The LH1000

Low Head Propeller Turbine

Personal Hydropower

Ownerõs Manual

PLEASE READ CAREFULLY

Made in Canada

by

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Congratulations on your purchase of a new *LH1000*! With a proper installation and a little routine maintenance, your LH 1000 will provide you with years of trouble-free operation. This manual will help you to install your LH 1000 as well as assist you in trouble-shooting and problem solving. Of course, you may contact Energy Systems & Design Ltd. if you run into trouble.

May your RE adventures prove successful!

PLEASE READ CAREFULLY

It is very important to keep the alternator rotor from contacting the stator (the stationary part under the rotor). If this occurs, serious damage may result.

Whenever you are operating the machine with a small air gap (distance between alternator rotor and stator) you should check the gap whenever an adjustment is made!

Do this by inserting a shim (0.015ò or 0.25mm thick), or something thicker in the gap when the rotor is stationary(hint: most business cards are 0.010ò thick, therefore, using two cards of this thickness could be used to check the air gap). Check all the way around the rotor. This is also a way to check for bearing wear on a monthly basis. If you **cannot** easily insert the shim into the gap, either all or in part, it is necessary to adjust the rotor upward (see *Output Adjustment* in this manual). DO NOT USE steel feeler gauges as they will be attracted to the magnets.

When making air gap adjustments, make sure the larger bolt is tightened (clockwise) against the shaft and the smaller bolt is also tightened (clockwise); so as to lock both parts in place.

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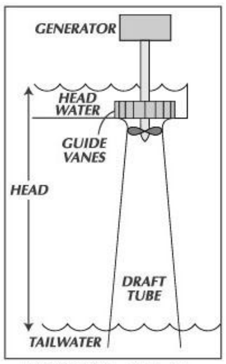
INTRODUCTION

This manual describes the **LH 1000**, which is manufactured by **Energy Systems & Design LTD**. The installer must have some knowledge of plumbing and electrical systems, as should the end-user of the system.

These machines are small, but can generate very high voltages. Even 12-volt machines can produce high voltages under certain conditions. Practice all due safety. Electricity cannot be seen and it can be lethal.

Electricity is produced from the potential energy in water moving from a high point to a lower one. This distance is called "head" and is measured in units of distance: meters (or feet) or in units of pressure: kilograms per square centimeter (or pounds per square inch-psi). "Flow" is measured in units of volume: liters per second - l/s (or gallons per minute-gpm), and is the second portion of the power equation: power [watts] = head x flow.



LH1000 Installation

The **LH1000** is designed to operate over a fixed range of heads from 0.6-3m (two to ten feet). The **LH1000** uses a permanent magnet type alternator. This design eliminates the need for brushes and the maintenance that accompanies them, while increasing efficiency. The **LH1000**'s output can be optimized by simply adjusting the rotorôs clearance from the stator.

SITE EVALUATION

Certain information must be determined concerning your site, in order to use its potential for maximum output. Head and flow must first be determined. The other factors are plumbing specifications, transmission distance, and the system voltage. These factors determine how much power can be expected.

Power is generated at a constant rate by the **LH1000** and stored in batteries as direct current (DC). Power is supplied, as needed, by the batteries, which store energy during periods of low consumption for use in periods where consumption exceeds the generation rate. Appliances can be used that operate directly from batteries, or alternating current (AC) power (at regular domestic specifications) can be supplied through an inverter, converting DC to AC power.

HEAD MEASUREMENT

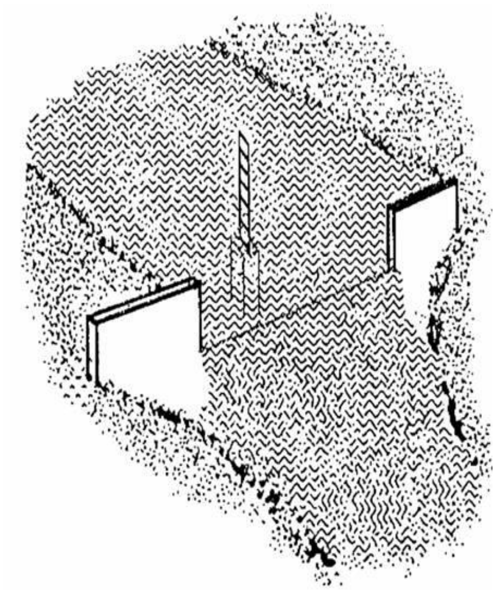
Head may be measured using various techniques. A garden hose or length of pipe can be submerged with one end upstream and the other end downstream. Anchor the upstream end with rocks or have an assistant hold it; water should flow out the low end, especially if the pipeline is pre-filled. Once water is flowing, raise the downstream end until it stops. Do this slowly since the water tends to oscillate. When the flow has stabilized, measure the distance down to the level of water in the stream with a tape measure. This will give a very accurate measurement of that stream section. Mark the spot and then repeat the procedure until the entire distance is covered.

