



AQUA CONTROL WATER FEATURES

60 Hz. ENDUR SERIES DISPLAY AERATOR & FOUNTAIN INSTRUCTION MANUAL



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SAFETY INFORMATION

WARNING

This product is not intended for use by young children or infirm persons unless they have been adequately supervised by a responsible person to ensure that they can operate the product safely.

Young children should be supervised to ensure that they do not play with the product.

Your *Aqua Control, Inc.* products are made entirely of corrosion resistant materials including stainless steel, aluminum alloy, bronze and engineered plastics. They will provide safe, long and satisfactory service if properly installed, operated and maintained.

1. Follow all applicable local and state electrical codes.
2. Protect exposed or vulnerable wiring with tubing or conduit.
3. Do not operate the unit when it is obvious the flow rate is reduced.
4. Do not work on the unit when it is turned on or operating.
5. Follow all normal safety precautions when working in and around the water.
6. Prevent tension on the electrical wires.
7. Do not carry or pull the unit by the lights or by the cable. Use the finger pockets on the float.
8. Never try to dislodge debris from the impeller or propeller while the motor is connected to the power supply.
9. Always verify the control panel and all electrical equipment are grounded properly.
10. Anytime high voltage electricity is used under water, a potential safety hazard exists. *Aqua Control, Inc.* builds and provides UL listed control panels for **single phase** that are standard equipped with a Class A Ground Fault Circuit Interrupter (GFCI) for both motors and lights. Class A GFCI's are designed to provide protection against electrocution for humans. They have a normal trip level of 5ma and are designed to shut the circuit off in 25 milliseconds. Such a system will shut off a current resulting from shorts or dangerous leakage, whether from the motor, electrical cables or controls, before a hazardous current can develop.

PRE-ASSEMBLY

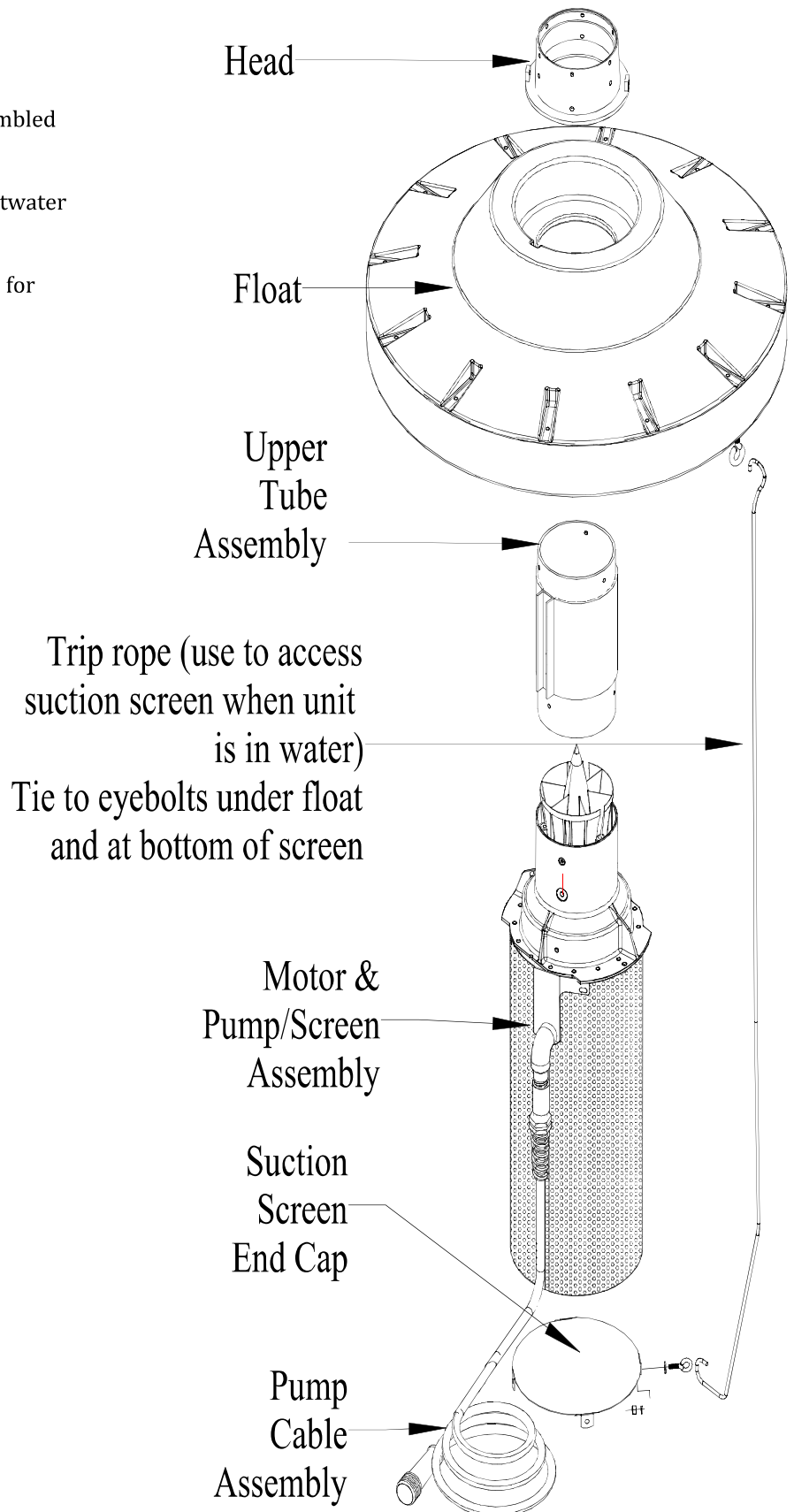
Prior to installing, verify the correct product has been ordered and received. *Aqua Control, Inc.* will not accept any returns for refund or exchange of product or components that have been installed in the water or modified in any way. Keep original packaging for returns to the factory or contact the factory for instructions as to how to obtain packaging for safe return of product. It is recommended the product warranty disclaimer be thoroughly reviewed. The warranty disclaimer can be found in the packet with these instructions. You may also obtain a copy from our website at www.aquacontrol.com

1. **Check the packing list** that came with the shipment. Make certain all the boxes have been received. Each label will have a box number and total for the shipment (1 of 5, 2 of 5). The packing list has the total number of boxes noted at the bottom.
2. **Check the pond depth.** Is the pond deep enough for the unit being installed?
3. **Verify the incoming voltage** where it will be connected to the control panel. Does the measured voltage match the rated motor voltage requirements? Note the HP, voltage and phase on the packing list.
4. **Is there a VFD operating** from the same power supply or in the vicinity that might interfere with the GFCI?

ENDUR SERIES

VERTICAL DISPLAY AERATOR, FOUNTAIN & TORRENT ASSEMBLY

1. All Endur Series units are shipped assembled and shipped via LTL freight.
2. The Endur Series is not available for saltwater applications.
3. See the nozzle and light set instructions for attaching these to the unit.



NOZZLES

Find the nozzle that is being attached to this unit in the table below. This table will tell you which of the four nozzle types a nozzle falls under to locate the correct instructions. The flow straightener has been replaced by the outlet fairing and intermediate flow straightener in the Endur Series.

Endur Series Aerator nozzles and Fountain nozzles are not interchangeable with any other aerator or fountain.

