



# Aqua Control, Inc.



## 60Hz / 50Hz COMBO SERIES INSTRUCTION MANUAL

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### SAFETY INFORMATION

#### WARNING

This appliance is not intended for use by persons (including children) with reduced physical, sensory, or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children should be supervised to ensure that they don't play with the appliance.

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 electrical codes. (Australia: AS/NZS 3000)
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 cord. 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 make certain that the control panel and all electrical equipment is grounded properly.
10. Pumps for outdoor fountains, garden ponds, and similar places have to be supplied through a RCD (operating current  $\leq 30$  mA). Any time high voltage electricity is used underwater, a potential safety hazard exists. Aqua Control builds and provides UL listed control panels 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 people. They have a nominal trip level of 5 ma (milli amps=.005 amps) and are designed to shut the circuit off in 25 milli seconds. 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.

**Notice:** Pollution of the water could occur due to leakage of lubricants.

### PRE-ASSEMBLY

Any components that have been removed from the packages and installed in the water will have a higher restocking fee if it is later determined that they have been ordered incorrectly and need to be returned to the factory and exchanged. Keep your original packaging for returns to the factory or contact the factory for packaging suitable for safe return of the product.

1. **Check the packing list** that came with the shipment. Make certain all the boxes have been received. Each label will have a boxnumber 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?

## COMBO SERIES HORIZONTAL FOUNTAIN

Horizontal Combo units are shipped fully assembled on a shipping pallet.

1. Remove straps holding the fountain to the pallet and remove any cartons that were shipped with the fountain on the pallet. (lights, cord, etc.). See diagram. **DO NOT CUT SUPPORT STRAPS**
2. Inspect for any visible damage that may have occurred during shipping. Contact Aqua Control, Inc. immediately if any damage is found. **DO NOT CUT THE SUPPORT STRAPS** holding the discharge to the lower pump.
3. See the nozzle, cord, and light instructions for attaching these to the unit.

## NOZZLES

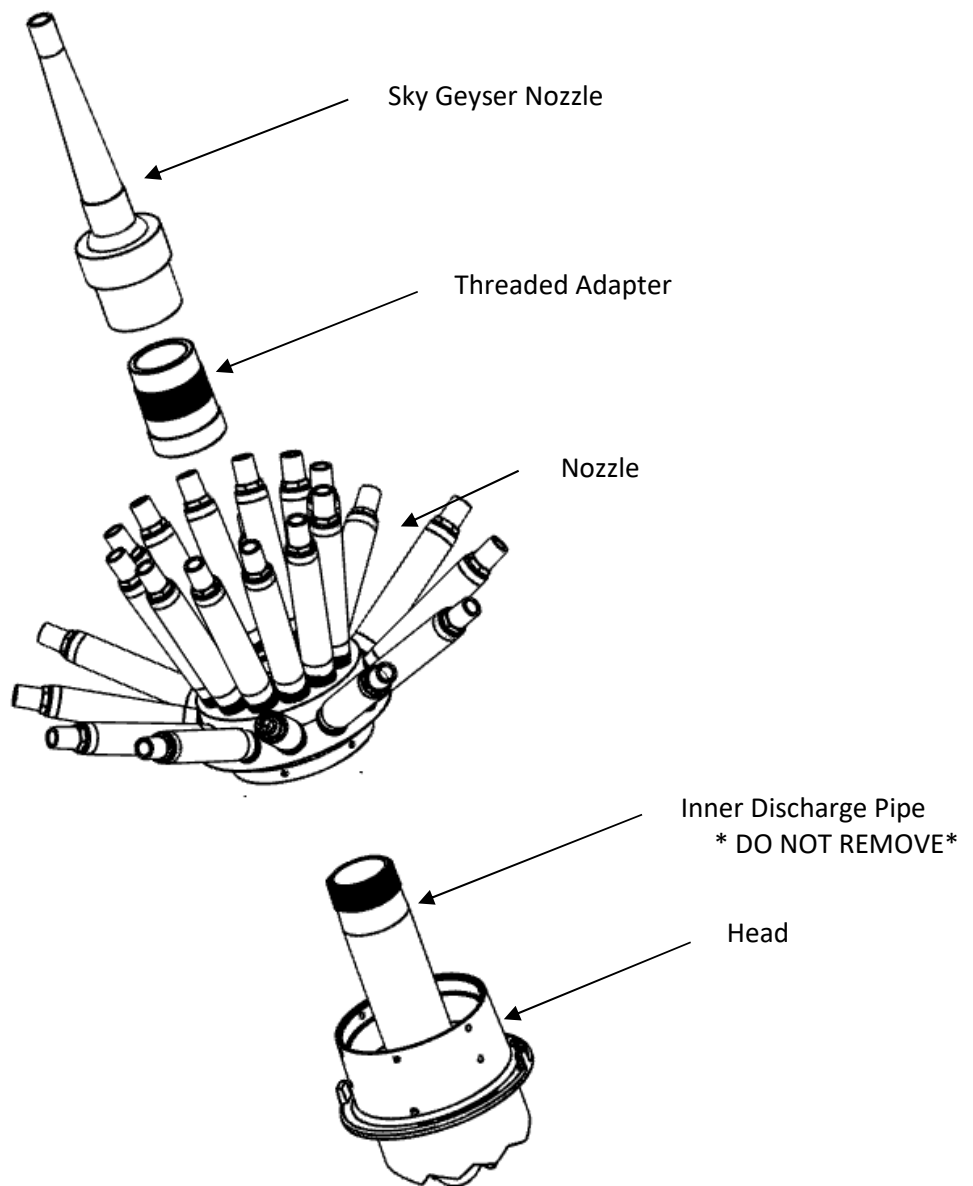
Find the nozzle that is being attached to this unit in the table below. This table will tell you which of the five nozzle types a nozzle falls under to locate the correct instructions.