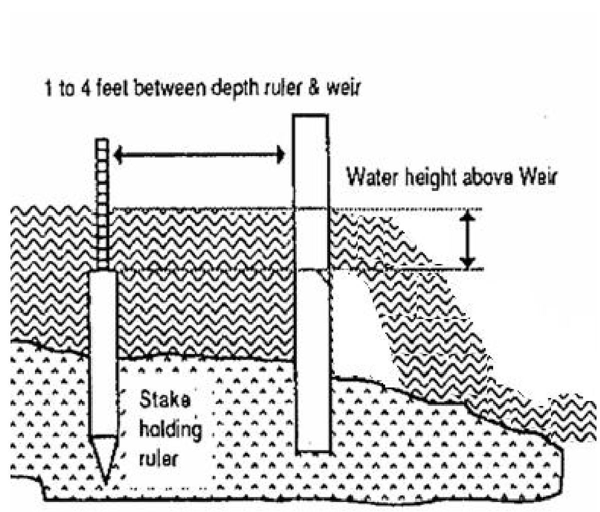
Another technique is to use a surveyor's transit. This method can also be approximated using a carpenter's level using a measuring stick or a "story pole." This technique is also done in a series of steps to arrive at the overall head. Note that with this reaction type machine, the entire head is used. No head is lost as with an impulse machine.

FLOW MEASUREMENT

The weir method can be used for the higher flows used with this machine. This technique uses a rectangular opening cut in a board or piece of sheet metal set into the brook like a dam. The water is channeled into the weir and the depth is measured from the top of a stake that is level with the edge of the weir and several feet upstream.

Measuring the flow at different times of the year helps you estimate maximum and minimum usable flows. If the water source is seasonally limited, you may have to depend on some other source of power during dry times (solar, wind). Keep in mind that a reasonable amount of water must be left in the stream (Don't take it all, that water supports life forms).





WEIR MEASUREMENT TABLE

Table shows water flow in gallons/minute (gpm) that will flow over a weir one inch wide and from 1/8 to 10-7/8 inches deep.

Inches		1/8ò	¼ò	3/8ò	½ò	5/8ò	¾ò	7/8ò
0	0.0	0.1	0.4	0.7	1.0	1.4	1.9	2.4
1	3.0	3.5	4.1	4.8	5.5	6.1	6.9	7.6
2	8.5	9.2	10.1	10.9	11.8	12.7	13.6	14.6
3	15.5	16.5	17.5	18.6	19.5	20.6	21.7	22.8
4	23.9	25.1	26.2	27.4	28.5	29.7	31.0	32.2
5	33.4	34.7	36.0	37.3	38.5	39.9	41.2	42.6
6	43.9	45.3	46.8	48.2	49.5	51.0	52.4	53.9
7	55.4	56.8	58.3	59.9	61.4	63.0	64.6	66.0
8	67.7	69.3	70.8	72.5	74.1	75.8	77.4	79.1
9	80.8	82.4	84.2	85.9	87.6	89.3	91.0	92.8
10	94.5	96.3	98.1	99.9	101.7	103.6	105.4	107.3

Example of how to use weir table:
Suppose depth of water above stake is 9 3/8 inches. Find 9 in the left-hand column and 3/8 in the top column. The value where they intersect is 85.9 gpm. That's only for a 1-inch weir, however. You multiply this value by the width of your weir in inches to obtain water flow.

LH1000 POWER OUTPUT CHART

Head (feet)	Flow Volume (GPM)	Watts (approximate)	Pipe Size (minimum)
1	320	25	8”
2	450	70	8”
3	550	150	10”
4	635	250	10”
5	710	350	10”
6	775	465	12”
7	840	585	12”
8	895	715	12
9	950	850	12”
10	1000	1000	12”

Head in feet can be converted to meters by multiplying feet by 0.3048.

Flow in gallons per minute can be converted to litres per second by multiplying gpm by 0.063.

If there is not enough water volume for the available head, the head can be reduced to match the available volume of water. The head can be reduced by adjusting the vertical drop for the diversion inlet and/or the length of the draft tube. If the site cannot produce the water volume necessary for the head, the turbine will not have enough water to operate, causing air to be sucked into the machine. This situation will reduce the power output considerably. If the water flow exceeds what is required to operate the machine, consider adding additional turbines.

INTAKE, PIPELINE, AND TAILRACE

All hydro systems require a waterway. Even systems operating directly from a dam require at least a short plumbing run. It is important to use the correct type and size of plumbing to minimize restrictions in the flow. When possible, pipelines should be buried; this stabilizes the line and prevents animals from chewing on it.

At the inlet of the plumbing, a filter should be installed. An open sluice can be constructed that is made of wood, metal or plastic (or any suitable material) to carry the water instead of a pipeline. If a pipeline is used, it is important to have a bell mouthed intake like the end of a trumpet in order for the water to enter easily. A screened box can be used with the pipe entering one side, or add a section of pipe drilled full of holes wrapped with screen or small holes and used without screen. A mesh size of about 20mm (3/4ò) and smaller can be used as debris of this size and will pass through the machine. However, it is important to keep sticks out of the intake as they may become jammed in the machine. This may require a smaller mesh size.

