Basics of Service and Troubleshooting

Foreword

This document has been created to give an insight into the required service and troubleshooting needed to repair a system. The information held herein will grow and be modified with each new understanding of system design that is made. This information is not for use as customer documentation and should not be modified as such without the written permission of EcoWater CHC, Schertz, Texas.

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1.0 WARNINGS & PRECAUTIONS

When trouble shooting a system it is very important to remember the following:

WARNING

HIGH VOLTAGE, Electrical Shock and or Death can occur if safety is not your #1 priority.

WARNING

Main Electrical Service is normally 480 VAC
Control Voltage is 120 VAC or 24VDC
Use Caution When Servicing This Unit
ONLY Qualified Electricians Should Attempt Any ELECTRICAL Service.

WARNING

Always disconnect electrical service before attempting service on any items found within this skid.

WARNING

Servicing of equipment should be completed only in a well ventilated area.

WARNING

Most Items located on the skid are Very Heavy. Use all appropriate lifting methods and safety precautions while lifting or moving items.

WARNING

In case of Fire, use appropriate notification methods of local fire departments and facility personnel. Turn OFF all power sources immediately.

WARNING

DO NOT operate the pump motor if the safety guard has been removed from its fan.

WARNING

DO NOT operate any motor or electrical device on this skid in the presence of standing water or direct rain.

Shutting Down the CHC System upon EMERGENCY.

1. Turn the power disconnect OFF on the CHC Motor Controller. Verify the CHC pump has stopped operation (look for motor rotation, and listen for the discontinuation of the standard CHC operational sound).
2. Close one of the Isolation valves found on either side of the basket strainer.
3. Close the Isolation valves found on the towers if necessary.

Shutting Down the Filtration Systems upon EMERGENCY:

1. Turn the power disconnect OFF on the Filtration Motor Controller. Verify the pump has stopped operation (look for motor rotation, and loss of pressure on gauge)
2. Close one of the Isolation valves found on either side of the basket strainer.
3. Close the Isolation valves found on the towers if necessary.

2.0 TERMINOLOGY

The following words are referenced throughout this manual, it is important that you have an acceptable understanding of the following words:

Actuator- A motorized system used to control a valve or positioning system. Actuators come in many different sizes and types. It is important to identify what type of actuator you need, some may be air operated (ZGF) or electrical. Call EcoWater CHC while you are looking at the actuator to make sure you get the appropriate replacement parts. An actuator can be powered by Air, AC voltage or DC voltage and it is important to understand what you have BEFORE you get a replacement.

Actuated Valve- An actuated valve references any valve that is controlled by a motor. When replacing an actuated valve it is important to record the type (Grey is VSI, Blue is Jordan, and Yellow is Apollo, Red can be Rotork or J&J), it is also important to record the valve size and type and control voltage (120VAC or 24VAC or 24VDC).

Alkalinity (Alk.): Alkalinity is a measurement of the buffering capability of water with the addition of acid. With the addition a certain amount of acid, pH can lower dramatically for water with low alkalinity, but pH only decreases slightly when its alkalinity is high. The main contributors of alkalinity are carbonate ions, bicarbonate ions, hydroxide ions, and dissolved CO_2 present in water. For most of waters, bicarbonate (HCO_3^-) is the dominant contribution to alkalinity. Alkalinity affects both corrosion and scaling tendencies.

Amiad (Filtomat)- The automated filtration systems added to some CHC offerings. These automated systems require appropriate sizing. And utilize a screen to capture the debris from the filtration water flow. An automated screen cleaning regime is used to clean debris from the screen and flush it to waste. We utilized the M100 Filtomat filters and you can learn more from www.amiad.com or from the appropriate Service Manuals.

Approach Temperature- This measurement is available if a chiller is being used. It references the efficiency of the chiller tubes at removing temperature from the refrigerant and the closed loop system. The approach temperature references the difference between the cooling water discharge temperature and the refrigerant temperature. Approach temperatures are only accurate if the Chiller is at 100% load. It can be used as an indication of scale within the tubes. If the approach temperature stays high, normally above 10 degrees than scaling could have occurred. Further analysis of the tubes are required for verification.

