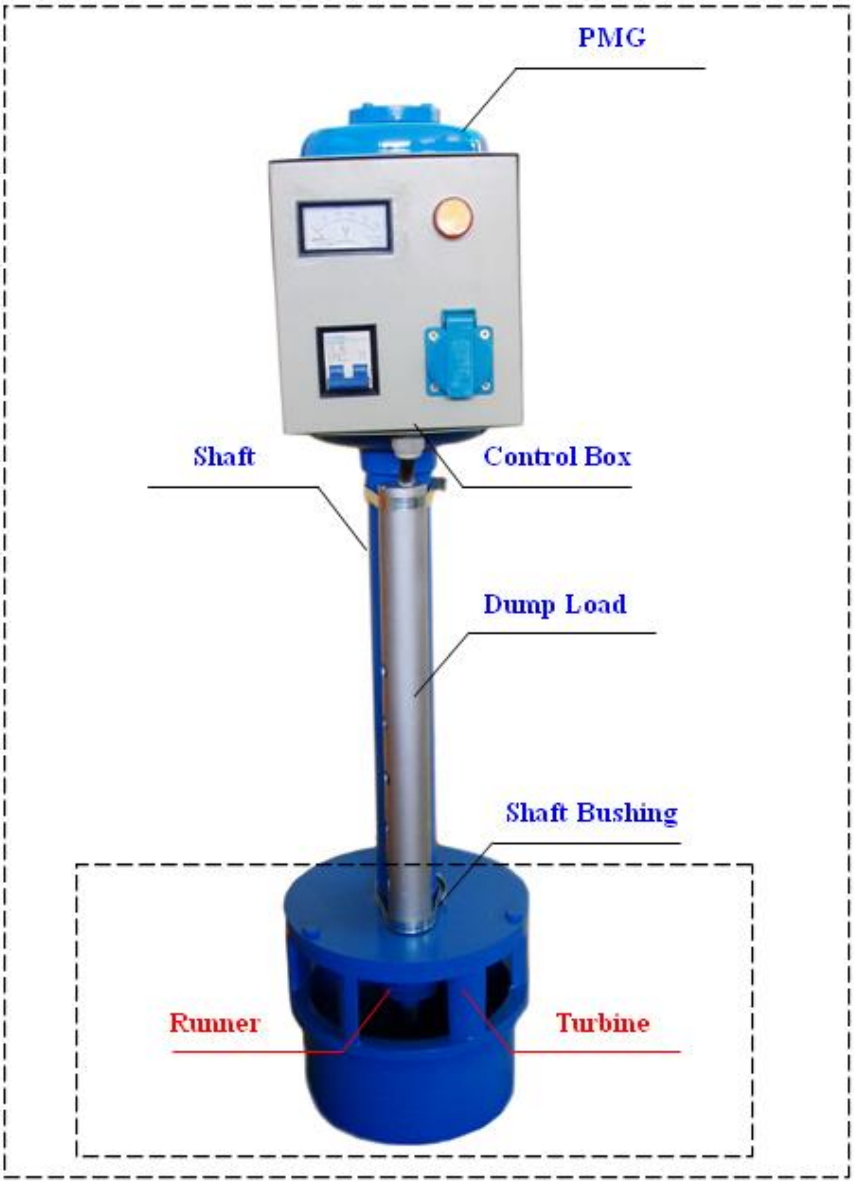
Use and Care Instructions for

ZD series Low Head Micro Hydroelectric Generator

Models: ZD1.8-0.3DCT4-Z
ZD2.0-0.5DCT4-Z
ZD3.0-0.7DCT4-Z
ZD3.5-1.0DCT4-Z



READ THIS FIRST

This manual contains important information concerning your new ZD series low head micro hydroelectric generator. It covers Models ZD1.8-0.3DCT4-Z, ZD2.0-0.5DCT4-Z, ZD3.0-0.7DCT4-Z and ZD3.5-1.0DCT4-Z. You should read this manual before installing or allow a trained technician from your local distributor.

The ZD series are designed to be simple to operate and easy to maintain. If used in accordance with these instructions they will give you many years of service. ZD series are also designed with safety in mind, but any electric device can be dangerous if not used correctly.

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 local distributor.

Product should be earth bonded(grounded).