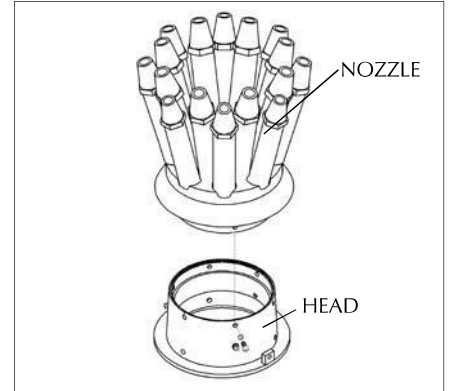
DISPLAY AERATOR NOZZLES	NOZZLE TYPE
Cluster Arch	Type 1
Crown Gusher	Type 2
Daffodil	Type 2
Delmar	Type 1
Double Arch	Type 1
Lily	Type 2
Pentalator	Type 1
Quad	Type 1
Scepter	Type 1
Spider & Arch	Type 1
Super Lily	Type 2
Tornado	Type 2
Torrent	Type 1
Trillium	Type 1
Triple Tier	Type 1
Weeping Willow	Type 1

FOUNTAIN NOZZLES	NOZZLE TYPE
Buckingham	Type 1
Flare & Sky Geyser	Type 4
Fleur de Lis	Type 1
Full Geyser	Type 3
Majestic	Type 1
Sky Geyser	Type 1
Spoke & Trellis	Type 1
Tiara	Type 1
Trellis	Type 1
Trellis & Sky Geyser	Type 1

NOZZLES

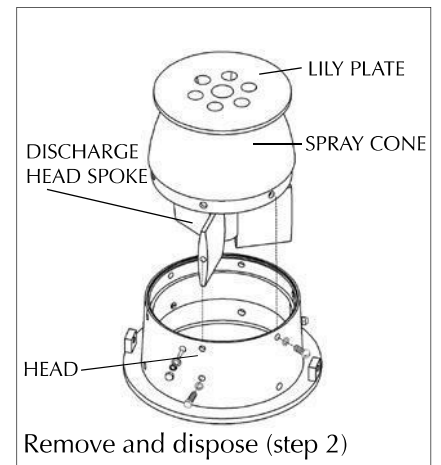
NOZZLE TYPE 1 - MULTIPLE NOZZLE CASTING/SPRAY CONE

1. Remove the screws with lock washers from the threaded holes in the nozzle.
2. Open the packet of petroleum jelly and apply it generously to the O-ring on the flange of the nozzle.
3. Slide the flange of the nozzle into the head, lining up the holes.
4. Re-attach the hardware removed in step #1.



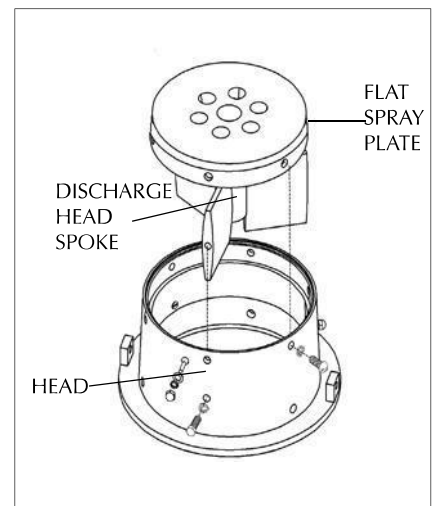
NOZZLE TYPE 2 - SPRAY CONE WITH DISCHARGE SPOKE

1. Remove the screws with lock washers from the spray cone; and the hex-head bolts, lock washers and flat washers from the discharge head spoke.
2. Remove the hardware in the center row of holes in the head using a 5/16" wrench on the cap nut. This hardware will not be reused.
3. Open the packet of petroleum jelly and apply it generously to the O-ring on the flange of the nozzle.
4. Holding the nozzle by the tip of the threaded rod, line up the threaded holes of the discharge head spoke with the center row of holes in the head. Slide the discharge head spoke inside the head and attach with the hex head bolts, lock washers and flat washer removed in step #1.
5. Slide the flange of the spray cone into the head, lining up the holes.
6. Re-attach the screws with lock washers removed in step #1.
7. The nozzle has been pre-set at the factory.



NOZZLE TYPE 3 - FLAT SPRAY PLATE WITH DISCHARGE HEAD SPOKE

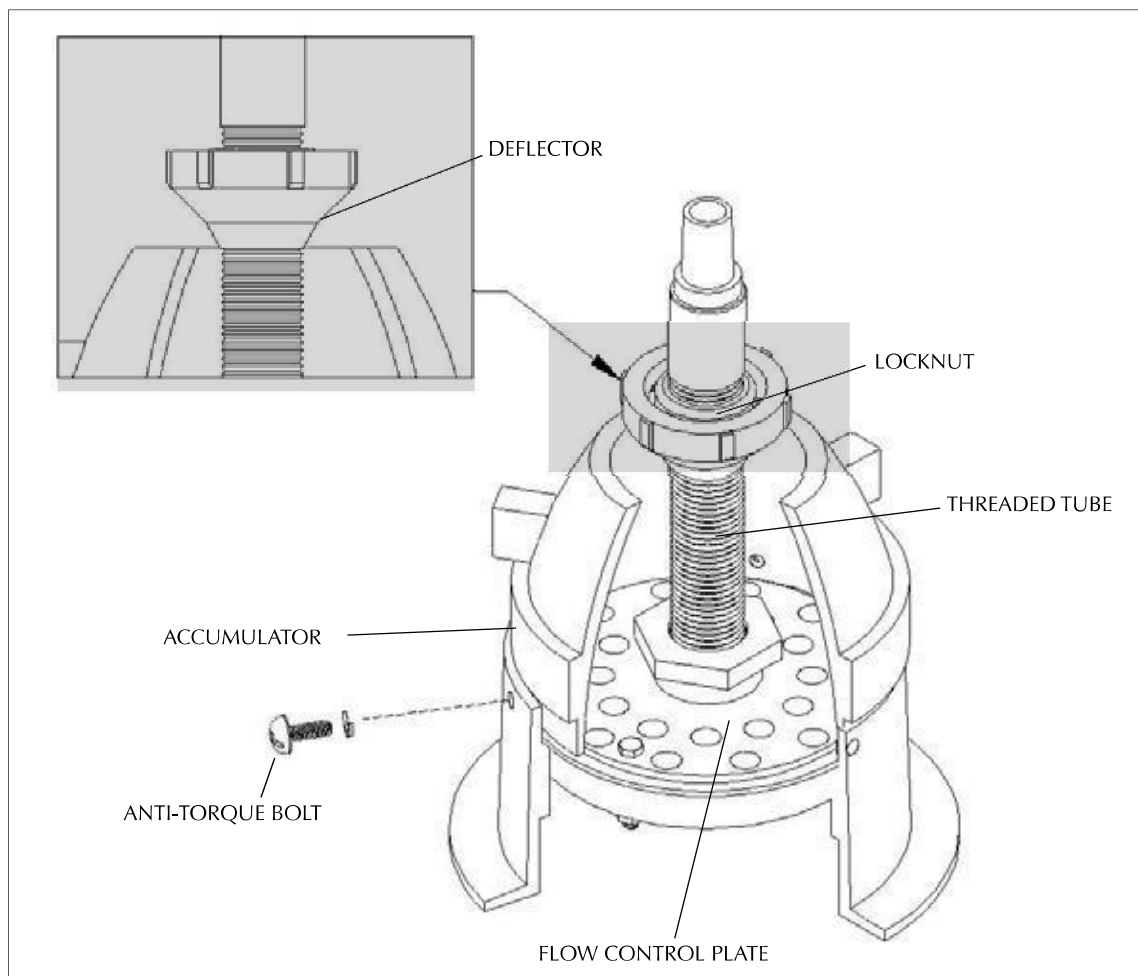
1. Remove the screws with lock washers from the threaded holes in the flat spray and the hex-head bolts, lock washers and flat washers from the discharge head spoke.
2. Remove the hardware in the center row of holes in the head using a 5/16" wrench on the cap nut. This hardware will not be reused.
3. Open the packet of petroleum jelly and apply it generously to the O-ring on the flange of the flat spray plate.
4. Line up the threaded holes of the discharge head spoke with the center row of holes in the head. Slide the discharge head spoke inside the head and attach with the hex-head bolts, lock washers and flat washers removed in step #1.
5. Slide the flange of the flat spray plate into the head, lining up the holes.
6. Re-attach the screws with lock washers removed in step #1.