Bacterial Colony Counts- When required the water sample is sent to CHC overnight in a refrigerated container. This container should only used a refrigerated gel (NO ICE) to maintain temperature. The sample should be marked to ensure appropriate processing by CHC. The sample is placed into specially prepared dishes, and left to incubate. Once the incubation is complete, the colonies are counted and a report is prepared for distribution. The normal results of this test are given as colonies/square cm.

Bag Filters- Bag Filters can be used in line or side stream they remove any debris within the filtration water flow that is larger than the bag micron size. It is important to know what type of

bag filter housing you have to be able to order appropriate bags for replacement purposes. CHC recommends the use of dual bags within these systems. If used in a side stream arrangement, we recommend approximately 20 % of the filtration water flow. If the Bag Filter is in line (100% of flow), then a bypass system must be utilized to allow filtration flow to continue when the bag blinds off.

Ball Valve- A ball valve is any valve that utilizes a ball for the valve mechanism, as the ball rotates a hole within the valve aligns with the inlet and outlet connections and water is allowed to flow.

Basket Strainer- The basket strainer is an initial filtering element that is placed in front (suction) of the pump. This element consists of a housing and basket. The basket has holes placed into it that initially remove any larger debris from the water flow that will not pass through the pumps impeller. The basket strainer holes are normally specified as smaller than the pump specifications indicate. The basket is required to be emptied at appropriate intervals to make sure the pump's flow is not restricted. Basket strainers come in many varieties and manufacturers and require appropriate maintenance to ensure no air intake into the system. CHC will normally oversize the basket strainer to make sure that the time between cleanings is maximized.

Biodispersant- A Biodispersant is a chemical surfactant that is used to loosen any Biofilm that may be on the walls of a cooling system. It is basically a soap that loosens up the film and allows it to flow with the water to the CHC chamber for treatment.

Biofilm- Biofilm is a growth of Biological material on surfaces within a system. This could include a growth of algae or other films on surfaces that could decrease the efficiency of the system as well as harbor other detrimental bacterial growths like Legionella. In many cases a Dispersant must be used to dislodge this film to allow it to be destroyed by the CHC treatment or biocides.

Blow Down- Blow Down is the water that is removed from the system to control the conductivity levels within the system. Blow Down is preferred from a water source within the system that contains the highest conductivity. As Blow Down water is removed it is replaced by fresh Make Up water.

Calcium Hardness (Ca): Calcium is one of the principle elements making up the earth's crust. Calcium normally gets into water when rain water causes calcium carbonate to leach from limestone deposits in the soil. It is the major contribution to water hardness. Calcium aids in the formation of soap curds during cleaning and in some instances can form hard scale.

Cartridge filters- Cartridge Filters can be used in line or side stream they remove any debris within the filtration water flow that is larger than the cartridge's micron size. It is important to know what type of Cartridge filter housing you have to be able to order appropriate bags for replacement purposes. CHC recommends the use of easy clean cartridges within these systems to make cleaning easier. If used in a side stream arrangement, we recommend approximately 20 % of the filtration water flow.

Centrifugal Separator- A centrifugal separator is a vessel that utilizes a speed centrifugal spinning to separate out the heavier than water particles from the water stream. It is very important to size a separator according to the filtration flow to make sure appropriate separator forces are

achieved and debris removed. Centrifugal Separators do not have any moving parts but do require an additional debris purging system.

CHC Chamber- The chamber is made up of many parts and normally consist of a common manifold (linking pump to chamber), riser tubes, end caps, nozzles, and chamber. Most CHC chambers assemblies utilize Groove lock fittings for connecting the components. The chambers are specified by their GPM flow rate. Chambers can be designed to increase their bacterial kill rates for specific applications. All current production chambers contain components that are made of stainless steel. Older systems could utilize plastic, nylon, or stainless steel construction. Chambers can be made to connect directly to a pump or even remotely. The remote chambers differ in their construction, due to the pump being placed remotely to the chamber. Each chamber requires specific applied pressures to perform appropriately. Some chambers allow for the monitoring of created vacuum by a vacuum gauge. The back pressure of the chamber must be verified and should not exceed 5 mmHg. The CHC sizing reflects the water analysis as well as the overall volume of the system being treated. It is important to understand this when sizing a CHC treatment system. Normally the CHC system is sized to see the entire system water at least seven times each 24 hour period. There are several parts that make up a chamber, they include the center weldment, nozzles, end caps (ends of nozzles) and end bells (covers for the nozzles that attach to the center weldment.