OPERATING CAUTIONS

ZD series hydroelectric generators are designed for simple operation and low maintenance. However, the following operating cautions must be followed to ensure a long life for it.

Under conditions of higher water flow rates than given for each model in this manual, ZD series are 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 Low Head Generator may be irrepairably damaged and require total rewiring. See the section on ‘Technical Specifications’.

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 110V or 220V, depending on your country. Otherwise, the life of lights and appliances may be reduced.

COMPONENTS

Inside your machine box you will find:

1 x generator-turbine assembly

1 x electronic load controller mounted on the generator
1 x spare 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 local distributor.

BRIEFING

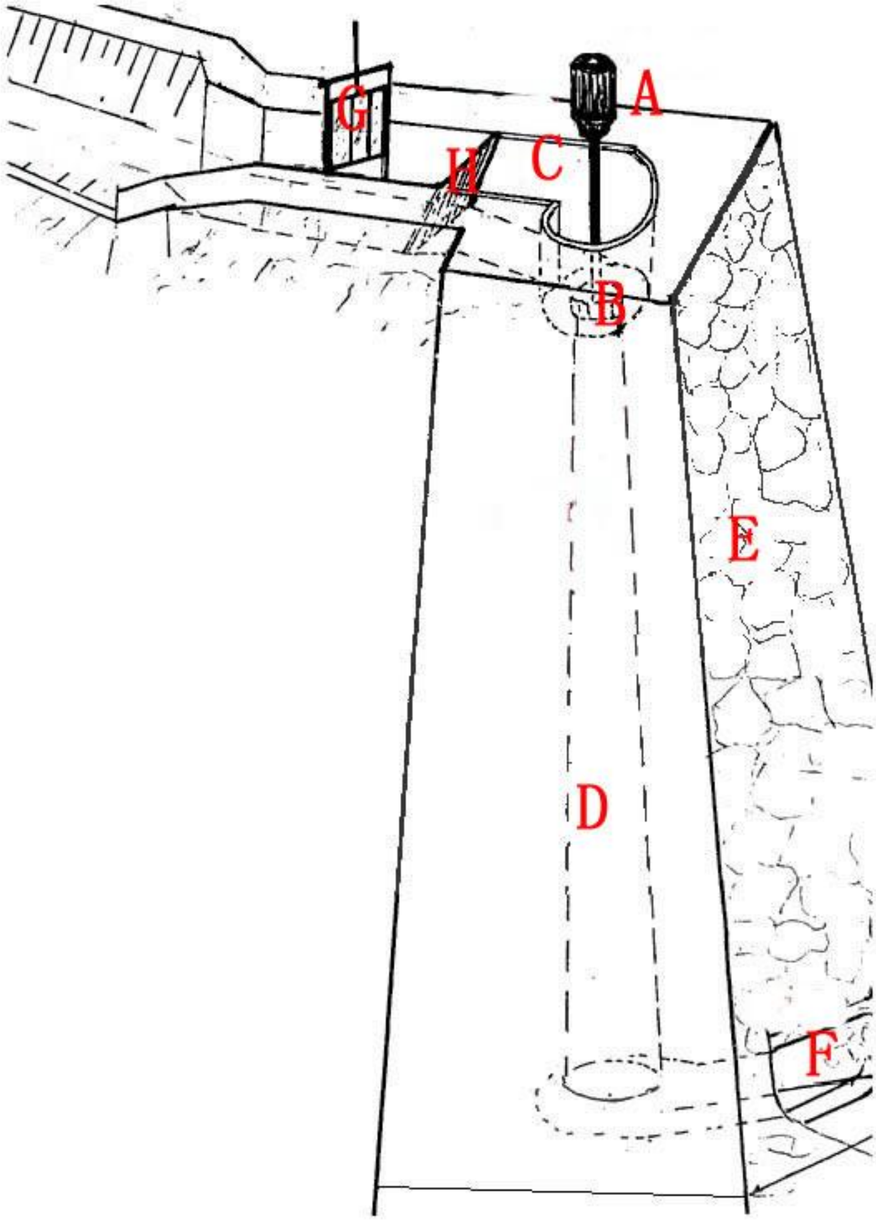
The ZD series are AC direct systems consist of a turbine-generator unit producing AC power which is used as needed. That is, it is fed directly to the appliances. Governing of such a system is done electronically by a electric load controller(ELC). In order to maintain the correct voltage and frequency within the parameters required, the power is monitored and that which is not used by the appliances is directed to an alternate load,

The ZD series consist 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 ZD series dealer can advise you about this.