NOZZLES

NOZZLE TYPE 4 - FLARE & SKY GEYSER

1. Remove the screws with lock washers from the threaded holes in the nozzle.
2. Open the packet of petroleum jelly and apply it generously to the O-ring on the flange of the nozzle.
3. Slide the flange of the nozzle into the top of the head, lining up the holes.
4. Re-attach the hardware removed in step #2.

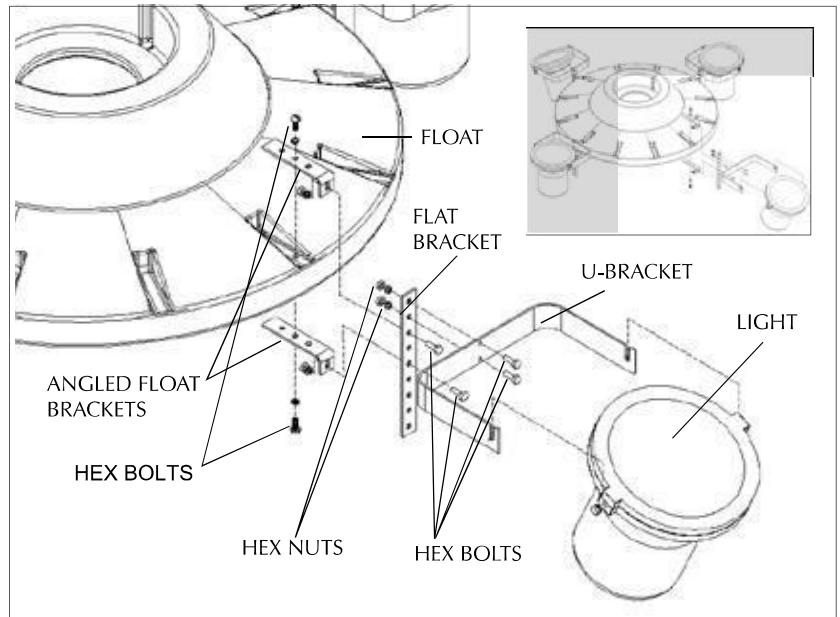


LIGHT SET ASSEMBLY

ENDUR SERIES FRESHWATER

ENDUR SERIES FRESHWATER

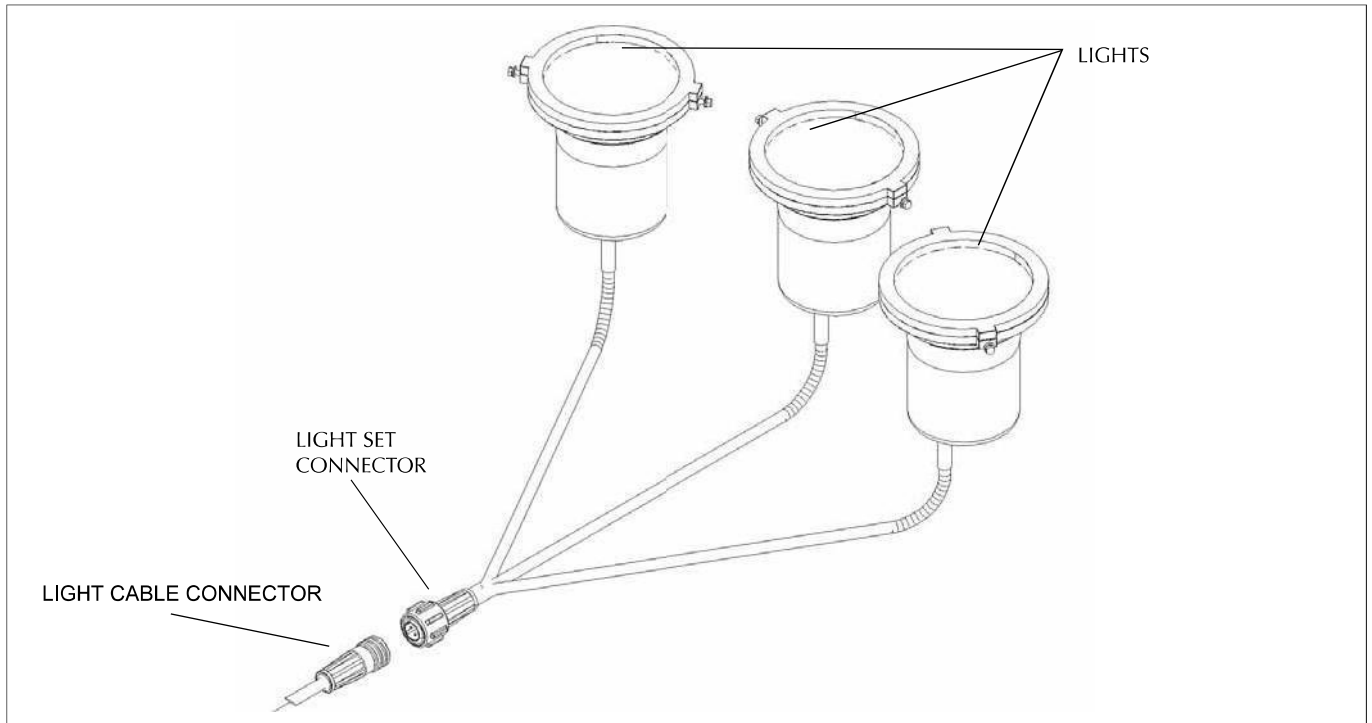
1. Open the light set box and remove the plastic bag containing brackets and hardware. The package contains one (1) straight float bracket, two (2) angled float brackets, six (6) hex head bolts, six (6) lock washers and four (4) hex nuts for each light set.
2. Attach one (1) of the angled float brackets to the top of the float at any one of the threaded inserts. Place a lock washer on a hex bolt and put the bolt through the middle hole or the hole furthest from the angle on the bracket.
3. Attach the remaining angled float brackets to the bottom of the float directly below the brackets attached in step #2, using the same hardware as in step #2. If you used the middle hole on the brackets in step #2, use the same hole in step #3.
4. Attach a flat float bracket to each set of angled brackets using a hex head bolt, lock washer and hex nut.
5. Take the light canisters with light brackets attached out of the box. Stretch out the light leads to make sure they are not tangled.
6. Using two (2) hex head bolts, two (2) lock washers and two (2) hex nuts, attach the light bracket(s) to the flat float bracket(s). The slots in the light U-bracket need to be pointed up towards the top of the unit. The light U-bracket is shown attached at the optimum height if the unit is floating at the recommended depth. (See flotation on page 12 for adding weights.) If the unit is weighted down then, the light bracket will need to be attached lower. The lights must be 2" below the surface of the water when the unit is running.
7. The unit is ready to be floated after the cable connection(s) have been made.