FOUNTAIN NOZZLES	NOZZLE TYPE
Buckingham	Type 1
Cluster Arch & Sky Geyser	Type 1
Daffodil	Type 2
Double Arch & Sky Geyser	Type 1
Fleur De Lis	Type 1
Spider & Arch & Sky Geyser	Type 1
Spoke & Sky Geyser	Type 1
Tiara	Type 1
Tornado & Sky Geyser	Type 2
Weeping Willow & Sky Geyser	Type 1

## NOZZLES

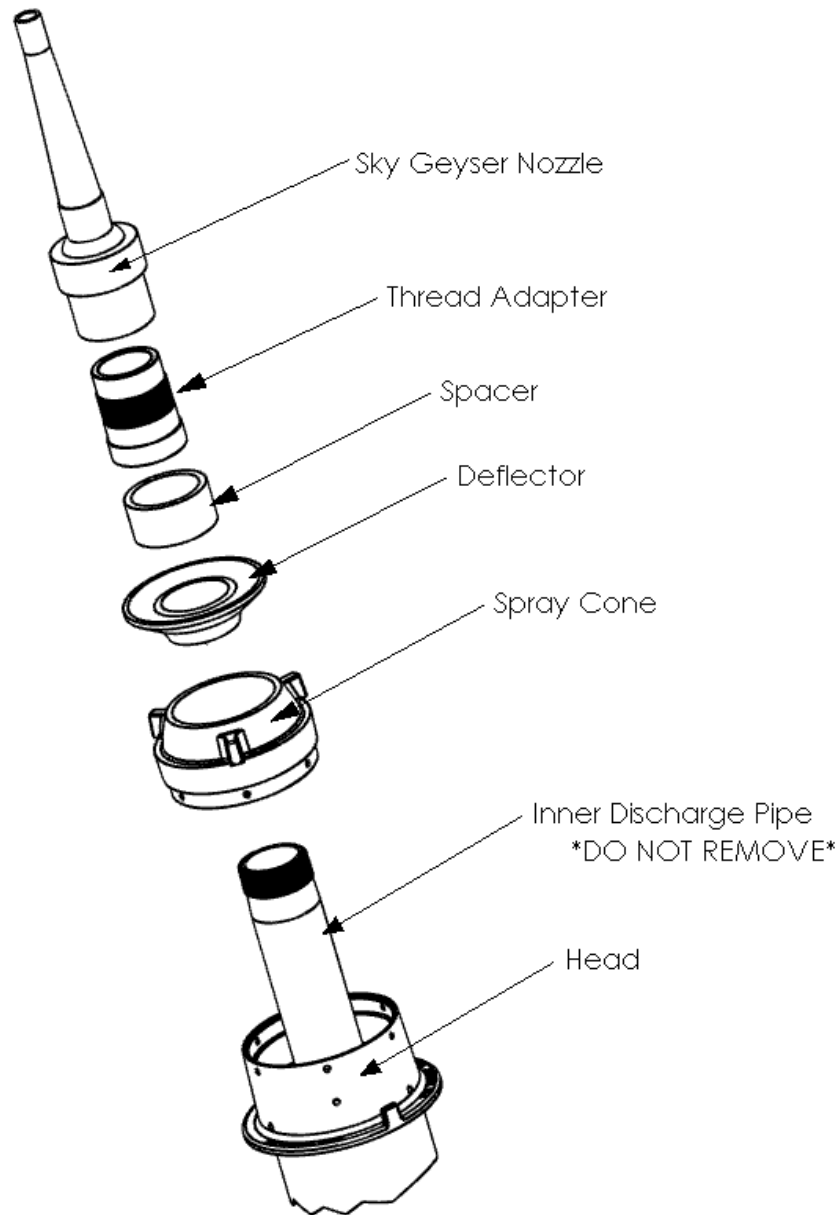
### NOZZLE TYPE 1 – MULTIPLE NOZZLE CASTING/SPRAY CONE

1. Nozzle will be preinstalled on the unit.
2. For Maintenance or repair disassemble the nozzle in the following order.
  - a. Sky Geyser Nozzle
  - b. Threaded Adapter
  - c. Remove silicone from around the Inner Discharge Tube and Multi-nozzle Casting mating surface. *Make sure to apply silicone when reassembling.*
  - d. Multi-nozzle Casting – make sure to retain the O-ring that goes between the Multi-nozzle Casting and Head.
3. To put the Nozzle back together, use the above order in reverse.
4. When reassembling the nozzle, use petroleum jelly and apply it generously to the O-ring on the flange of the nozzle. Spread it evenly over the O-ring. Never use the petroleum jelly on the electrical quick disconnects.