Therefore, other parts which are not included in the box but which are required to make ZD series 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.
These are available from your local electrical store.

SYSTEM DIAGRAM

The following 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

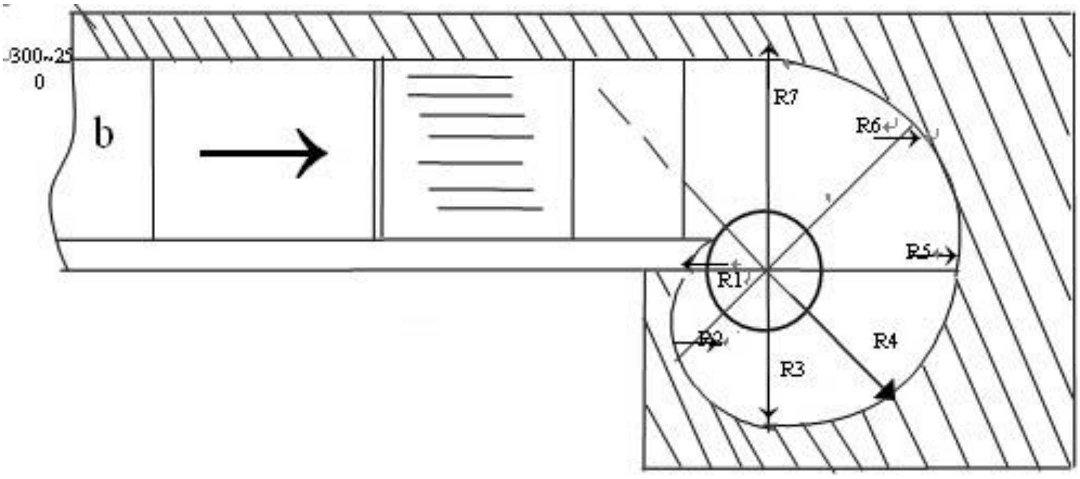
F. Stream bed.

G. Water gate

H. Debris screen

I. Spillways

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

The ZD series are 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. The following table shows the minimum flow rate and head to achieve the quoted power output for each model:

Model	ZD1.8-0.3DCT4Z	ZD1.8-0.5DCT4Z	ZD2.0-0.7DCT4Z	ZD2.5-1.0DCT4Z
Head (m)	1.6 ~ 1.8	1.8 ~ 2.0	2.0 ~ 2.2	2.3 ~ 2.5
Flow(l/sec)	40	45	50	50
Power(W)	300	500	700	1000

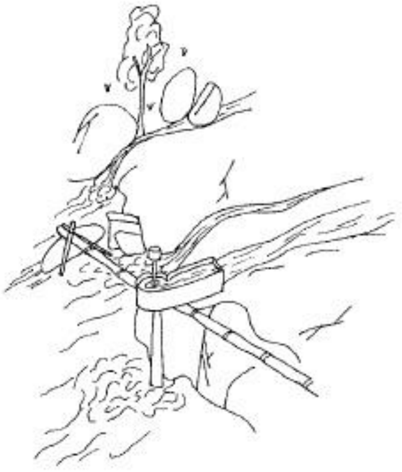
It is important to keep in mind that output can only be accurately determined if head and flow measurements are made correctly, so care should be taken during this process. If water head and water flow is smaller than required, then the power output will be reduced. Two other important factors in a site assessment are system voltage, and transmission distance. The voltage and distance the power must travel can affect the efficiency and cost of your transmission lines.

SITE PREPARATION

There are three basic situations that are suitable for installing ZD series hydroelectric generator. They are:

1. Waterfall

This is the simplest method. If your house is near a stream with a small waterfall around 2.5~4 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 even concrete. The dam wall should be 2.8meters high to allow for the head. If there is a waterfall less than 2.5 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.

