or performance will be significantly reduced.



2. Place the canal-pipe assembly in the stream and support the pipe end so that the pipe is not touching the stream bed. The lower end of the pipe must be at least 20 cm above the stream bed as well as at least 20 cm below the water surface (see the System Diagram). The water level in the canal should be at least 20cm and the recommended flow rate should be available. The base of the canal must be level, or horizontal. When installed correctly, a vortex should be observed over the hole that enters the pipe.
3. If provided, insert the debris screen into the upstream end of the canal, but not the flow gate.
4. Place the turbine end of PowerPal into the hole in the canal (shown below). This should be a good fit so that PowerPal is vertical and does not move from side to side. You will notice from the sound and gentle vibrations that PowerPal begins working immediately. If you do not notice this then there is a problem with your site. Check again that you have followed the initial procedures correctly. The lower bearing is lubricated by water so water must be allowed to enter the lower hole drilled in the shaft tube.





*Keep fingers away from the moving propeller.*

5. If the rate of water flow entering the canal is too high you will need to insert the flow gate to the required position to reduce this rate. One way to determine if the flow rate is too high is if the water level in the canal is too high. The water level should not be so high that it overflows the canal sides. Another indicator is the presence of ‘standing waves’, or stationary waves on the water surface in the canal. The water surface should be reasonably smooth, without stationary waves. If, after inserting the flow gate there is a high level of water turbulence you will have to reduce this. The easiest way is to modify the stream flow upstream of the canal. Use boulders or sticks to achieve the desired flow.

6. To avoid electrical shock, divert the water flow or remove PowerPal from the canal before proceeding to the following electrical connection.

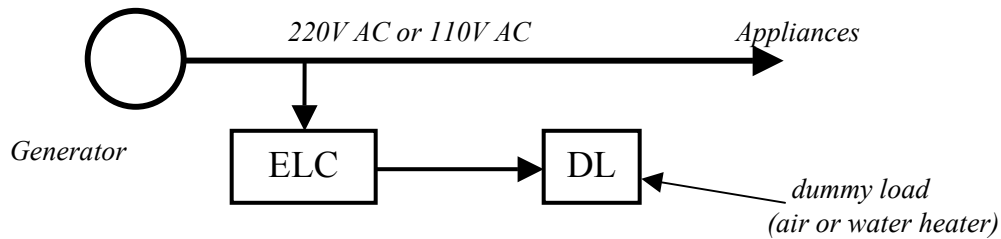
7. Earth-bond (ground) PowerPal. Do this by attaching one end of a suitable length of 0.75 sq.mm/A wire to PowerPal and the other end to a metal object or metal stake in the ground nearby PowerPal. Although the risk of electric shock is already low, this earth-bonding is still best practice.

8. Run the required length of two-strand, jacketed electrical cable from PowerPal to your house etc. Use 3.75 Ampere wire (0.75 sq. mm / Amp) for both MHG-200 and MHG-500 models. This is thicker than is required but thinner wires are more fragile. For the MHG-1000 model use 5 Ampere wire (1.0 sq. mm / Amp). Attach the electrical cable to the red and black connecting points on the PowerPal generator.



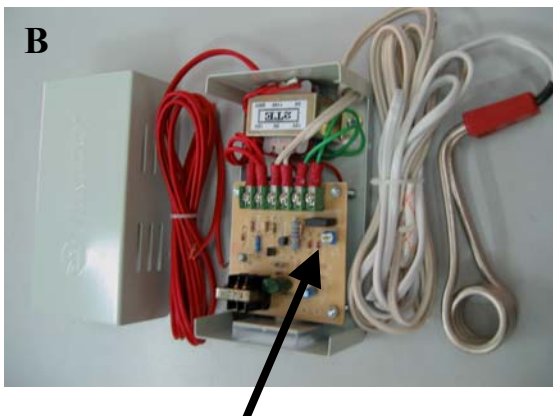
*Do not allow electrical contacts to become wet. Use dry hands. Beware of electrocution.*

9. Install the electronic load controller (ELC) in a dry place inside the house (or next to the generator) and connect the ELC’s two red wires to the end of the electrical cable to the generator.