A settling basin should be used with this machine. This is a pool of low velocity water that enables the grit to settle so that it will not enter the machine and wear the edge of the propeller and the guide vane housing.

See LH1000 installation illustration at back of manual

The turbine can be mounted in the waterway, through a 17-cm (7ò) hole with the draft tube extending to the tail waters below. The small tabs (supplied) are adequate to retain the machine. The draft tube is connected to the machine using a rubber sleeve and hose clamps. These are standard plumbing items. If the head is greater than about two meters (six feet) PVC pipe of 150mm (6") diameter with a 4mm (0.160ò) wall thickness is used between the guide vane assembly and the draft tube to extend the length and another rubber sleeve is needed. Using the thin wall pipe will allow for a more streamlined flow as it can slip over the guide vane stub pipe. Install the rubber sleeve at the lower end of the guide vane tube so as to create a smooth transition from one to the other. It is recommended to have the LH1000 in a small enclosure or under some cover to keep it dry and provide a place for auxiliary equipment. Mounting the machine in concrete is also possible (you may wish to try a temporary wood mounting first).

The draft tube must be supported. This can be done with straps from the top down or it can rest on ñfeetò that are positioned on the stream bed.

PIPE FRICTION LOSS - PVC Class 160 PSI Plastic Pipe

Pressure Loss from Friction in Feet of Head per 100 Feet of Pipe

Flow US GPM	6ò	8ò	10ò
500	1.45	0.42	0.14
550	1.75	0.48	0.16
600	2.05	0.58	0.18
650	2.37	0.67	0.23
700	2.71	0.76	0.25
750	3.10	0.86	0.30
800	3.50	0.97	0.32
850	3.89	1.08	0.37
900	4.32	1.20	0.42
950	4.79	1.34	0.46
1000	5.27	1.45	0.51

BATTERIES, INVERTERS & CONTROLLERS

System Voltage

A small system with a short transmission distance is usually designed to operate at 12 volts. Larger systems can also be 12 volts, but if higher power is desired or the transmission distance is long, then a system of 24 volts or higher may be preferable. This is especially true if all loads are inverter-powered. In a 12-volt system, operating at a low power level, it may be advantageous to operate all loads directly from batteries. Many 12-volt appliances and small inverters are available. In 24-volt systems, it may also be preferable to operate the loads directly (although not as many appliances are available).

In higher power systems, it is usually better to use an inverter to convert battery voltage to regular domestic AC power. This has been made feasible with the advent of reliable high power inverters. Thousands of home power systems are in operation with only AC loads.

Sizing Battery Capacity

A typical hydro system should have about two days of battery storage capacity. This will generally keep lead-acid cells operating in the upper end of their charge range where they are the most efficient and long-lived. Alkaline batteries like the nickel-iron and the nickel-cadmium types can have a lower capacity since they can be more fully discharged without harm.

Batteries should be located outside of living space, or adequate ventilation should be provided, as a rising charge level tends to produce both hydrogen gas and corrosive fumes. Also, distilled water should be added as needed to maintain the electrolyte level.

Charge Control

A hydro system requires that a load be present so that the power has somewhere to go. Otherwise, system voltage can rise to very high levels. This situation provides an opportunity to do something with the excess power like heating water.

As the batteries become fully charged, their voltage rises. At some point, the charging process should stop and the power be diverted to the dump load. The voltage set point should be about 13.5 to 14.5vdc for a 12-volt system depending on the charge rate. The higher the charge rate, the higher the voltage can go. If batteries are often in a high state of charge, the voltage limit should be on the low end of the range.

A voltmeter or a watt-hour meter can be used to monitor battery charge level. Battery voltage is roughly a function of the charge level, and varies according to the load level and charge rate. There are many commercially available monitors that conveniently display these features to the user, including the state of charge.

WIRING AND LOAD CENTER

Every system requires some wiring to connect the various components. Load centers are available as a complete package that easily facilitates the connection of loads and power source(s). All circuits in the system should use wire of adequate size and have fuses or breakers of sufficient capacity to carry the expected load current. Even the LH1000 must be fused since it can suffer from a short or similar fault just like anything else in the system.

Inside the ñjunction boxò, are two terminal lugs for the battery cable leads. The negative terminal lug is bolted to the box and the positive terminal lug is bolted to the clear plastic terminal block and the screw is red. Transmission wire ends are inserted into these two connectors (after being stripped of insulation) and then tightened.

The precision shunt installed in the junction box will give a readout of the hydro output in amperes if the digital multimeter is plugged into the jacks (color coded in the shunt body), and turned to 200m (the 9 oćclock position). A voltmeter connected to the batteries will roughly indicate the charge level, as described in ñCharge Levelò above, and an ammeter will indicate the output of the machine. This is shown on page 14.