## NOZZLE TYPE 2 – FLARE AND SKY GEYSER

1. Nozzle will be preinstalled on the unit.
2. For Maintenance or repair disassemble the nozzle in the following order.
  - e. Sky Geyser Nozzle
  - f. Threaded Adapter
  - g. Spacer – spacer will slide over the Inner Discharge Pipe freely.
  - h. Deflector – deflector will slide over the Inner Discharge Pipe freely.
  - i. Spray Cone – make sure to retain the O-ring that goes between the Spray cone and Head.
3. To put the Nozzle back together, use the above order in reverse.
4. When reassembling the nozzle, use petroleum jelly and apply it generously to the O-ring on the flange of the nozzle. Spread it evenly over the O-ring. Never use the petroleum jelly on the electrical quick disconnects.



## LIGHT SET ASSEMBLY COMBO SERIES FRESHWATER & SALTWATER - HORIZONTAL

### COMBO SERIES FRESHWATER

1. Open the light set box and remove the plastic bag containing brackets and hardware. The package contains (1) one straight float bracket, (2) two angled float brackets, (6) six hex head bolts, (4) four lock washers, and (4) four hex nuts for each light in the set.

2. Combo horizontals have two sets of floats, one on either side of the nozzle. The floats must be turned so that the (2) two eyebolts are at the outsides of the unit, away from the nozzle. The lights need to be attached symmetrically around the nozzle in the center, the same number of lights on each upper float and in the same position if possible. Attach one of the angled float brackets to the top of the float at one of the threaded inserts. Place a lock washer on a screw and put the screw through the middle hole or the hole furthest from the angle on the bracket.

**If this is a saltwater unit,** place a small rubber washer from the float hardware package onto the bolt. Thread the screw into the insert and tighten. Repeat this step for each light in the set, placing the brackets symmetrically around the nozzle.

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 3/4" hex bolt, lock washer, and hex nut at each angled bracket.

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.

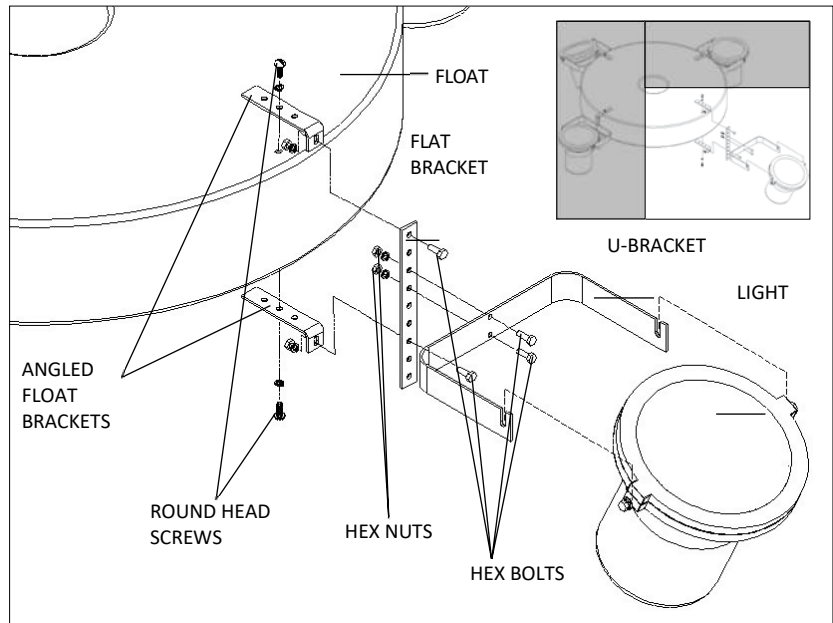
6. Loosen the (2) two hex head bolts that attach the light bracket to the light and slide the bracket off the light.

7. Remove the (2) two hex head bolts, (2) two lock washers, and (2) two hex nuts from the center of the light U-bracket. Use this hardware to attach the light U-bracket(s) to the flat float bracket(s). The slots in the light 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 pg. 11 for adding weights.) If the unit is floating higher when running and is not going to be 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.

8. Reattach the light canisters to the light brackets by setting the bolts back into the slots. Retighten the bolts. This step must be done at the shoreline or after the unit is floating. **DO NOT** transport the unit from the shop to the installation with the lights attached.

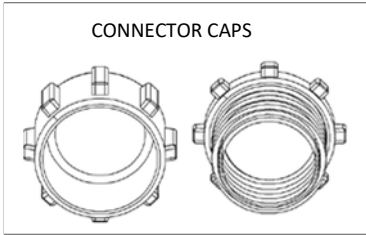
9. **If this is a saltwater unit,** plug the remaining threaded inserts on the float with the hardware in the float hardware package. Place a lock washer then flat washer then rubber washer onto the bolt and thread into the insert. If weight pins are used, a rubber washer must go between the flat washer and float insert.