LIGHT CABLE ASSEMBLY

3-WIRE LIGHT CABLE (one light set)

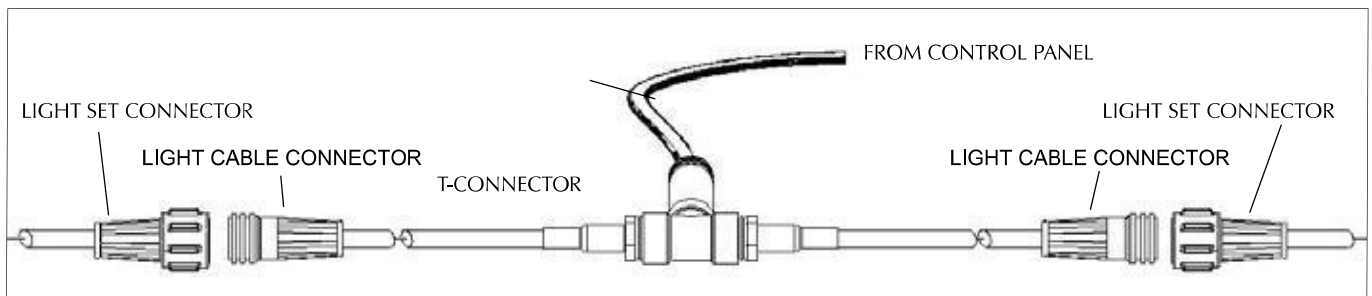
Simply join and hand tighten connectors.



T-CONNECTOR LIGHT CABLE (two light sets)

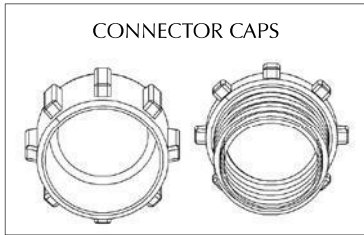
The T-Connector Light cable has two 3-wire connectors connected to one 4-wire cable. One of the two connectors is marked with red tape. The one without tape gets its power from the black wire in the 4-wire cable. The two connectors share the ground and neutral line.

Join connectors and hand tighten.



CONNECTORS

CONNECTOR CAPS

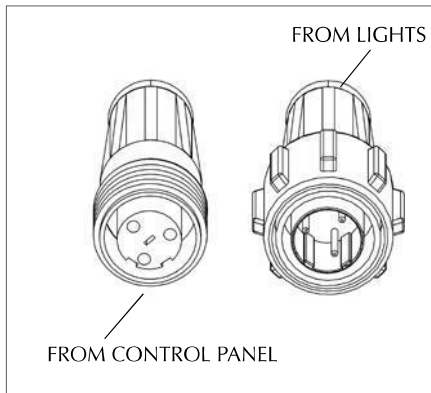


Blue connector caps are used to protect the connectors during handling and to keep them dry if submerged while unconnected to mating connection.

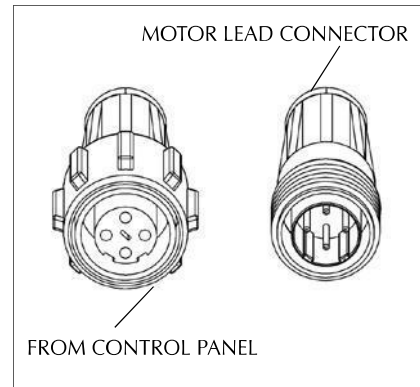
CONNECTOR IDENTIFICATION

WARNING: Do not use grease on connectors. No tools are required for tightening.

LIGHT CABLE

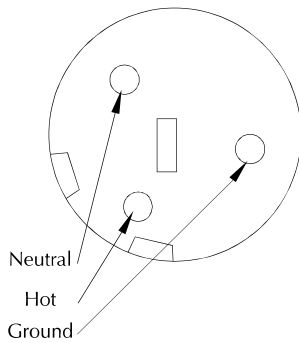


3-WIRE WITH GROUND PUMP CABLE

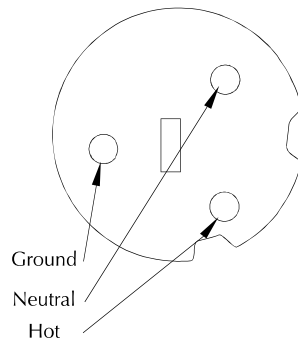


WIRE IDENTIFICATION

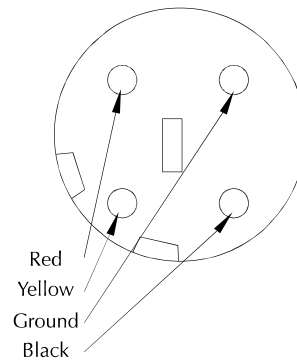
2-Wire with Ground Motor Lead Connector & Light Set Connector



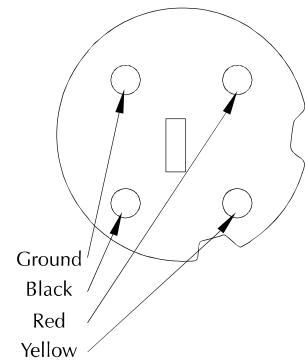
2-Wire with Ground Pump Cable Connector & Light Cable Connector



3-Wire with Ground Motor Lead Connector



3-Wire with Ground Pump Cable Connect



CONTROL PANELS

INSTALLATION

Aqua Control, Inc. is certified to manufacture UL Listed Industrial Control Panels (UL 508A). Standard, 2hp - 5hp, **single phase** control panels are UL Listed. **All** three phase, Titan and certain specially configured control panels are not UL Listed.

(If an *Aqua Control, Inc.* control panel was ordered with your unit, the control panel instructions may be found inside the control panel enclosure.)

LOCATION OF CONTROL PANELS

Control panels should always be installed in a manner that minimizes heat inside the panel since the panels generate some heat and they contain heat sensitive components (motor overloads). Sunlight is the most significant source of heat so, the control panels should be installed out of direct sun as much as possible. The door of the control panel in particular, should not face south or west unless it is protected from sunlight.

PRE-START UP

Verify voltage at the rotary disconnect prior to start up. Each outer leg should be 120 volts to neutral unless you have 460/480 volt 3-phase power. If you have power with a hot leg, e.g. 230 volt 3-phase power, that wire should be connected to the center lug of the rotary disconnect.

It is good practice to provide power to the motor for a few seconds prior to installing the unit.

START UP

At installation and initial start up, it is recommended to record the actual voltage under load (while the unit is running) and the running amperage of the unit. This should be kept inside the control panel for future reference. This helps identify operating changes at site. The correct voltage and amperage ratings are on the door label of the control panel.