DESIGN EXAMPLE

This example shows how to proceed with a complete installation. The parameters of the example site are:

-2 metres (six feet) of head over a distance of 15 metres (50 feet)
-a flow of at least 63 l/s (1000 gpm)
-30 metres (100 feet) distance from the house to the hydro machine
-24 volt system

The first thing to do is determine the pipe size. Given that there is friction between water and the pipe in which it flows, this friction can be reduced by increasing the size of the pipe to minimize the friction to acceptable limits. Therefore, pipe size must be optimized based on economics and performance.

Note that with this machine, the flow is determined by the head, as there is nothing to adjust that changes the flow. A head of two metres requires a flow of about 50 l/s (800 gpm).

The pipe flow charts show us that eight-inch (approx. 20cm) diameter PVC pipe has a head loss of 0.97 feet of head per 100 feet (30m) of pipe at a flow rate of 800 GPM (50 l/s). This is about 0.5 feet (15cm) of loss for 50 feet (15m) of pipe.

Next, we subtract the head losses from the measured head (often referred to as the static), or gross head (Abbreviated Hg), in order to determine the actual, operating head (often referred to as the dynamic), or net head (Abbreviated Hn).

6 feet head (Hg)-0.5 feet head losses = 5.5 feet (1.85m) actual head (Hn)

It is now known that the **LH 1000** will be operating at an actual, or net head of 5.5 feet (1.85m) Hn. By referring back to the output chart, it can be determined that the LH1000 can, realistically, be expected to produce approximately 400w.

COPPER WIRE RESISTANCE

Wire Gauge	Diameter Inches	Ohms per 1000'	Ohms per Mile
0000	0.460	0.05	0.26
000	0.410	0.06	0.33
00	0.364	0.08	0.42
0	0.324	0.10	0.52
2	0.258	0.16	0.84
4	0.204	0.25	1.34
6	0.162	0.40	2.13
8	0.128	0.64	3.38
10	0.102	1.02	5.38
12	0.081	1.62	8.56
14	0.064	2.58	13.6
16	0.051	4.10	21.6
18	0.040	6.52	34.4

Since we require 24 volts and the transmission distance is short, we can generate and transmit 24 volts using the **LH1000**. This **LH1000** could also be used for other voltages like 12 and 48, or even 120 or 240V, and power could be transmitted longer distances. We need to go 100'(30m) with 400 watts at our site. The amperage can be determined using the formula: volts x amperage = watts. So, a 24v system usually operates at an actual voltage of about 30v at the generator, therefore: 400/30 = 13.3 amps. The machine will need to be wired series delta for this site.

This will be about 13.3 amps at 30 volts at the generator. Note that there will be some voltage drop in the line and batteries require somewhat higher voltages than nominal to become charged. So the 13.3 amps must pass through 200'(60m) of wire for the distance to the batteries and back which completes the circuit. As there is friction between water and the pipe that carries it, causing losses, so there is resistance between electricity and the conductor that carries it, and is measured in units called ohms. Resistance losses should be kept as low as economics permit, just like the pipeline losses. Letôs assume that a 5% loss is acceptable at this site, resulting in the loss of 25 watts.

The formula to calculate resistance losses is I (amps) x I (amps) x R (resistance) = w (watts). We put our known figures into the formula to learn the resistance that we require in a copper conductor to achieve this.

13.3 x 13.3 x R = 25w

177 x R = 25w

R = 0.14 ohms

It has been calculated that a copper conductor with losses of 0.1 ohms over a total distance of 200 feet (60m) will result in a 5% loss. The Wire Loss Chart shows losses per 1000' (300m) of wire, so:

1000'/200' x 0.14 ohms = 0.7 ohms per 1000'.

The chart shows 8 ga. wire has a resistance of 0.64 ohms per 1000', so:

200'/1000' x 0.64 ohms = 0.128 ohms.

This is close enough to the desired level, that with a little more investigation we can determine whether this will result in acceptable power losses:

13.3 amps x 13.3 amps x 0.128 ohms = 22.6 watts of loss.

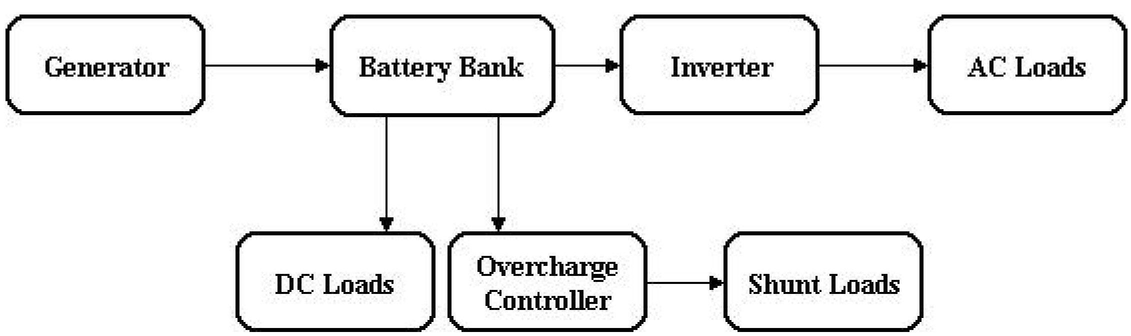
Increasing the wire size can further reduce the losses, but can also increase costs, as larger wire is usually more expensive. Resistance in a length of wire results in power loss that is seen as a voltage drop from one point in the line to another. For example, if your voltage, as measured at the generator, is 30vdc, then it could be assumed that if the voltage were measured along the line to the batteries, it would be lower as you got further from the generator: Voltage drop= I (amps) x R (ohms resistance in your circuit). So:

Voltage drop = 13.3 amps x 0.0128 ohms = 1.70 volts

Hence, if your battery voltage is 28.3vdc, your generator voltage will be 30vdc. Keep in mind that it is always the batteries that determine the system voltage, as they are the stabilizing force in your system. All voltages in the system will rise and fall corresponding to the battery voltage, or the battery's state of charge. At the site, we would be generating 13.3 amps continuously. Typically, a battery bank is sized to have two days storage capacity. If we choose lead acid batteries and wish to have two days of storage capacity, then we use the formula: amps x hours x days = amp/hrs capacity. So:

13.3 amps x 24 hrs x 2 days = 638 amp. Hrs. Capacity

The Trojan L-16 has a rating of 6vdc and 350 amp/hr. Using these you would require at least eight batteries; there would be two strings paralleled, with each string consisting of four batteries in series to give the 24vdc system voltage we have chosen. This would give 700 amp/hrs at 24vdc capacity, which is about two days storage. An inverter and charge controller are usually used in the system. The diagram for such a system would look like this:



OUTPUT ADJUSTMENT

For the machine to produce the highest output, the rotor height should be adjusted, so as to match the magnetic power of the rotor to the power of the water at the site. This involves raising and lowering the rotor to change or adjust the magnetic flux level until the optimum level is found.

After the machine is installed, perform a trial operation to establish a power output level. This can be determined using a digital multimeter (supplied) plugged into the colour coded output jacks in the ñshuntò (precision resistance) found in the junction box (see page 14). Use the DC millivolt (200 m) scale for this which corresponds to the handle of the meter in the nine oćlock position. You may also use your meter for other tasks in your system. It is recommended to keep a logbook to note any output changes in relation to settings, and to monitor long-term performance. After everything is installed, start the **LH1000** by opening the water source. Operate it long enough for the output level to stabilize and note the current or voltage in a high voltage system with no shunt at the generator).

The **LH1000** comes with the rotor (the round piece on the top that rotates) set very close to the stator (the stationary, black body of the generator). To increase this distance, and reduce the magnetic flux level, you first must, while holding the rotor stationary with the 1/4-inch rotor pin (supplied) placed in the hole in the rotorôs edge, loosen the smaller (7/16" head) bolt. Next, hold the rotor stationary with the pin, and tighten (clockwise rotation) the larger (3/4ò head) bolt, which will force the rotor up. Each full turn of the bolt will move the rotor vertically 0.050" or 1.25 mm. If raising the rotor causes the current (or you may be monitoring the voltage in a high voltage site) to increase when the machine is operating, then continue to do so until there is no longer an increase. If a point is reached where a decrease occurs, then the rotor should be lowered. This is done by loosening the larger bolt (counter-clockwise rotation) and then tightening the smaller one (clockwise rotation). Turning the smaller bolt causes the rotor to move vertically the same distance per turn as the larger bolt does. When you have found the best position (no increase in current or voltage), make sure the larger bolt is turned until it is tight and ñpushingò on the shaft. Now the smaller bolt should be tightened securely to lock everything in place. No further adjustments should be required unless site conditions change.

When adjusting the rotor downward, it may contact the stator. If this occurs, always adjust it upwards by at least a 1/4 turn of the larger bolt. Operating the machine with the rotor any closer than this will not result in any power increase but may damage the machine.

PLEASE READ CAREFULLY

It is very important to keep the alternator rotor from contacting the stator (the stationary part under the rotor). If this occurs, serious damage may result.

The machine is operated with a small air gap (distance between alternator rotor and stator). You should check the gap whenever an adjustment is made!

Do this by inserting a shim (0.015ò or 0.25mm thick), or something thicker in the gap when the rotor is stationary (hint: most business cards are 0.010ò thick, therefore, using two cards of this thickness could be used to check the air gap). Check all the way around the rotor. This is also a way to check for bearing wear on a monthly basis. If you **cannot** easily insert the shim into the gap, either all or in part, it is necessary to adjust the rotor upward (see *Output Adjustment* in this manual). DO NOT USE steel feeler gauges as they will be attracted to the magnets.

When making air gap adjustments, make sure the larger bolt is tightened (clockwise) against the shaft and the smaller bolt is also tightened (clockwise); so as to lock both parts in place.