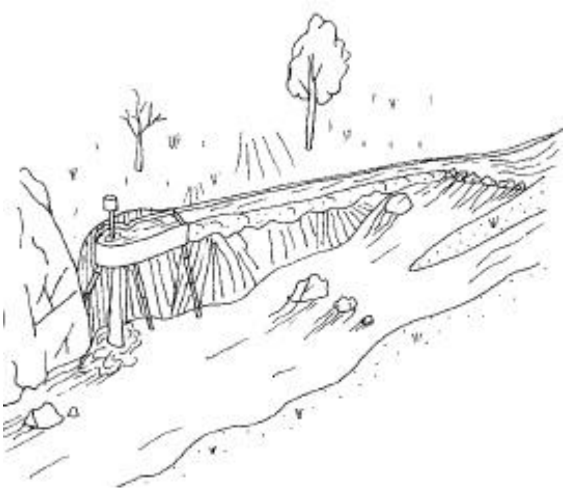
Dams have both advantages and disadvantages. If used in a village setting they can provide additional uses as a fish pond and washing area. The dam wall may support a row of ZD generators so that several families can have access to electricity. If the village works together to build the dam the time and construction costs are lower. Dams are less likely to be effected by flooding if diversion channels are adequate, so ZD 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 2.5 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 liming the trench with smooth material such as a plastic tarpaulin to reduce friction.



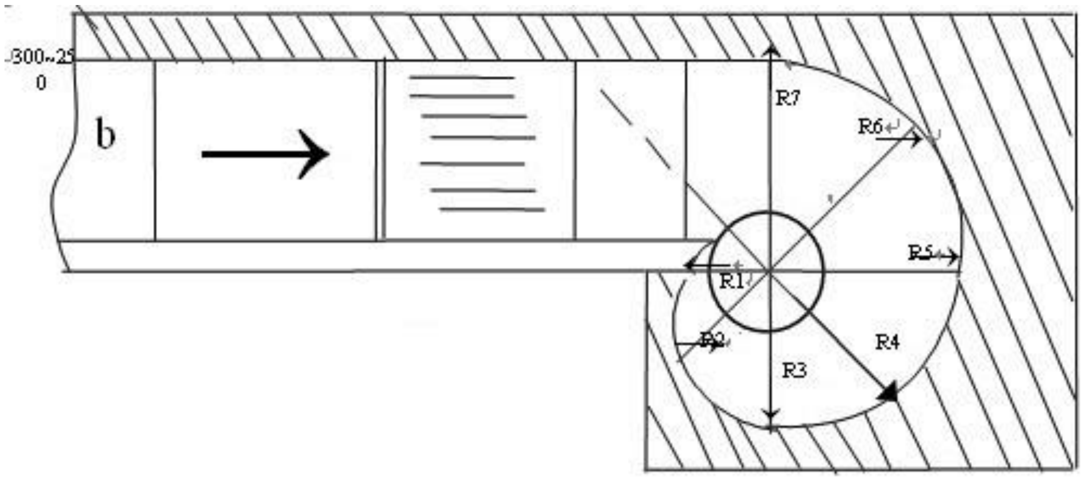
Simpler than a dam, it is most suitable for small villages or isolated houses. It also avoids the worst of flooding as most of the stream flow will follow the main stream channel.

ELECTRONIC LOAD CONTROLLER

Water turbine, like petrol or diesel engine, will vary in speed as load is applied or relieved. This speed variation will seriously affect both frequency and voltage output from a generator. Traditionally, complex hydraulic or mechanical speed governors altered flow as the load varied, but we have developed an electric load controller(ELC) which has increased the simplicity and reliability. We amount ELC directly on the generator. The ELC prevents speed variations by continually adding or subtracting an artificial load, so that in effect, the turbine is working permanently under full load. A further benefit is that the ELC has no moving parts, is very reliable and virtually maintenance free. The advent of electronic load control has allowed the introduction of simple and efficient, multi-jet turbine, no longer burdened by expensive hydraulic governors.

SYSTEM INSTALLATION

1）Construct the water intake canal(B) and the water outlet pipe bed from river boulders, bricks, clay and concrete(see the drawing 1 and 2).