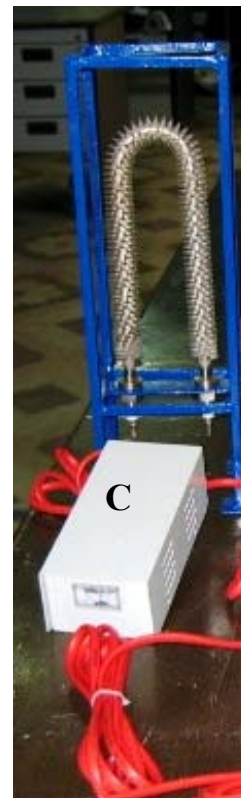


10. For both MHG-200 and MHG-500 models, place the dummy load water heater (A & B) attached to the white cable into a water tank of minimum volume 50 litres. The tank should be made of non-conductive material and the dummy load should be fully immersed. For the MHG-1000 model an air heater is supplied instead (C). The ELC is always positioned between the generator and any circuit breaker. Check all the connections again.

11. Observe the meter to check the operational state of the ELC - is the voltage at 220V or 110V (depending on your country) when the water is let into the turbine? If the voltage still increases, then stop and check the connections, and the voltmeter. Adjust the potentiometer on the circuit board (B) slowly until the voltmeter reads 220V or 110V.



*Adjust voltage here*



#### **About the electronic load controller**

The water turbine captures the water's energy and converts it into electricity. The generator's output voltage is dependent on the load consumption. When there is no power being consumed, the output voltage can reach 300V (or 150V)-. This output voltage will decrease with any increase in power consumption. The electronic load controller is used to eliminate this excess output voltage so that it is safe to use household appliances.

12. You can now plug lights and appliances directly into the ELC ready for use, with or without additional house wiring or a circuit breaker. The voltage needs only to be checked and adjusted if the water flow rate changes. Heavy rain may increase the flow rate, or a prolonged dry period may gradually reduce it. Check the voltmeter from time to time and adjust the ELC if necessary.



*Avoid plugging appliances directly into PowerPal without using the load controller. Incorrect voltage may result, which can damage your appliance.*

## **CARE AND MAINTENANCE**

General care for your PowerPal will enhance its life. Following the instructions in this manual is important.

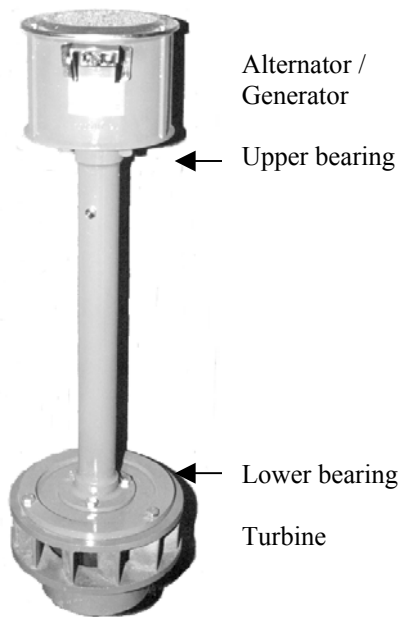
If flooding causes the inside of the generator assembly to become wet, remove the cap and leave PowerPal in the sun to dry. No permanent damage will result, but check the upper bearing to see if it has collected water. If so, turn PowerPal upside down to drain and dry the internal shaft assembly. Do not try to dry it near a fire as the rotor is bonded with epoxy that could be damaged by excessive heat. Before using again, make sure that the power socket is also dry. Condensation inside the generator is normal in tropical areas and will not effect the performance of PowerPal.

There is only one task that must be completed at regular intervals. This is greasing of the upper bearing assembly.

### **Greasing the Bearing**

PowerPal has three bearings, two at the top of the shaft below the generator and one at the bottom of the shaft above the turbine. The upper bearing assembly consists of two steel ball bearing units placed 5cm apart\*. One is sealed and requires no greasing while the other has been greased in the factory ready for use and requires re-greasing through the grease nipple every 3 months of continuous use. Two cubic centimeters of grease is enough. The bottom bearing is made of polyamide composite material and is lubricated by water. No greasing is required.

\* Note – this applies to models MHG-200LH & MHG-500LH. If you have purchased model MHG1000-LH you may find one of the upper bearings located above the generator and one below the generator. The bearing below the generator requires greasing (near the grease nipple).