10. The unit is ready to be floated after the cord connection(s) have been made.



# CORD

## CORD CAPS

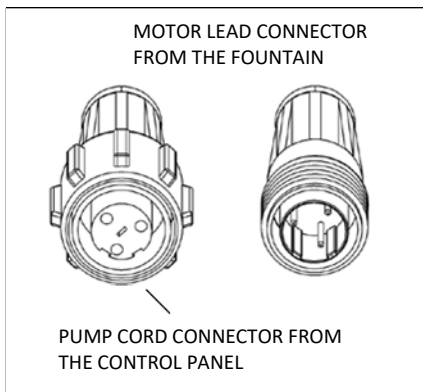


Blue quick disconnect caps are used to protect the quick disconnects during handling and to keep them dry if submerged while unconnected to mating quick disconnects.

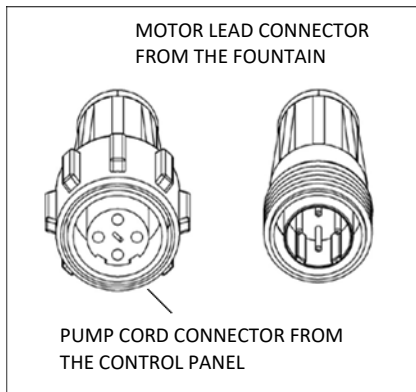
## CONNECTOR IDENTIFICATION

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

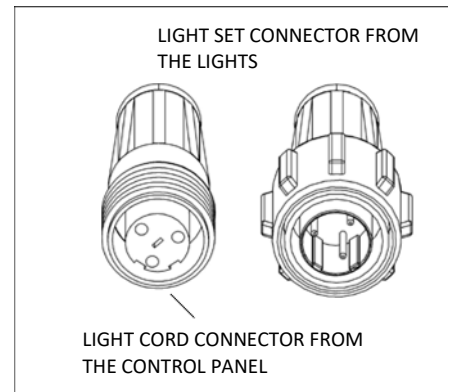
### 3 WIRE PUMP CORD



### 4 WIRE PUMP CORD

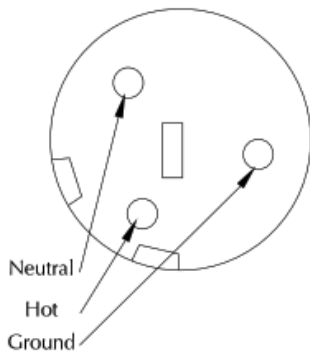


### LIGHT CORD

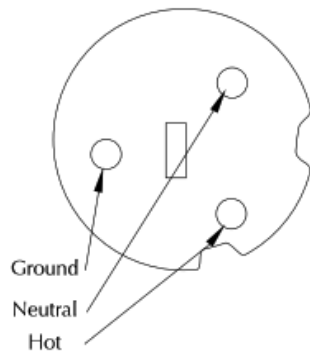


## WIRE IDENTIFICATION

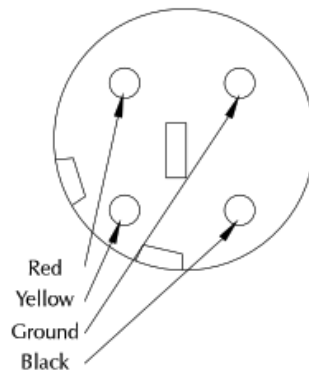
2 Wire with Ground  
Motor Lead Connector  
& Light Set Connector



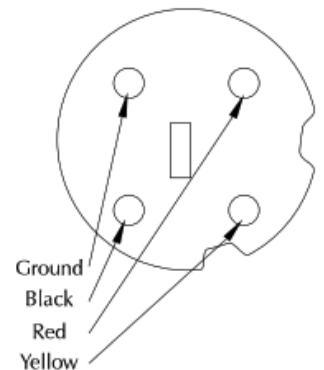
2 Wire with Ground  
Pump Cord Connector &  
Light Cord Connector