Drawing 1

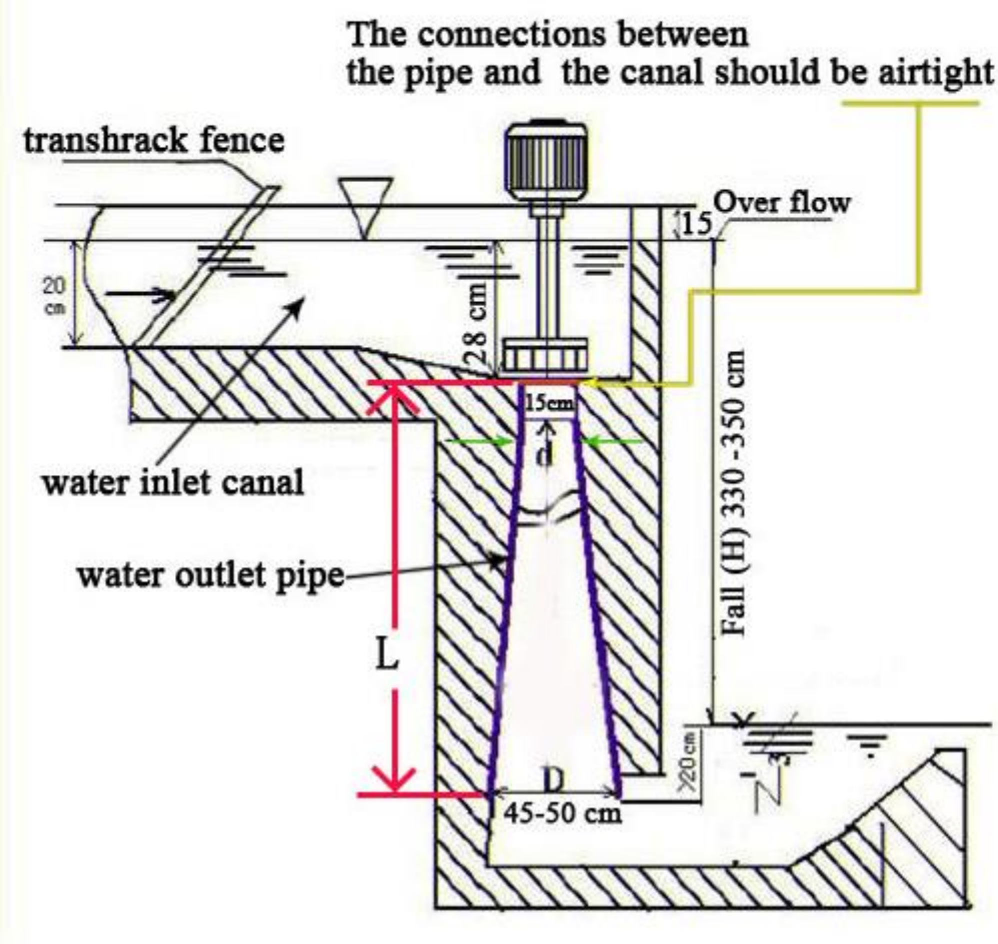
Model	Diameter	Canal size Width/height	R1	R2	R3	R4	R5	R6	R7
	100	200x250mm	106	136	150	176	200	226	251
ZD-0.3KW ZD-0.5KW	120	250x300mm	130	167	185	217	247	280	311
ZD-0.75KW ZD-1KW	150	300x350mm	158	203	224	263	299	338	376
	200	400x400mm	180	230	250	280	320	350	400
	250	600x600mm	210	250	280	310	340	380	450

Note : the connection point of the water outlet pipe to the intake canal should be airtight or performance will be significantly reduced(see drawing 2)

2）Make the water outlet pipe mold from steel sheet and pour it into the bed with concrete. 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 tube.

3）Make a debris screen and insert it into the upstream end of the canal, but not the flow gate.

4）Place the turbine end of ZD into the hole in the canal and insert it into the upper end the water draft tube. This should be a good fit so that ZD is vertical and does not move from side to side. You will notice from the sound and gentle vibrations that ZD 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.



Drawing 2

Tail water pipe size	L	d	D
（mm)	(m)	(mm)	(mm)
Diameter100（ ZD1.8-0.3DCT4-Z）	2～2.8	120	300
Diameter120（ZD2.0-0.5DCT4-Z& ZD2.2-0.7DCT4-Z）	1.6～2.8	140	400
Diameter150（ ZD2.5-1.0DCT4-Z）	1.6～3.5	170	500

5）To avoid electrical shock, divert the water flow or remove ZD from the canal before proceeding to the following electrical connection.