*Failure to grease the bearing on time will shorten its life and require its replacement. The increased friction will also reduce power output. Always dry PowerPal before greasing.*

## TROUBLESHOOTING

If any problems are encountered, check this section before contacting your Service Center.

*1. Head and flow conditions appear to be OK, but PowerPal will not work.*

It is likely that the system has been installed incorrectly. Check this. If still not working, remove the cap from the generator and use your fingers to quickly turn the nut on top of the rotor. If the rotor begins to spin freely then PowerPal is working.

*2. PowerPal has provided electricity for a while and suddenly the electricity stops.*

If this instruction manual is not followed and power consumption is too high, or if there is a short circuit in an appliance the overcurrent protection relay in the electronic load controller will trip. Remove the excess load and press the overcurrent protection relay button on the ELC to reset.

*3. Testing in the stream showed that PowerPal was capable of producing the rated output power (200W, 500W or 1000W, depending on model). However, after running the electrical cable to the house this output power was found to be less.*

Due to resistance from the cable, long cable runs will result in a small loss of output power. Power loss over a 100m cable run is approximately 10W. If the loss is greater than this it means that the wrong diameter cable was used.

*4. Power output has been falling recently.*

Falling output suggests that the turbine is rotating more slowly than usual. Check that the canal and propeller are free of leaves and other debris.

5. *Frequency varies too much to safely use an appliance that is rated for use at a specific frequency.*

If an exact frequency is required for frequency-sensitive appliances it will be necessary to attach a battery system.

6. *An appliance is supposed to be grounded (earthed).*

PowerPal is not grounded by its position in the stream. If grounding is required for certain appliances it will be necessary to ground them separately. The usual method is to run a wire from the earth pin to a metal stake in the ground outside.

## TECHNICAL SPECIFICATIONS

	<u>MHG-200LH</u>	<u>MHG-500LH</u>	<u>MHG-1000LH</u>
1 Rated power output	200W	500W	1000W
2 Maximum allowable load	250W	650W	1200W
3 Intended voltage	110 / 220V~	110 / 220V~	110 / 220V~
4 Frequency at rated power output	50-60 Hz	50-60 Hz	50-60 Hz
5 Frequency at runaway speed	75 Hz	75 Hz	60Hz
6 Rotor runaway speed	1500rpm	1500rpm	1200rpm
7 Weight	16kg	32kg	75kg
8 Height	68cm	78cm	92cm
9 Diameter	20cm	30cm	42.5cm
10 Generator	Single phase permanent magnet alternator		
11 Rotor characteristics	NdFeB 3-pair pole permanent magnet		
12 Stator wire size	0.5mm	0.7mm	1.0mm
13 Load controller fuse	1.0A	2.5A	5.0A
14 Upper Bearings size – greased	2 x 6203	2 x 6204	1206
Upper bearing size - sealed			6004-2Z
15 Recommended cable	0.50sq.mm/A	0.75 sq.mm/A	1.50 sq.mm/A
16 Operating temperature	5 to 50 ° C	5 to 50 ° C	5 to 50 ° C
17 Operating humidity	0 to 90%	0 to 90%	0 to 90%

### Notes:

1,2. Rated power output is the manufacturer's specified output for the given head and flow conditions. A higher output is possible if the head is greater or the flow is faster than recommended. If the maximum allowable load is exceeded then permanent damage to the stator may occur.

3. Is approximately 110 / 220V when the ELC is used.

5,6. Runaway speed is the speed of the rotor if no load is applied. This speed is reduced under load.

14 We recommend SKF brand or similar high quality bearings.

## DECLARATION OF CONFORMITY

We,  
Asian Phoenix Resources Ltd.  
2-416 Dallas Road  
Victoria, BC V8V 1A9  
Canada

Declare that the products described within are, in accordance with Directive 73/23/EEC – the Low Voltage Directive, in conformity with the following standards:

EN 61116:1995 Electromechanical equipment guide for small hydroelectric installations  
and

EN 61362:1998 Guide to specification of hydroturbine control systems.



D. L. Seymour  
Authorized signatory

25<sup>th</sup> March, 2008