3 Wire with Ground  
Motor Lead Connector



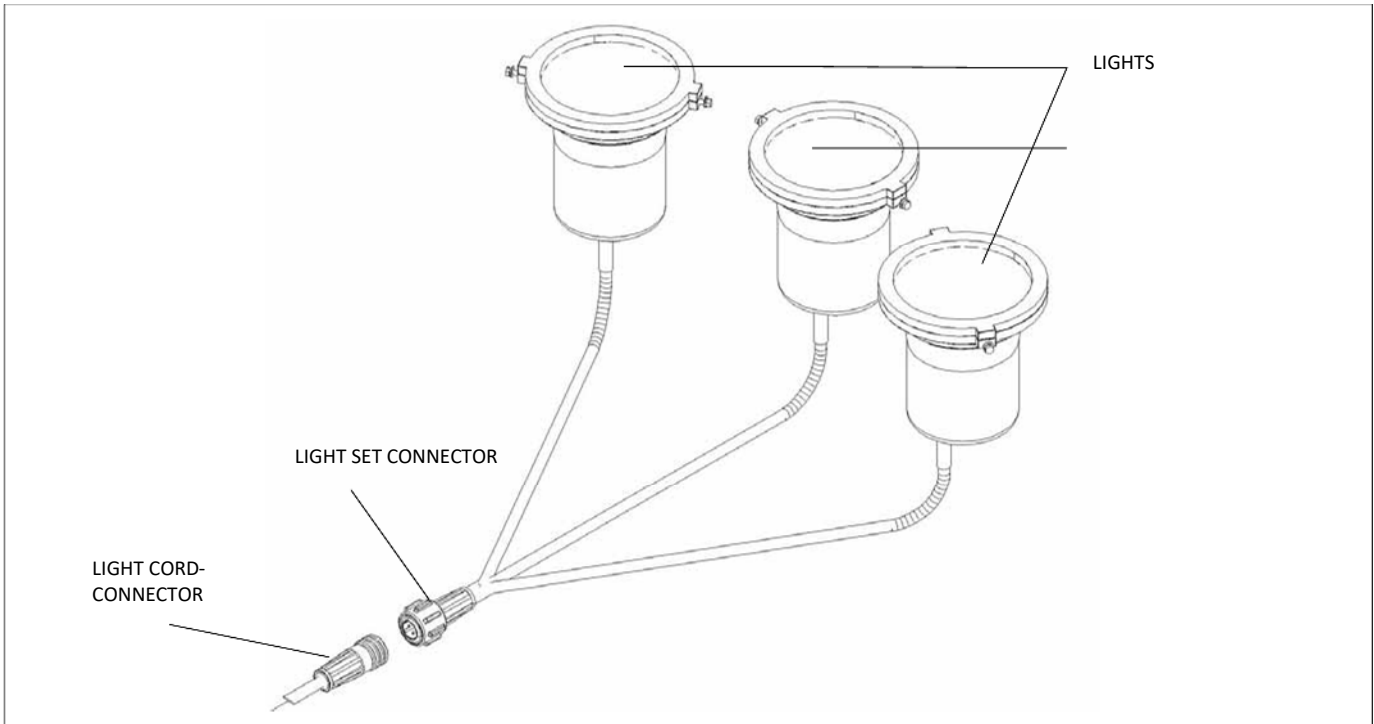
3 Wire with Ground  
Pump Cord Connector



## LIGHT CORD ASSEMBLY

### 3 WIRE LIGHT CORD

One light set will be attached to each quick disconnect. Make sure the quick disconnect is properly aligned with the notches (see picture) in the mating quick disconnect. Firmly push the quick disconnects together. Tighten by holding the quick disconnects and turning the large blue nut on the other quick disconnect. Tighten snugly by hand. No tools are required.



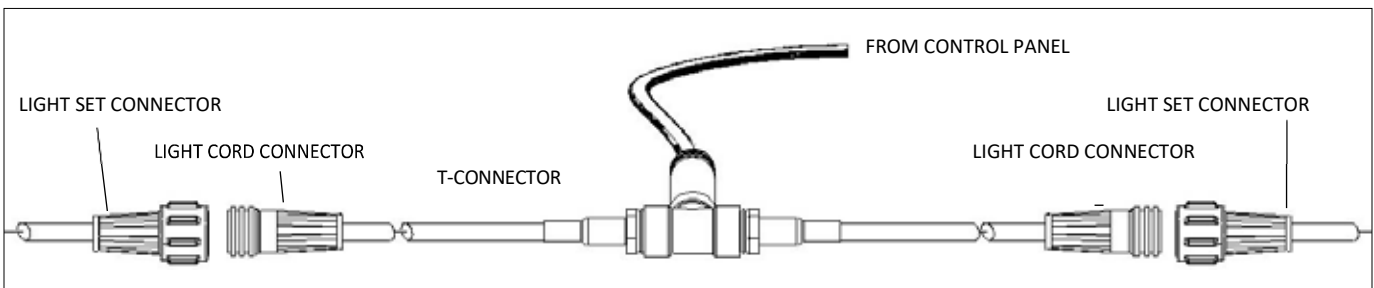
## LIGHT CORD ASSEMBLY

### 4 WIRE LIGHT CORD

#### T-CONNECTOR LIGHT CONNECTION

The T-Connector Light cord has (2) two 3-wire quick disconnects connected to one 4-wire cord. One of the two quick disconnects coming out of the tee is marked with red tape. That quick disconnect gets its power from the red wire in the 4-wire cord. The one without tape gets its power from the black wire in the 4-wire cord. The two quick disconnects share the ground and neutral line.

One light set will be attached to each quick disconnect. Make sure the quick disconnect is properly aligned with the notches (see picture) in the mating quick disconnect. Firmly push the quick disconnects together. Tighten by holding the quick disconnects and turning the large blue nut on the other quick disconnect. Tighten snugly by hand. No tools are required.