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

6) Run the required length of two-strand, jacketed electrical cable from ZD to your house etc. Use 5 Ampere wire(1.0 sq. mm/Amp) for model ZD1.8-0.3DCT4-Z and model ZD2.0-0.5DCT4-Z. This is thicker than is required but thinner wires are more fragile. For the model ZD2.2-0.7DCT4-Z and model ZD2.5-1.0DCT4-Z use 7.5 Ampere wire(1.5 sq. mm/Amp).

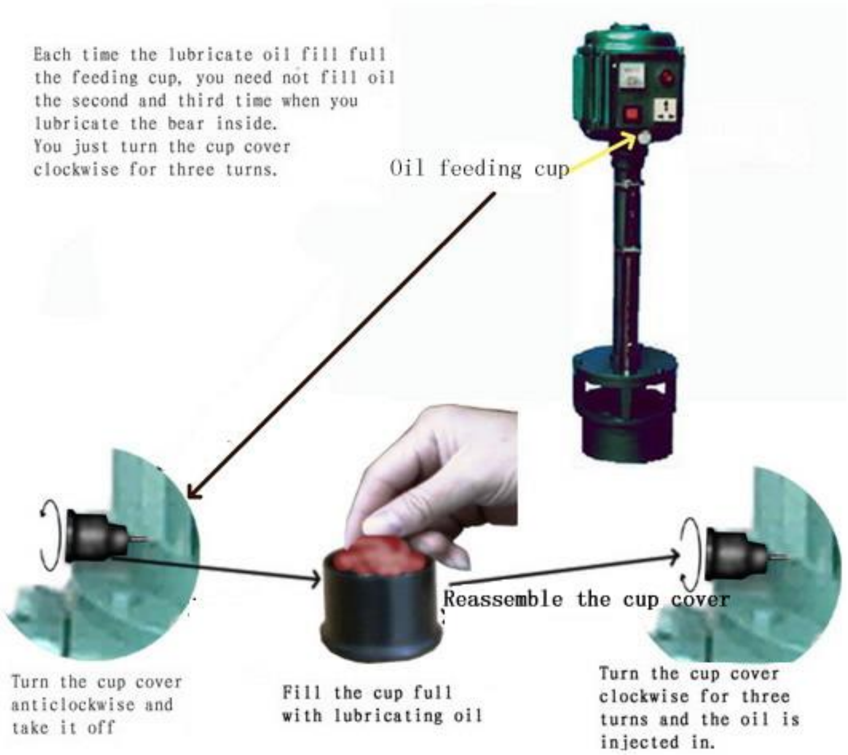
OPERATION

1. Check that the power conduit and forebay are free of debris.
2. Ensure that the turbine is shut down and that all supply lines are electrically dead. The switch on the Electric Load Controller must be in the off position.
3. Fill the forebay and allow the water to flow freely into the water intake canal.
4. As the water flow starts to create electric power, the voltage will rise until the voltmeter on the ELC reads 230V.

Operate like this for 15 minutes while observing any unusual noise, excessive temperature or other problems and if OK then switch on the power to the user.

CARE AND MAINTENANCE

There is only one task that must be completed at regular intervals. This is the greasing of the bearings inside the turbine



Each time the lubricate oil fill full the feeding cup, you need not fill oil the second and third time when you lubricate the bear inside.
You just turn the cup cover clockwise for three turns.

Turn the cup cover anticlockwise and take it off

Fill the cup full with lubricating oil

Turn the cup cover clockwise for three turns and the oil is injected in.

When considering a micro-hydroelectric installation, one of the primary issues is whether it will be all AC direct system or battery based system.

AC direct systems consist of a turbine-generator unit producing AC power which is used as needed. That is, it is fed directly to the appliances. Governing of such a system is usually done electronically, with reliable, off-the-shelf equipment that is readily available. In order to maintain the correct voltage and frequency within the parameters required, the power is monitored and that which is not used by the appliances is directed to an alternate load, such as heating. This also means that the appliance load can not exceed the power generated, as this win result m system collapse. The generated power is monitored cycle by cycle and is diverted as required.