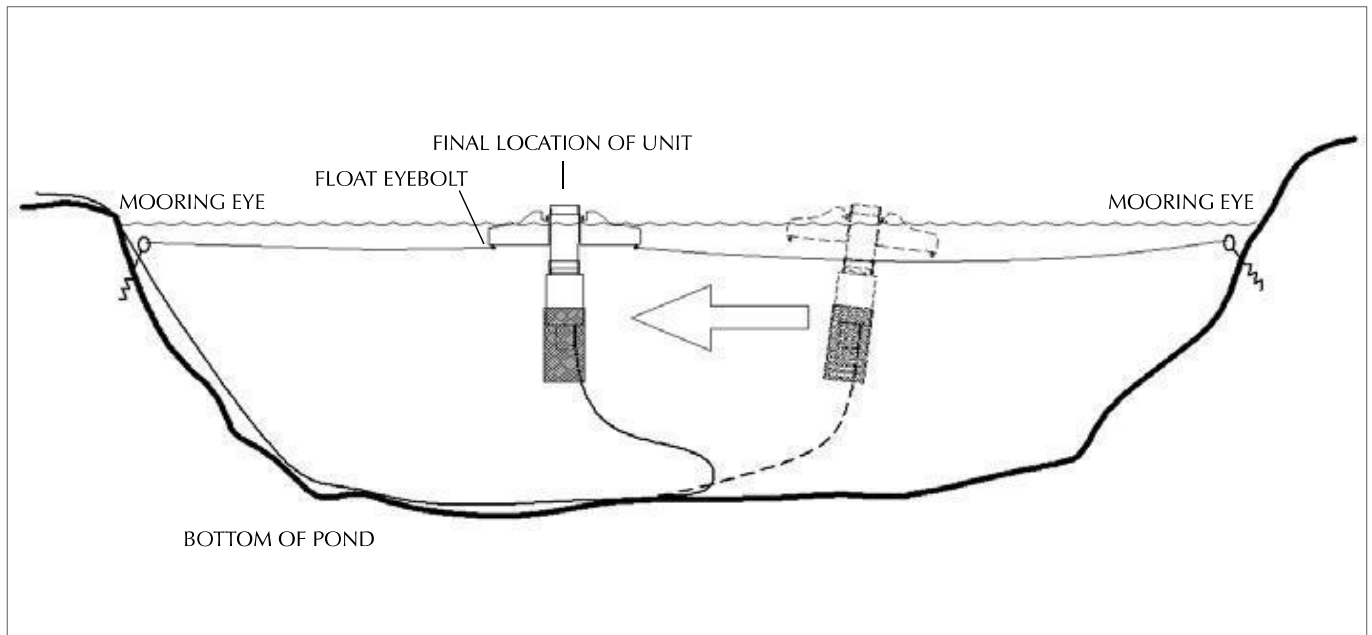
Any *Aqua Control, Inc.* aerator can be operated continuously or intermittently as desired except during freezing weather. If a less than normal flow is observed, it is imperative that the cause be promptly investigated and corrected. Failure to do so can cause cavitation resulting in pump and motor damage and will void the warranty. Reduced flow will usually be due to a blockage that must be removed.

INSTALLATION

ENDUR SERIES LAUNCHING

MOORING - FLOATING UNITS

1. Tie the mooring line to the eye-bolts on the float.
2. Pull the unit past its final location by a distance at least equal to the pond depth at the desired final location.
3. Bring the unit back to the final position. There should be slack on the electric cable to allow it to hang straight down without tension on the unit causing it to tilt the spray pattern.
4. Motor torque causes the unit to try to rotate. Upon start up, watch to verify that the unit cannot rotate more than 1/3 of a turn. If it is allowed to rotate, the electric cable can pull around the unit very tightly and cause damage.
5. Never allow lengths of rope to float near the intake of the unit where it can be pulled in and entangled in the pump.

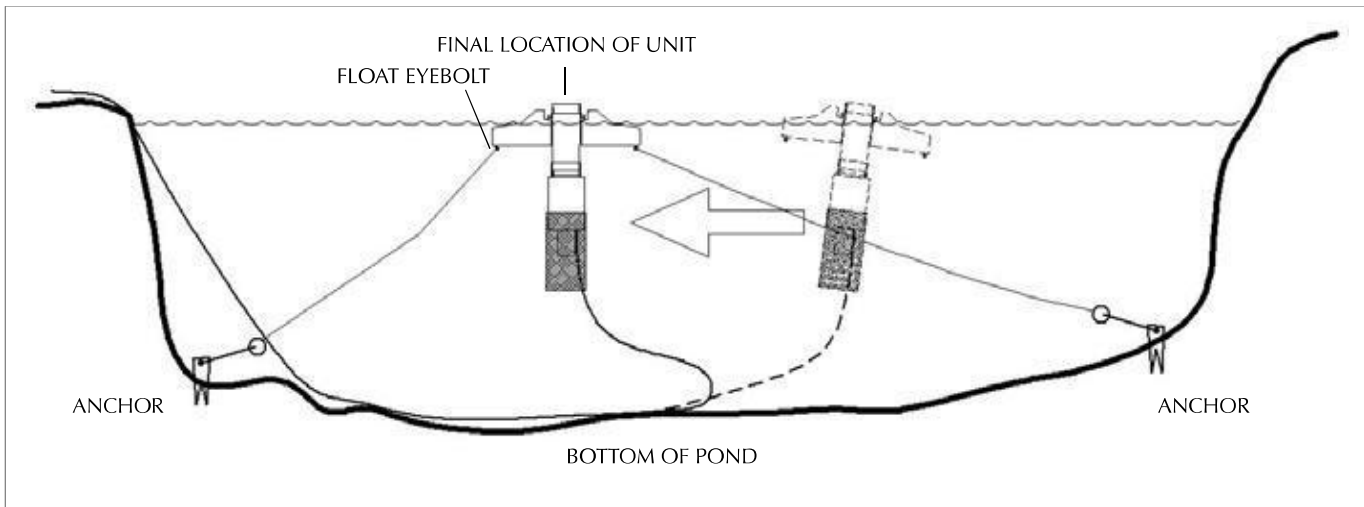


INSTALLATION

ENDUR SERIES LAUNCHING

ANCHORING - FLOATING UNITS

1. Tie the anchoring rope to the eye-bolts on the float. Use a rope at least three times the depth and be sure it has no slack.
2. Pull the unit past its final location by a distance at least equal to the depth of the pond at the desired final location.
3. Bring the unit back to the final position. There should be enough slack on the electric cable to allow it to hang straight down without tension on the unit causing it to tilt the spray pattern.
4. Tie the anchors to the anchor lines. Use multiple anchors if the pond bottom is smooth or slippery. Heavy or multiple concrete blocks are suitable for soft bottoms where they will sink into the mud but, they are inadequate on hard, smooth, slippery or sloping bottoms.
5. Anchors should be set out at a MAXIMUM of 45 degrees to the surface of the water. It is preferred to have the anchor line as parallel to the surface as possible. They should be on opposite sides of the float. To ensure the unit remains very close to certain position, a third (or fourth) anchor line can be used.
6. Be sure that the electrical cable has slack, hangs straight down from the unit and is not tangled with the anchor lines.
7. The anchor lines must be kept tight enough to prevent the unit from rotating. If the water level changes or the anchor lines otherwise become slack, the unit will rotate and twist the electrical cable causing cable damage.