CHC Control Station or CCS- This is a Programable Logic Controler (PLC) who's software was made by EcoWater CHC to control and monitor the filtration and CHC skid's operation.

Chemical treatment- Chemical treatments are costly and must be maintained continuously. From making sure chemicals are on site at all times, to making sure that bacteria does not become resistant to the treatment, Chemical treatment regimens must be continuously monitored and adjusted for the changing conditions. It is this service that makes most customers loyal to chemical systems, while it is also the need for this service that make most customers wish they had a reliable non-chemical treatment system.

Chloride (Cl^-): Like Sodium (Na), most chloride salts are very soluble in water. They can cause corrosion at high levels. Chloride is used to calculated cycles of concentration because it is stable in cooling water systems.

Clearance for Electrical Panels- In general we must meet the local regulations at the customer site. However EcoWater CHC recommends at least 36" clearance in front of the motor starter for electrical servicing.

Cooling Towers- A cooling tower is part of a system that uses water as a cooling agent within a larger system. This system, as in air conditioning, passes this cool water from the cooling tower to a chiller that is the similar to a heat exchanger. The chiller is the link between the cooling tower water, and the water used within the building's for air conditioning. The chiller uses a refrigerant like FREON, to remove the heat from the buildings cooling water and passes that heat back to the cooling tower's water. Within this type of system, the customers want to decrease their water usage by increasing the recycling rate of water within the cooling tower. But as they increase the times water is reused, the dissolved solids within the system increase due to evaporation. These dissolved solids are what is left behind as the water evaporates out of the system. Traditionally, chemicals were used to control scale and corrosion and reduce any bacterial growths. The only problem with chemical treatment programs is, in many cases, it takes one chemical to dissolve the

solids, one to reduce corrosion rates, one to keep the solids from scaling up in the chiller and one or more to reduce the bacterial levels and it relies on blow down to remove any dissolved solids. A filtration system is the only system that can physically remove solids from the tower water and most chemically treated systems do not use filtration. The types of chemicals and amounts vary by the type of system being treated, the season, the external sources of particulate, the type of bacteria, the temperature, and on and on and on. Normal cooling towers utilize a basin (water storage site), cooling media (normally called fill, this normally plastic structure allows water to drain down it surface while air is passed through the fill to cool the water, a pump to move the water up above the fill to the spray nozzles that distribute it equally over the fill and a fan to force air through the fill.

Conductivity: Conductivity is defined as the ability of an aqueous solution to carry an electric current and can be easily measured by a conductivity meter. It is used to estimate Total Dissolved Solids (TDS). CHC has used several types of Conductivity meters in the past. Walchem WCT series is the most common, while we have also used the LMI brands or utilize the CCS.

Corrosion - Most metals used in cooling water systems are very susceptible to corrosion. Keeping surfaces clean is the most important aspect of preventing corrosion, since under-deposit corrosion can take place and result in serious damage. Corrosion can be uniformly distributed throughout the system or it can be localized, causing severe pitting and rapid equipment failure. There are various corrosion inhibitors used in chemical treatment.

Customer Service Report- This report is the record of what service was conducted at the customer's site. In most cases the customer will be given a copy of this report at the time of service. The report is then completed with any appropriate test results (Dip Slide Test), any appropriate comments and then sent to EcoWater CHC at the end of the week for processing. A Service Order will be completed at EcoWater that will include any Water Analysis results and recommendations for continued service in the future. The Service Order will be sent to the appropriate personnel with any recommendations for modifications.

Customer System Survey- A Customer Survey is a report that is completed at the time of a monthly or quarterly service that is a detailed listing of the equipment at the customer site as well as specific application information that is needed to identify equipment or usage. It is a good idea that as pumps are replaced or piping modified that this survey is updated. If allowed pictures are worth a thousand words and will make identification of system parts much easier, but always verify with the customer before any pictures are taken, if pictures are even allowed. This report is sent to EcoWater CHC to ensure appropriate system information for phone support and other reporting needs.