** Always turn the rotor by hand before starting the machine to check for rubbing and make sure you can always fit a shim or two business cards in the space between the rotor and stator**. Remove the pin from the rotor edge before starting the machine.

BEARINGS, SERVICE & ASSEMBLY

In order to remove the generator to access the ball bearings, you must first remove the wiring from the terminals on the clear, plastic terminal block in the junction box. Be sure to note their position for later re-installation. An alternative is to remove the junction box from the alternator base by removing the two bolts on the bracket. Then, undo the four Allen head bolts that attach the generator to the finned, aluminum base, using a 5/32ò (4mm) Allen wrench. The four bolts are located under the generator base, and thread upward into the generator.

Next, unscrew the white plastic spinner (nose cone) from the base of the unit, located inside the guide vane assembly, at the end of the shaft in a counter-clockwise or left hand direction.

Proceed to remove the propeller by removing the ¾ inch (19mm) brass nut and slide the propeller from the shaft. Now, the generator and shaft assembly may be pulled up, and out of the generator base and shaft housing. The best way to remove the shaft from the generator is to tighten the two nuts (one is the bronze one holding the propeller and the other is supplied) against each other on the end of the shaft so you can unscrew the shaft while holding the generator rotor with the ¼ò pin. *Please note: During assembly the longer bore in the shaft adapter fastens to the generator and the shorter bore goes toward the long shaft.*

The finned alternator base can be removed from the shaft housing by unscrewing it. The shaft housing tube can also be unscrewed from the guide vane base. The aluminum guide vane base is attached to the polyurethane guide vane assembly with four 1/4 ï 20 Allen head bolts that may be removed using an Allen wrench and a 7/16 (11mm) wrench.

IMPORTANT Bearing maintenance is important. You should replace bearings **ONCE PER YEAR** or as soon as you notice any looseness from wear. If they are too loose, severe damage to both the rotor and the stator can result. Check the clearance often making sure you can insert two business cards (or something the same thickness) between the rotor magnets and the stator. Even if the bearings are not worn, changing them once per year will help keep the area free of corrosion and make future bearing changes easier. This machine uses three 6203 ball bearings with contact seals. Presently the bearings in the machine are a slip fit in the housing bore and Loctite 243 has been applied to the bearings before assembly in order to secure them. This adhesive and corrosion may make the bearing difficult to remove. Tapping with a block of wood should be sufficient but the use of a press may be required if the bearings are stuck in the housing.

To replace generator bearings:

1. Using the rotor pin to hold the shaft, unthread the runner from the generator shaft.
2. Remove rotor. To remove rotor and shaft raise the rotor as described in *output adjustment* until the magnetic attraction is low enough to separate the rotor/shaft assembly from the housing and stator.
3. Unscrew two bolts and washers that retain the bearings.
4. With the LH1000 sitting inverted, using your thumbs, push out the bearings from the housing or tap the bearings out. This may require a press in some situations.
5. Clean bearing sleeve and insert new 6203 bearings and apply Loctite 243 or equivalent. .
6. Reassemble.

PLEASE NOTE: The propeller must be installed with the *rounded* edges up. This means that the thicker edge of the blades should be on the upper side

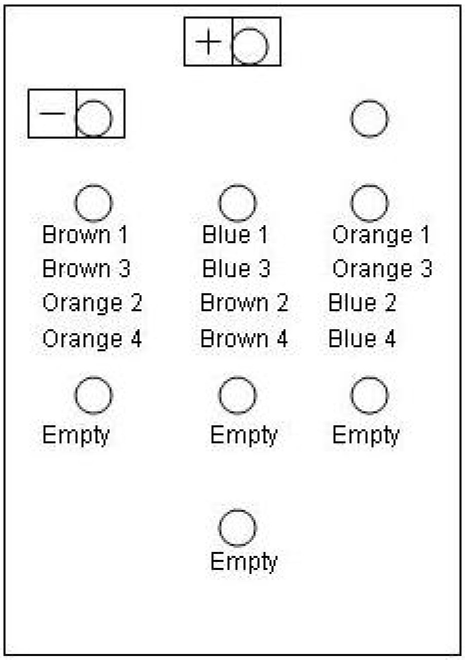
To replace the lower shaft bearing (water lubricated cutless type):

After removing the spinner and propeller, the guide vane and aluminum casting above it can be removed as a unit. Simply unscrew the aluminum casting from the aluminum tube and access to the bearing is possible. This is a bronze piece with a rubber liner. Once the tube is unscrewed from the casting, it should be easily removable. Note the condition of the shaft and there should only be very small clearance between the shaft and the bearing. If score marks are evident on the wear strip surrounding the prop, then the bearing, shaft or both may require replacement.