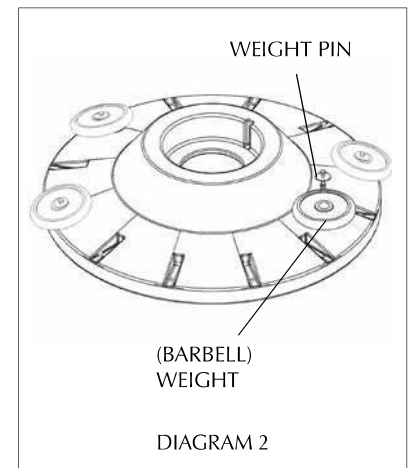
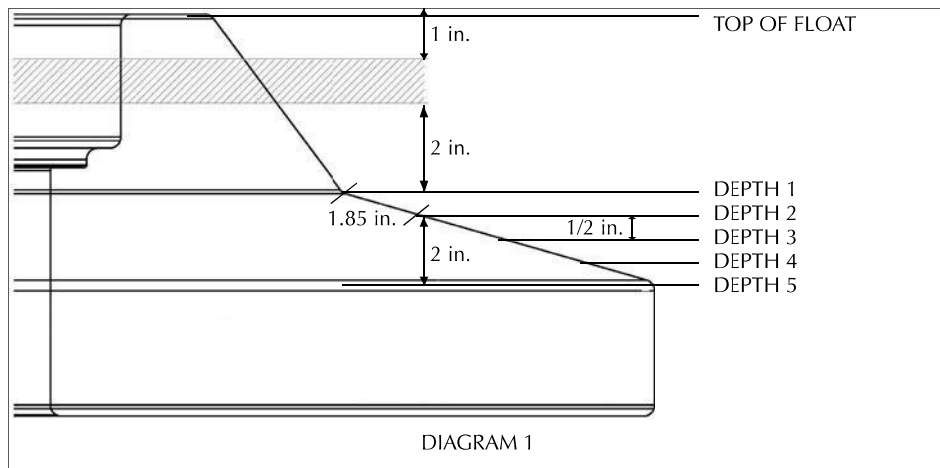
FLOTATION ENDUR SERIES

Diagram 1 below shows the optimum floating depth for an *Aqua Control, Inc.* unit. The shaded area of the diagram shows the least amount of float and nozzle possible. The chart shows the amount of weight that needs to be added to sink the unit to the optimum depth. This is an optional step. The unit will operate properly without adding any weights but, more of the float will be showing. The only time weight has to be added is to sink the unit far enough for the lights to be 2" under water while operating. Remember that the unit must be running to decide how much weight has to be added. If you add weights to the float at the optimum depth while the unit is off, the thrust of the nozzle could sink the unit.

After turning the unit on, estimate the floating depth from diagram 1 below. Look on the chart to determine the amount of weight that needs to be added. The chart also gives recommended combinations of weights to accomplish the desired weight.

Attach the weights to the top of the float using the hardware provided in the float hardware package. There are (6) six 2 1/4" long bolts with a 1" diameter flat washer and a hex nut on each bolt. Slide the flat washer up to the head of the bolt and put the threaded end of the bolt through the center of the weight. Thread the bolt into any open insert on the top side of the float. The 1" diameter flat washer keeps the weight from sliding off the bolt. The weights must be distributed evenly around the float to keep it floating level.

FLOAT VS. WEIGHT					
DEPTH WHEN RUNNING	TOTAL WEIGHT REQUIRED	NUMBER OF WEIGHTS			
		2	3	4	6
DEPTH 1	15 lbs.	-	5	-	-
DEPTH 2	20 lbs.	10	-	5	-
DEPTH 3	30 lbs.	-	10	2x10 + 2x5	5
DEPTH 4	40 lbs.	-	-	10	-
DEPTH 5	55 lbs.	-	-	-	4x10 + 2x7.5

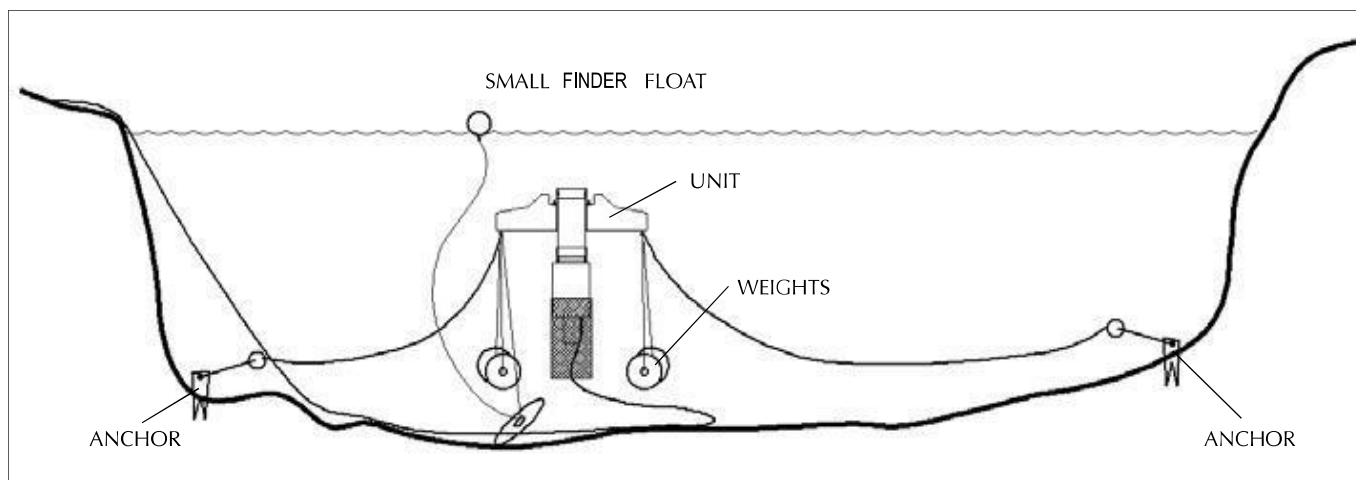


FREEZING WEATHER STORAGE

SINKING

This procedure is the best and simplest method of winter storage, if a boat is available. By sinking the unit, it cannot freeze, the unit is not damaged from handling, the seals do not dry out and it saves on labor of removing and re-installing the units.

To sink a unit for winter storage, the pond depth must be 4 to 6 feet plus the height of the unit itself. Get the minimum water depth from the *Aqua Control, Inc.* specs, add 4 to 6 feet plus the normal depth of ice on the pond. If the pond does not have sufficient depth then, sinking is not an option for winter storage. Any *Aqua Control, Inc.* unit can be stored by sinking with enough depth in the pond.



1. Attach poly rope for retrieval. Use a rope that floats for finding and retrieving the unit. Attach a small finder float to the rope end if desired.
2. Determine how many inches of float are above the water when the unit is off. Use the information under flotation, page 12, to determine the amount of weight it will take to sink the unit.
3. Weight lifting weights are a convenient and economical source of such weight. Do not use concrete blocks as weights. They are bulky and weigh only about 1/2 their normal weight when in water.
4. Secure a 25 lb. weight to each eye bolt on the float. Tie a rope through the hole of one weight. Tie the other end of the rope to a float eye bolt or tie it to a snap hook and snap the hook over the eye bolt (the snap must fit over the 3/8" diameter eye of the eye bolt). Repeat for the other float eye bolt. The ropes must be long enough so that these weights hang down below the bottom of the unit. Attach a poly rope for retrieval. Use a rope that floats for finding and retrieving the unit. Attach a small marker to the rope end if desired or if a non-floating rope is used.
5. Using a rope 6' to 8' long, tie each end to a weight. Wrap the center of the rope completely around the head and lower the weights alongside to just below the float. Keep the weights clear of lights or cable. These weights do not need to hang down past the lower tube.
6. Repeat until all the weights have been added. When the last weights are added, the assembly should gently sink until deepest weights rest on the bottom. The unit will then float upright in this position until pulled back up in the spring.
7. Spring retrieval will require very little effort since just enough weight has been added to sink the unit.
8. When properly submerged, the top of the unit should be at least 2' to 3' below the surface of the water so that it is out of the ice layer.
9. Be sure to follow the instructions so that the unit is not driven into the mud.