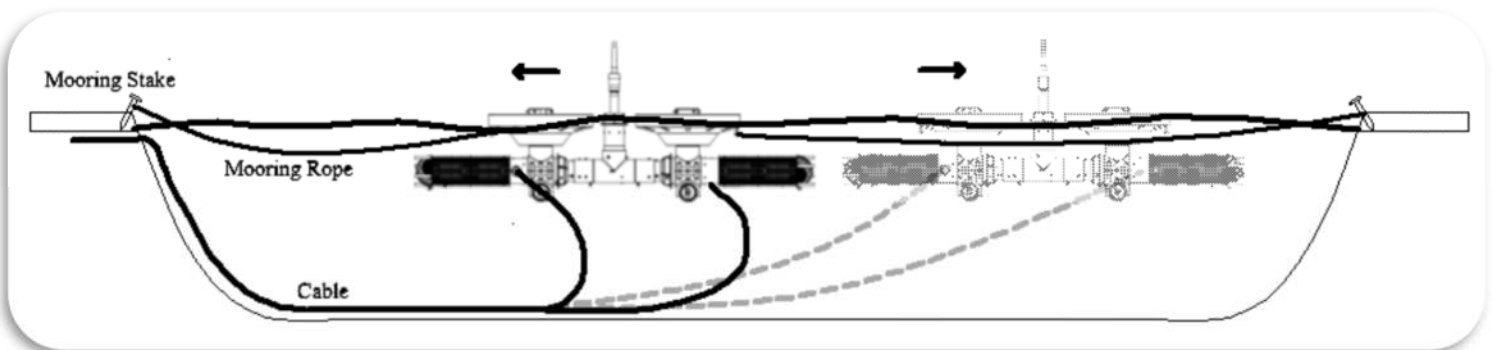


# INSTALLATION

## MOORING - FLOATING UNITS

Mooring a floating product means running a 3/4" nylon rope from the eyebolts on the floats to the stakes on either side of the pond. Mooring is usually easier to accomplish than anchoring and makes maintenance much simpler since the unit can be towed back to shore.

1. Tie the mooring line (preferably nylon because it sinks out of sight in the water) to the eyebolts on the float.
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 cord to allow it to hang straight down without tension on the unit causing it to tilt the spray pattern.
4. Hold the position of the unit in the water by tying the mooring lines from the eyebolts to the mooring stakes on shore.
5. Motor torque causes the unit to try to rotate. Upon startup, watch to make sure the unit cannot rotate more than 1/3 of a turn. If it is allowed to rotate, the electric cord can pull around the unit very tightly and cause damage.
6. Never allow long lengths of rope to float near the intake of the unit where it can be pulled in and entangled in the prop or impeller.



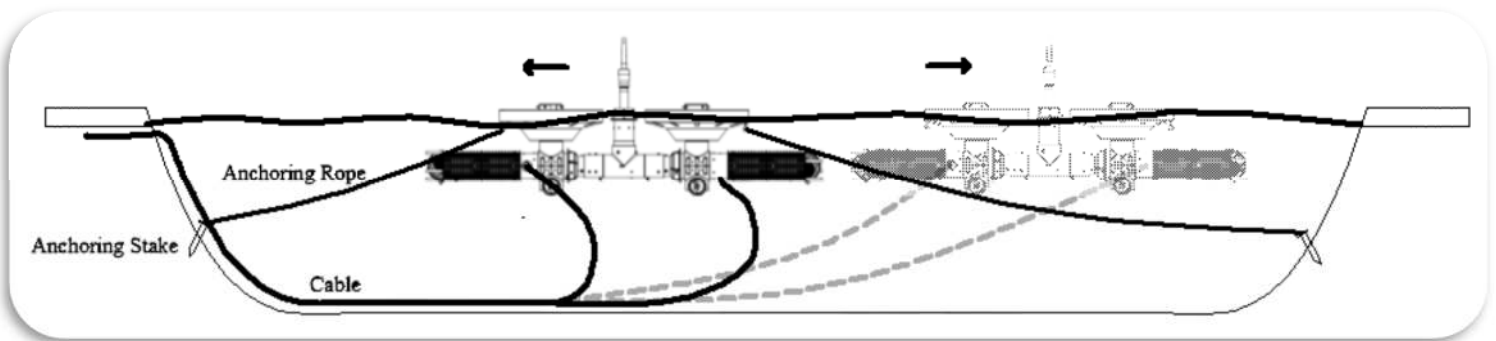


# INSTALLATION

## ANCHORING - FLOATING UNITS

Anchoring means the floating unit is held in one place by anchors. The anchors are sunk at the bottom of the pond by ropes connected to the eyebolts on the float. Use anchors when waders, swimmers, fishermen or boaters could tangle with mooring lines running to the edge of the pond. In shallow ponds where even anchor lines could be a problem, suitable pipes could be driven into the bottom about 5 feet apart and the unit tied to them.

1. Tie the anchoring rope (preferably polyethylene since it floats and can be located) to the eyebolts 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 cord to allow it to hang straight down without tension on the unit causing it to tilt the spray pattern.
4. Tie mushroom anchors to the anchor lines. Use multiple anchors if the surface 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) anchorline can be used.
6. Be sure that the electrical cord 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 due to motor torque. If the water level changes or the anchor lines otherwise become slack, the unit will rotate and twist the electrical cord causing cord damage.



## LIFTING THE UNIT

1. Remove the nozzle before lifting, if using straps around the Main Body or straps under the Floats. Can also lift on the ends of the Suction Screens.
2. If using straps around the Main Body or Suction Screens, connect anti-tip auxiliary ropes from Upper Tubes to lifting straps.
3. Install the nozzle after the unit is floating if removed in step 1.

## PLACING UNIT IN WATER

1. Auxiliary tie ropes must be used to prevent the unit from turning over while using lifting straps around Main Body.
2. The front and rear saddles may only be used to attach restraining ropes.
3. Leave some slack in the auxiliary ropes so that they are not used for any lifting.
4. Gently lower the unit into the water until flotation has been established.
5. Remove lifting harness and restraining ropes.
6. Attach mooring/anchoring ropes to the eyebolts on the front and rear floats. These locations should only be used for mooring or anchoring rope, not for towing rope.