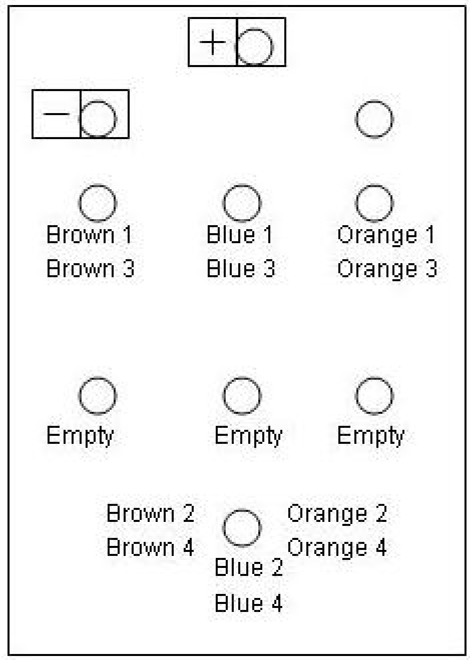
WIRING DIAGRAMS

These diagrams represent the four possible combinations of output wiring. They are in order of potential. If you find your air gap adjustment to be at a minimum and wish to try for more power, then try using the next higher combination. If you find the air gap is very large, try the next lower one. Note that there is only a small change in potential between #2 to #3. There is a ground lug on the junction box for grounding the machine. The negative output is on the terminal block and is isolated.