FREEZING WEATHER STORAGE (con't)

REMOVAL

1. Disconnect the motor from the cable or cut the cable at the splice.
2. Store with the shaft end of the motor inclined up. If the unit is resting on the float and on the bottom of the lower tube, the angle will be satisfactory. Do not rest the unit on the lights or light brackets. Protect the motor lead connector by using the winter cap that was supplied with the unit.
3. The under water cable should not be left on the ground since it could easily be damaged when brittle from cold weather. Re-attach winter cap and re-immersion the cable so it is below the ice and away from shore traffic.

WINTER OPERATION

SAFETY ADVISORY! If winter activities occur on the lake, operation of a unit during the winter will compromise the thickness and stability of the ice that develops around the perimeter of the open water and could create a safety hazard for anyone on the ice.

WARRANTY DISCLAIMER: Many variables must be considered before deciding to operate an Endur Series Vertical Aerator or Fountain during the winter. These variables include but are not limited to the depth of the lake, overall size of the lake, climate variation, predictability of cold and loss of power in winter conditions. *Aqua Control, Inc.* does not warranty any damage incurred during winter operation, even if the following guidelines are followed.

MARGINALLY FREEZING WEATHER

Continued winter operation of either aerators or fountains is seldom a problem if the surface of the pond **does not** normally freeze solid.

1. During a cold snap, it may be necessary to shut the unit off to prevent ice accumulation on the float, which could cause the unit to tip. If the unit tips and has lights, some of the lights could come out of the water, possibly allowing them to break or leak from overheating. It might also allow the gasket to freeze and water could leak into the fixture.
2. To be certain that operation with a nozzle does not create a large mound of ice which could cause the aerator to roll over and result in motor lead damage, simply remove the nozzle and let the water gush to provide circulation of the warmer deep water up to the surface.
3. Do not remove the head or the unit will slip through the float and sink to the bottom.

MAINTENANCE

GENERAL

Aqua Control, Inc. products do not require yearly maintenance of the motors or pumps. The motors should never be opened for maintenance and doing so will void the factory warranty.

MOTOR AND PUMP SERVICING: Any servicing of Endur Series motors must be done by a qualified *Aqua Control, Inc.* certified service person that has attended an annual *Aqua Control, Inc.* service training seminar. Periodic oil changing may be necessary and it is important that the proper oil is used in order to preserve the life of the motor. The special bio-degradable oil in the Endur Series motor assembly must be provided by *Aqua Control, Inc.* This oil is suitable for marine environments.

SUCTION SCREEN CLEANING: Routine cleaning of the suction screen is required to assure adequate water flow past the motor to cool it during operation. If the screen becomes fouled with debris the motor can overheat and the spray pattern can be diminished.

LIGHT LENS CLEANING: The light lenses should be cleaned frequently to prevent algae and dirt buildup. Buildup dims the amount of light that comes through the lenses and can cause them to overheat. If rock guards are used on the lights, the lights should be monitored more frequently for algae buildup.

TROUBLESHOOTING

GENERAL TROUBLESHOOTING

1. Set up the Multimeter
 - a. Ohms
 - i. Know the range of Ohms available for your multimeter and whether your meter is auto-ranging.
 - ii. Set the multimeter to the lowest Ohm (resistance) setting. Resistance is designated by Ohms.
 - iii. Determine how your multimeter designates open line. Observe the reading when both probes are held in the air, not touching.
 - iv. Determine how your multimeter designates continuity. This is done by touching the two probes. This should be either zero or very close to zero. If your meter has an "auto-zero" feature, use it to zero the meter.
 - b. Volts
 - i. Set the multimeter to the highest setting.
 - ii. Select AC volts. This is usually designated by VAC.
 - c. Amps - Use only a clamp ammeter e.g. Amprobe.
2. Check Neutral to Ground Voltage
 - a. Set multimeter to AC voltage, highest rating.
 - b. Check the voltage between Neutral and Ground.
 - c. The voltage should be zero.
 - d. If the voltage is other than zero, the neutral line may be bad.
 - e. A bad neutral may lead to faulty GFCI tripping.
3. Check Input Voltages - Readings should be within 10% of nominal voltage.
 - a. Single Phase
 - i. Each line to Neutral should be approximately half of the input voltage.
 - ii. Each line to one another should be the source voltage.
 - b. Three Phase
 - i. 208 Volt, Y
 1. Each line to Neutral should be 120 volts.
 2. Each line to one another should be source voltage.
 - ii. 230 Volt, Delta
 1. L1 and L3 to Neutral should be half source voltage.
 2. L2 to Neutral should be substantially higher. This must be the wild leg connection.
 - iii. 480 Volt / 480 Volt, Grounded
 1. Each line to Neutral should be approximately 277 volts.
 2. Each line to one another should be source voltage.
 - iv. 480 Volt Delta
 1. Each line to one another should be source voltage.
 - c. Analysis
 - i. If lines read good to Neutral but zero to one another, the same leg is used for both lines. Correct this at the source.
 - ii. If the lines read bad to one another or bad to Neutral, the power source or power cable must be corrected.
 - iii. A three-phase, 230 volt delta power source must have the wild leg connected to L2, the center input of the disconnect switch.
4. Check Output Voltages
 - a. 2-Wire: T1 - T2
 - b. 1-Phase: Black - Yellow
 - c. 3-Phase: Analysis
 - d. Analysis
 - i. Each reading should give source voltage.
 - ii. If good, problem is not in control panel although overloads or GFCI's may be too sensitive and cause premature tripping.
 - iv. If low voltage: very unlikely, control panel wired incorrectly.
5. Check Amps - Readings should be within 10% of nominal voltage.
 - a. Single phase - Check yellow wire.
 - b. Three phase - Check each hot wire; readings should be within 5% of one another.
6. If GFCI tripped, perform "GFCI Troubleshooting Procedures".
7. If overload tripped, perform "Overload Troubleshooting Procedures".

TROUBLESHOOTING

CABLE TROUBLESHOOTING

Two problems affect cable integrity, shorted lines and broken or open lines. The following procedures will determine cable integrity. The cable should be disconnected from both the motor and the control panel. Verify the power is off before removing the cable.