## COMBO MOORING AND ANCHORING

**NEVER pull Combo units with the mooring or anchoring rope. Always use the towrope connected during assembly.**

Attach mooring/anchoring ropes to the eyebolts on the front and rear floats. These locations should only be used for mooring/anchoring and not for towing the unit to the desired location in the lake or pond. A towing rope should be tied around the front tee of the outlet wishbone assembly. Pulling the unit by the mooring/anchoring eyebolts may bend them or loosen the insert, due to the weight of the unit itself and the additional force required to pull the unit, with the added weight of the motor cord and light cord, to the desired location.

## INSTALLATION

Aqua Control Inc. (ACI) is certified to manufacture UL Listed Industrial Control Panels (UL 508A), and all control panels are UL listed except 460V panels or panels built with prior agreement for certain special configurations. Certain special configurations, the 1hp-115V, all 460V and all 575V control panels cannot be UL Listed because of the National Electric Code and UL requirements.

### INSTALLER QUALIFICATIONS

ACI control panels must be installed by a QUALIFIED electrician who will read and understand the instructions and knows electrical installation to your local and state codes. Do not install this control panel if you are not qualified. Only a qualified electrician can safely make this installation. If you do not understand the instructions and you are not qualified to make electrical installations, it is NOT SAFE for an unqualified person to be making this installation. A complete set of instructions, which is specific to each control panel, are shipped inside each control panel. Refer to those instructions for each specific component's operation instructions. Control panel schematics are also included in all control panels.

### 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, particularly, should not face south or west unless it is protected from sunlight.

1. Install the control panel facing north and with the back covered to minimize heating from the sun.
2. Install a sunroof over the control panel and leave an air gap of at least 2 inches. The roof should shade the control panel from midmorning until late afternoon to minimize heating from the sun.
3. Install on a wall so that the control panel faces north or east.
4. Install in a building so that direct sunshine will not heat the control panel.
5. Control panels with Variable Frequency Drives (VFD) MUST be protected from sunlight since the drive creates a substantial additional heat load. Fans and vents are included in all panels that contain VFDs.

## SUPPLY CORD (INCOMING POWER)

The supply cord from the power supply to the control panel must be sized for a power supply voltage drop of no more than 3%. All output cord sizing is based on a maximum of 5% voltage drop, so the supply cord voltage drop of 3% must not be exceeded.

### NUMBER OF REQUIRED SUPPLY CORD CONDUCTORS

**WARNING:** It is the installer's responsibility to provide and connect a neutral wire to the neutral input terminal block. Failure to connect a neutral wire will burn out the GFCI-Circuit Breakers. GFCI-Circuit Breakers that fail during installation are **NOT COVERED UNDER WARRANTY**.

1. Single phase, 120V power supply should be 3 wires: 1 hot, 1 neutral, and a ground.
2. Single phase, 208/230V 60 Hz power supply should be 4 wires: 2 hots, 1 neutral, and a ground. Both hots must be 120V to neutral.
3. Three phase, 208 or 230V, 60 Hz power should be 5 wires: 3 hots, 1 neutral and a ground.
4. Three phase, 460/480V 60 Hz should be 4 wires: 3 hots and a ground.
  - A. If no external source of 120V is to be supplied, the required 120V for the only control circuit can be supplied from an optional internal control transformer.
  - B. If an external source of 120V is supplied for the control circuit and/or lights, 120V supply power must also be supplied along with the 460/480V. (6 wires total)
  - C. If an external source of 120/240V is supplied for the control circuit and for 2 or more sets of lights, 120/240V power, (2 hots with 240V between them and each 120V to neutral) must be supplied. (7 wires total)

## START UP

At installation and initial startup, it is recommended to record the actual voltage under load (while the unit is running) and the running amperage of the unit. This can be kept inside the control panel for future reference. This allows for easy determination if something at site or with the installation has changed. The correct voltage and amperage ratings are on the schematic and on the door label of the control panel.

Any Aqua Control, Inc. Fountain 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.

## MODIFICATION OF THE CONTROL

### PANEL UL RATING

Field modifications to the control panel made by anyone not qualified and authorized by UL to make such modifications, or modified with non-UL rated components, will render the control panel no longer UL Listed.

### ACI WARRANTY

Modification of the Control Panel will void the Aqua Control warranty on the entire unit unless Aqua Control specifically approves the changes.

### ADDING VENTILATION

If ventilation is added in the field, it must be done with a NEMA 3R rated and screened (or filtered) ventilation kit. A screened ventilation hole or holes can be put in the bottom of the enclosure.

## FLOTATION COMBO SERIES

1. Bar weights can be added to level the unit, sink lights below the water surface, or to make the floats less visible during operation.
2. Each large bar weighs ten (10) lbs. in the water and the smaller bar weighs five (5) lbs. The weights should be placed inside the vertical saddle tubes at either the front or rear floats until the unit is at the desired depth and floating level.
3. The front and rear floats should have an equal amount exposed above the water at the front and rear saddles.
4. Each inch of float depth showing while the unit is running requires 33 lbs to sink. (Because there are two floats, it requires 66 lbs. of evenly distributed weight to sink the unit one inch.)
5. After the unit is leveled, additional weights can be added in the front and rear saddle tubes to sink the unit further, if necessary.
6. Lights need to be completely submerged when the unit is operating.