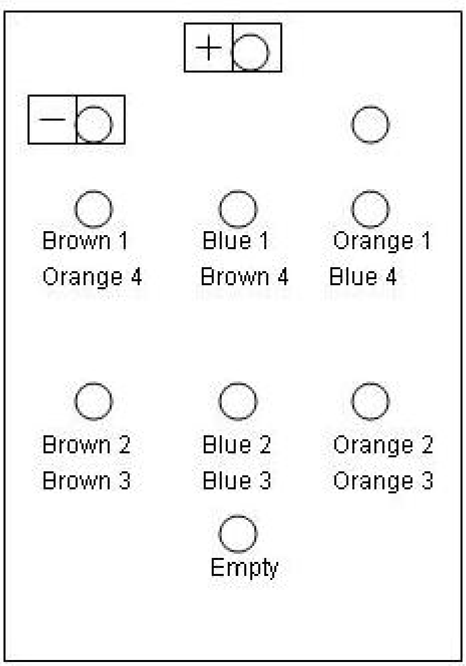
#1 Parallel Delta



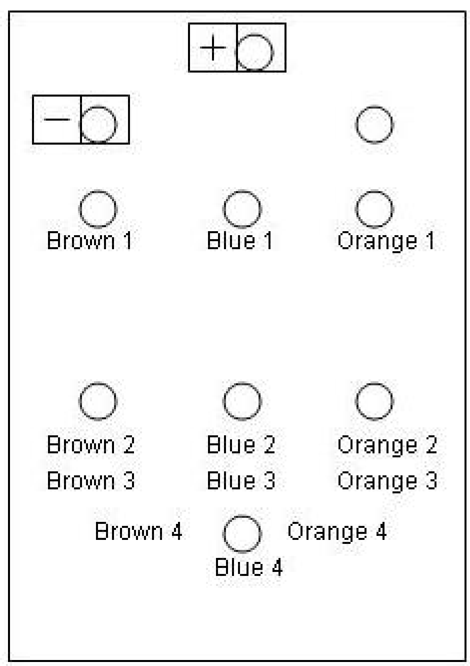
#2 Parallel Y



#3 Series Delta



#4 Series Y



Revision 11/27/2008

WIRING SCHEMES

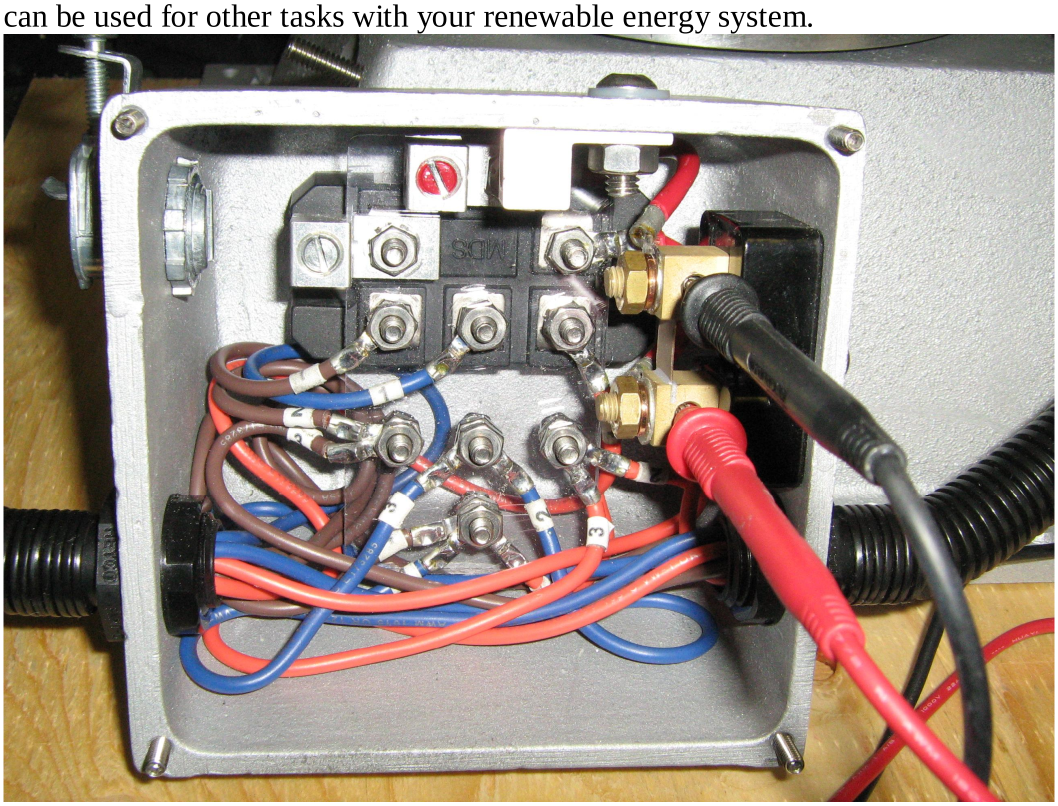
12 VOLTS	24 VOLTS	48 VOLTS
Parallel Delta All Heads	***Series Delta*** **up to 60'/18 m**	***Series Y*** *up to 60'/ 18m*
	Parallel Delta *30'/ 9m and up*	***Series Delta*** *30'/9m to 250'/75m*
		Parallel Delta *140'/43m and up*

Note: At a given site, more than one scheme may work. But one will work best.

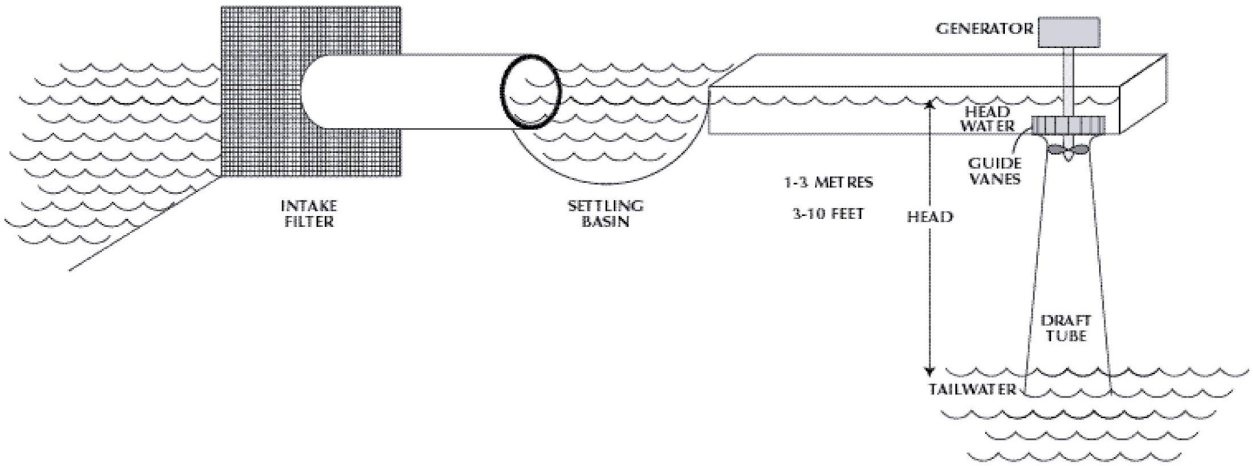
Parallel wye configuration is not mentioned because it is very similar to series delta. It differs by about 15%. If you have a site where series delta is used and you think the output could be greater, try it. Remember to adjust the rotor for highest output when changing the wiring.

CURRENT MEASUREMENT TECHNIQUE

A built-in shunt (precision resistance) is installed in the junction box which allows the current to be measured digitally. This is done with the supplied DMM (digital multi meter). To measure the current produced by the generator, set the DMM scale to "DC milli-volts" or "200 m". **<u>Do not use the amps scale.</u>** Plug the leads into their corresponding color-coded jacks on the shunt in the junction box. This will give current readings from 0.1 amps to 99.9 amps. Of course, the DMM can be used for other tasks with your renewable energy system.



LH1000 INSTALLATION



Head (feet)	Flow Volume (GPM)	Watts (approximate)	Pipe Size (minimum)
1	320	25	8”
2	450	70	8”
3	550	150	10”
4	635	250	10”
5	710	350	10”
6	775	465	12”
7	840	585	12”
8	895	715	12
9	950	850	12”
10	1000	1000	12”

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Product Information

Model # ______________________ Serial # _____________________
Date Purchased ____
Purchased From ____
Name: ____
Address: ____
City: ____
State/Prov: __________________ Zip/Postal Code: _______________
Telephone: ____
Email: ____
Comments: ____
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