1. Set up the Multimeter
 - a. Set the multimeter to the lowest Ohm (resistance) setting. Resistance is designated by Ohms.
 - b. Determine how your multimeter designates open line. This is done by observing the reading when both probes are held in the air, not touching.
 - c. Determine how your multimeter designates continuity. This is done by touching the two probes. This should be either zero or very close to zero. If not zero, this may be resistance internal to the meter and should be subtracted from all subsequent reading.
2. Disconnect the cable from the control panel and the load (pump or lights). Both ends must be dry. Verify the power is off before removing the cable.
3. Check for shorted lines. A short is an unintentional electrical path and can be caused by faulty insulation.
 - a. Set the multimeter to the highest Ohm (resistance) setting.
 - b. Take readings by touching the probes to each pair of wires; e.g. red -black, red-yellow, black-yellow, etc.
 - c. Analyze the readings.
 - i. The readings should be the same as the open line readings you observed in step 1b.
 - ii. If the readings designate continuity by giving a zero reading or any reading less than open line, a short exists.
 - iii. If any of the readings with green (ground) indicate continuity, a leak to ground exists.
 - d. Determine the action to take.
 - i. Visually inspect the cable.
 - ii. Any manual connection sites are candidates for inspection, e.g. junction boxes, splices.
 - iii. It may be impossible to determine the location of the short and a new cable may be the best solution.
4. Check for open lines - An open line is a break in a wire.
 - a. Set the multimeter to the lowest Ohm (resistance) setting.
 - b. At the control panel, with the cable disconnected from the control panel, join two wires, e.g. red and yellow, by wrapping the ends together. If you have four wires, you may wish to connect the other two together. Note which wires are connected.
 - c. From the other end of the cable select on of the pairs of joined wires and take readings by touching the probes to each wire or socket of the connector.
 - d. Analyze the readings.
 - i. The readings should indicate continuity, (either zero or close to zero). The readings should not exceed a few Ohms.
 - ii. If the readings indicate either open line or a very high number, a break or partial break exists.
 - iii. If a break exists, one or both of the wires tested may be involved.
 1. Visually inspect the cable.
 2. Any manual connection sites are candidates for inspection, e.g. junction boxes, splices.
 3. It may be impossible to determine the location of the open line and a new cable may be the best solution.
 - e. Perform these steps for each combination of wire pairs.

TROUBLESHOOTING

MOTOR CONTROL BOX (MCB)

1. Test Overloads - Perform test for each overload. Verify the power is off before testing.
 - a. Overload Identification
 - i. Left overload is "Run" or "Main".
 - ii. Right overload is "Start".
 - b. Push red reset button to verify closure. It may be necessary to press these buttons very hard to reset.
 - c. Set ohmmeter to lowest range.
 - d. Test resistance between the two soldered connections on the top of the overload.
 - e. If the resistance is less than 0.5 Ohms, the overload is good.
 - f. If the resistance is greater than 0.5 Ohms, replace both overloads.
2. Check the amps on the red wire from MCB.

- a. This test requires careful attention. The amp readings may change within seconds.
- b. Power off the control panel.
- c. Attach the ammeter to the wire connected to the "RED" terminal of the MCB.
- d. Power on the control panel.
- e. If amps do not drop, go to "Test Capacitor" and check "Start" capacitor.
- f. If amps jump and stay high, go to "Test Relay".
- g. If amps jump and return to zero, to the "Test Capacitor" and check "Run" capacitors.
- h. If amps jump and return to normal "Red" amps (see table below), the MCB is functioning correctly.
- i. Normal Amp Readings.

HP	YELLOW AMPS	BLACK AMPS	RED AMPS
1	10	10	0
2	13	12	3
3	17	13	6
5	28	19	11

3. Test Capacitor. Verify the power is off before testing.
 - a. Capacitor identification - Usually "Start" capacitors are large and black and "Run" capacitors are small and silver.
 - b. Set ohmmeter to 20,000 Ohms.
 - c. Remove all wires from one terminal of the capacitor.
 - d. Test resistance between the two terminals.
 - i. Resistance should climb towards infinity (open Line). If testing the 5HP Start Capacitor, the resistance should climb to 15,000 Ohms.
 - ii. If resistance does not climb, switch meter leads.
 - iii. If the resistance still does not climb, replace capacitor.
 - e. If the meter has capacitance checking capability, check the capacitance. See table below.

HP	# RUN CAPS	RUN μ F	# START CAPS	START μ F
2	1	20	1	105-126
3	1	45	1	208-250
5	2	20/40	1	270-324

TROUBLESHOOTING

MOTOR CONTROL BOX (MCB) (con't)

4. Test Relay. Verify the power is off before testing.
 - a. Test Coil
 - i. Disconnect all wires from terminal 5 (upper right terminal); yellow wire and possibly red if panel has light circuit(s).
 - ii. Set ohmmeter to 10,000 Ohms.
 - iii. Check resistance between terminals 2 (center terminal, red) and 5 (where the yellow wire was connected).
 - iv. Reading between 4,500 Ohms and 7,000 Ohms are good.
 - v. If resistances are out of that range, replace relay.
 - vi. Reconnect all the wires removed from terminal 5 in step i.
 - b. Test Contact
 - i. Disconnect the orange lead from terminal 1.
 - ii. Set ohmmeter to lowest range.
 - iii. Check resistance between terminals 2 (red) and 5 (where the orange wire was connected).
 - iv. If resistance is greater than 1 Ohm, replace relay.

OVERLOAD TROUBLESHOOTING

1. Check Motor Amps
 - a. Determine "true" amp (yellow) requirement of motor. This is listed on the schematic as "Pump Motor Amps", on a decal on the panel door as "Motor FLA" and in the ACI brochures.
 - b. Power on control panel.
 - c. Check all output leads to motor for proper amps.
 - d. If amps are good, go to "Nuisance Tripping".
 - e. If amps are high, continue.

1-PHASE			3-PHASE		
HP	VOLTS	AMPS	HP	VOLTS	AMPS
1/2	115	12	1	208	6
1/2	230	6	1	230	5
1	115	16	1	460	3
1	208	11	2	208	9
1	230	10	2	230	8
2	208	14	2	460	4
2	230	13	3	200	12.5
3	208	20	3	230	10.9
3	230	18	3	460	5.5
5	208	30	5	200	20.5
5	230	28	5	230	17.8
7.5	230	15	5	460	8.9

TROUBLESHOOTING

OVERLOAD TROUBLESHOOTING (con't)

2. Check line-to-line resistance. Verify the power is off before testing.
 - a. Power off control panel.
 - b. Remove the pump cable connections from the terminal blocks at the bottom of control panel.
 - c. Set the ohmmeter to lowest resistance range.
 - i. Check each pair of pump cable wires, excluding Ground. Reading should be 2 - 20 Ohms.
 1. Single phase 3-wire: Black-Yellow, Red-Yellow, black-Red.
 2. Single phase 2-wire: T1-T2
 3. Three phase: T1-T2, T1-T3, T2-T3; All reading should be identical.
 - ii. Readings of zero indicate a "Short". Reading greater than 20 Ohms indicate an "Open" or partially broken line. Either of these readings indicates a problem.
 - d. If line-to-line readings indicated a problem, it is necessary to isolate the problem.
 - i. Any connection points, e.g. junction boxes, splices, connectors, etc., provide a potential problem area. Additionally, animal bites, cuts or scrapes could create a problem.
 - ii. Perform step #2c at each connection point from the end of the cable at the control panel to the motor lead, until a good reading is found. The problem will be in the previous connection tested. If the final test is at the motor lead, the problem is with either the motor or the motor lead.
 - e. If line-to-line readings are good, continue.
3. Investigate Mechanical Problems
 - a. 70% of overload problems are mechanical e.g., worn or bad bearings, locked rotors, bent motor shafts or broken shrouds. An improperly pitched prop, missing shims or nozzle problems may cause overloads to trip.
 - b. When thrust bearings are worn, the motor shaft may be pulled 1/8" or more. When radial bearings are worn, the motor shaft may be moved side to side slightly.
4. Nuisance Tripping
 - a. Nuisance tripping can be caused by temporary voltage irregularities e.g., brownouts, spikes.
 - b. Excessive heat, above 122°F may cause overload tripping. A control panel in direct sunlight will heat up and temporarily degrade thermal overloads protection. One possible solution is to remove the cover of the motor control box. Another solution is to cover the control panel with an awning or face the panel north or west.