In a battery based system, the generated power is used to charge a battery bank, then the power is sent to DC loads, or to an inverter to power AC loads, or both. Regulation consists of diverting excess power to an alternate load to prevent battery overcharge. The battery/inverter combination can provide large surges of power to handle loads such as pumps, lights, tools etc. As well, with battery based systems, other sources of power call be easily integrated (i.e. PV cells, or wind turbines) and fed to the batteries.

An AC direct micro-hydroelectric scheme is simpler in its overall design than battery based systems, and for this reason they are sought by many people. However, the output of AC direct systems must be capable of handling all of the power requirements at any instant, which can be substantial when startup surges are considered. For instance, incandescent lights typically require ten times their running current at turn-on; induction motors, such as those typically found in refrigeration and water pumps, may require five to seven times their operating current for starting. This power must be available when needed for the system to continue functioning, as exceeding its capacity win cause an electrical collapse. Since AC power cannot be stored, and kinetic energy can, the addition of a flywheel to the turbine can help carry the system through such power overdraughts. A battery based system stores the generated electricity chemically, and so only the average usage needs to be generated. The batteries handle the peaks and valleys of the electrical loads. The generation components of the system can even be taken out of service for repairs or maintenance without immediately affecting the power delivered to the loads.

Both AC and battery based systems can supply AC power to appliances that is indistinguishable from commercial power. The AC direct system usually requires far more power to be generated than in a battery scheme. This may be the most important factor in determining the system type at any given site. As an example, when a refrigerator drawing running power of 200 W starts, there is a surge of less than a second during which it may require up to 1500 W. If this power is not available, beyond the other loads operating coincidentally, the system voltage will drop to the point of failure. AC direct systems, for these reasons, seldom have a capacity of less than 2 kW. This contrasts with battery systems which typically require generator outputs of around 300 W in order to meet the needs of standard household electrical loads (excluding heat). Exceptions to this are some residents who use AC direct induction systems to produce only a few hundred watts to meet their needs for lighting and small electrical appliances (mention was made of a system of this sort in the September 1998 issue of Renewable Energy World, 'Long Distance Power Transmission for Renewable Energy Systems', p. 72). Note that if power on this scale was used to charge batteries, then far more substantial loads could be sustained. The big advantage to the large output AC direct systems is that they meet the need for appliances and lighting while the excess power is usually sufficient to meet all the hot water needs and most, if not all of the space heating requirements.

If there are sufficient resources to implement an AC direct micro-hydro system, there arises one significant consideration: the infrastructure required to complete such a system is much more weighty, both physically, and in the finances necessary to procure it at the outset, than that of a battery charging system. Firstly, the pipeline used to feed a battery scheme is seldom larger than 6 inches (about 15 cm), and is typically 4 inches (10 cm) or less. Compare this with the much larger piping necessary to carry the flows required for AC production, and the price difference can be prohibitive, not to mention the considerable toil and expense required to move and bury large-scale pipe. Secondly, consider the power generating components, and the equipment necessary to support them. Beginning at the pipeline, the differences between the AC direct and the battery based systems can easily be seen, primarily, in the actual size of the generators. Usually, a generator that produces a few hundred watts can be on the scale of the typical automotive alternator, while a generator in the multi-kW range is certainly much larger, and depending on whether it is a synchronous or induction generator, the price can be even more disproportionate. Add to this the turbine runners that would necessarily be much larger in the AC system, and one can easily see how the initial costs involved in the generation components would outweigh a battery based micro-hydro generator. From the generator, leading to the point of usage, run the conductors, in the form of copper or aluminum wire. The size of the wire is dependent upon the voltage and current of the transmission and the distance over which it is to travel. In long distance situations, AC travels well as it is usually high voltage, thereby minimizing line loss on a given wire gauge; in battery based schemes, the voltage is determined by the battery bank, so in the cases of low voltage battery banks, transformers may be necessary in order to step, then step down voltage, so as to minimize line loss. Large gauge wire can be used to the same effect. On the side of battery charging systems, if the transmission distance is modest, the wire gauge necessary to conduct hundreds of watts is significantly smaller than that required to carry thousands.

While there are many factors to consider when choosing a micro-hydroelectric scheme, if the pertinent details involved are given adequate attention, an optimal solution can be found for the generation potential of any given site. It is hoped that the information necessary to begin this process has been summarized in this article so as to be a starting point for the system designer where ever the site may be.