## FREEZING WATER

### REMOVAL

1. Disconnect the motor from the cord or cut the cord at the splice.
2. Store in a heated area that will not freeze.
3. Store with the shaft end of the motor inclined up. If a vertical unit is resting on the float and on the bottom of the lower tube. The angle will be satisfactory. Do not rest it on the lights or light brackets.
4. The underwater cord should not be left on the ground since it could easily be damaged when brittle from cold weather. Re-immers the cord so it is out of the ice and away from shore traffic.
5. Protect the cord connector in the water by using the cap that came with the unit.

### SINKING

This procedure is the best and simplest method of winter storage if a boat is available. By sinking the unit, the motor has no possibility of losing some of its internal motor fluid, it cannot freeze, the unit is not damaged by handling, seals do not dry out and it saves the work of removing and re-installing the unit. **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 brochure, 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 unit can be stored by sinking with enough depth in the pond.

## 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 a Combo 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 does not warrant any damage incurred during winter operation, even if the following guidelines are followed.**

## MARGINALLY FREEZING WEATHER

If the surface of the pond does not normally freeze solid, then continued winter operation of either aerators or fountains is seldom a problem.

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 or light damage, simply remove the nozzle and let the water gush out 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

The Aqua Control 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.

**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. The suction screens on the horizontal units are close to the water's surface to make them easy to reach. A wire brush can be used to remove any debris.

**LIGHT LENS CLEANING:** The light lenses should be cleaned frequently to prevent algae and dirt buildup on them. Buildup dims the amount of light that comes through the lenses and can cause them to overheat as well.

# TROUBLESHOOTING

## 60Hz 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 not zero, this may be resistance internal to the meter and should be subtracted from all subsequent readings. 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. Amp probe.

### 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  $\frac{1}{2}$  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. 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. 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 cord must be corrected
  - iii. A three-phase 240 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: T1 - T2, T1 - T3, T2 - T3
- d. Analysis
  - i. Each reading should give source voltage.
  - ii. If good, problem is not in control panel although overloads or GFCIs may be too sensitive and cause premature tripping.
  - iii. If zero voltage: backtrack through components, checking input vs. output voltages, to determine which one is tripped or faulty.
  - 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"

## GENERAL TROUBLESHOOTING

### 50Hz 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 not zero, this may be resistance internal to the meter and should be subtracted from all subsequent readings. 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., Amp probe.
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. Verify voltage rating of control panel matches supply voltage at the rotary disconnect prior to startup.
4. Check Output Voltages
  - a. 1-Phase: Black – Yellow
  - b. 3-Phase: T1 – T2, T1 – T3, T2 – T3
  - c. Analysis
    - i. Each reading should give source voltage.
    - ii. If good, problem is not in control panel although overloads or GFCIs may be too sensitive and cause premature tripping.
    - iii. If zero voltage: backtrack through components, checking input vs. output voltages, to determine which one is tripped or faulty.
    - 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 overload tripped, perform "Overload Troubleshooting Procedures"

## GENERAL TROUBLESHOOTING

### CORD TROUBLESHOOTING

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

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 readings.
2. Disconnect the cord from the control panel and the load (pump or lights). Both ends must be dry. Verify the power is off before removing the cord.
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 cord.
    - 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 cord 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 cord 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 cord select one of the pairs of joined wires and take readings by touching the probes to each wire or socket of the quick disconnect.
  - 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.
    - iv. Determine the action to take.
      1. Visually inspect the cord.
      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 cord may be the best solution.
  - e. Perform these steps for each combination of wire pairs.

# GENERAL TROUBLESHOOTING

## 60Hz 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 jump, go to “Test Capacitor” and check “Start” capacitors.
  - f. If amps jump and stay high, go to “Test Relay.”
  - g. If amps jump and return to zero, go to “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
3	17	12.6	6
5	27.5	23.2	7.8

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.
  - f. Reconnect the leads to the capacitor.

HP	# RUN CAPS	RUN $\mu$ F	# START CAPS	START $\mu$ F
3	1	45	1	208/250
5	2	20/40	1	270/324

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. Readings between 4,500 ohms and 7,000 ohms are good.
    - v. If resistances are out of that range, replace relay.
    - vi. Reconnect the all 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.



# GENERAL TROUBLESHOOTING

## 60Hz MOTOR CONTROL BOX (MCB) continued

### 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
3	230	17	3	208	12.5
5	230	27.5	3	230	12.2
			3	460	6.5
			5	208	20.5
			5	230	19.8
			5	460	19.8

2. Check line-to-line resistance. Verify the power is off before testing.

- a. Power off control panel.
- b. Remove the pump cord 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 cord wires, excluding Ground. Readings 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 readings should be identical.
  - ii. Readings of zero indicate a “Short”; readings greater than 20 ohms indicate an “Open” or partially broken line. Either of these readings indicate 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 cord 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 de grade 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.