Cycles of Concentration- It is a comparison of the concentrations of dissolved salts in makeup water and basin water. Because of evaporation, H_2O left water to evaporate and leave the dissolved salts in cooling water. So the concentration of the dissolved salts in the cooling tower water will increase. Cycles of 2 means the concentration of certain species (like sodium or chlorides) in the cooling tower water are 2 times the concentration in the makeup water. As cycles increase the less make up water is required to maintaining the water level because there is less blow down and more water remaining the tower basin. Higher CoC are helpful to control bacteria levels.

Descaler- Descalers are chemicals that are used to dissolve scale for cleaning purposes. EcoWater uses the Rydlyme product.

Differential Pressure Switch- The differential pressure switch is a switch that compares two pressure sources and closes an electrical switch upon the differential pressure reaching the specified set point.

Dip Slide Testing- The Dip Slide test can be used to verify the concentration of bacteria within the system. This test requires a Dip Slide to be placed into the system water and then placed aside for a period of 48 hours for results to be taken. Results of the test should be recorded on the copy of the Customer Service Report that is sent to EcoWater CHC at the end of the week. Please refer to the paper "Dip Slide Testing" for instructions on how to conduct this type of test.

Electrical Supply- The electrical supply is the power that will be supplied for the use by the CHC skids. Normally a CHC system utilizes a 480 Volt, three phase supply. This is the main supply and is normally the type of electrical supply used directly by the pump's motor. Three phase voltage works very well for industrial type applications because it lends itself very well for pump use. The electrical supply may also be stepped down inside of the motor starter for use as a control voltage.

Evaporative Condensers- Similar to cooling towers, except the condenser is also the heat exchanger. Condensers are normally used in industries where refrigeration is required. The condenser passes its water directly over the hot refrigeration lines that pass through it. It too, suffers from the same type of problems as found in cooling towers. It is made up of a basin, heat exchanging tubes, pump and nozzles and a fan to move the air. The condensers can be used wet (with water) or dry (no water, normally only used in the winter time dry).

Flow Meter- CHC has utilized a flow meter to aid in the flow setting through the corrosion rack. The normal flow that we try to achieve is 5 to 8 GPM. The flow meters are made by Blue and White. You must test the flow meter with different flows to verify that the bobbin moves freely over the entire range. When ordering a flow meter it is important to record the total flow as well as the inlet and outlet sizes.

Filtration Systems- Since the CHC treatment system creates crystalline debris by design, it is the Filtration systems job to remove this debris from the system. All CHC systems require some type of filtration. CHC systems have incorporated ZGF, centrifugal separators, bag filters, cartridge filters, Turbo Disk, Amiad, and Forsta filtration systems. Each of these systems are designed to remove water borne debris. Some of them remove only larger particles while others cost more and remove a wider variety of particulate. Some require frequent user intervention to clean the media while others are fully automated and clean themselves. It all depends upon how much the customer is willing to pay, how much interaction with the system they are willing to do, and what type of water their system uses for makeup water.

Filtomat- (see Amiad)

FLA- Full Load Amperage of a motor, this is the rated amperage draw for a motor that is working at 100% load. If the pump motor is flowing more water that it is rated for (pressure too low) than the amperage will be above the FLA rating and if the pump has a blockage in the inlet or outlet so that it is flowing little or no water the amperage rating will be far below the FLA rating as found on the rating plate of the motor.

Forsta Filter- Similar to the Amiad and the Orival Filters it also is a screen filter that is utilized by CHC to remove lighter than water particles from the filter flow. Their housings are always Stainless Steel constructed.

Gauge- CHC utilizes many gauges within our system. We only use stainless steel, glycerin filled gauges. It is important when ordering a replacement gauge to specify the range, units of measure, if it is flanged or not and if the pressure connection is on the back (cbm) or on the lower edge of the dial. EcoWater CHC requires that the replacement gauge's range be at least 20% larger than the expected pressure being measured (if you expect 90 psi, then the gauge's maximum range should be 120 psi.)

Globe Valve- A globe valve is used to control the flow within a pipe, as the round handle is turned a large flat plunger (valve seat) is pushed towards the valve body. As the plunger gets closer to the valve body the flow diminishes, as it moves away the flow increases.

Head Pressures- Head pressures are used in refrigeration systems to identify the efficiency of the heat exchange surfaces. If the heat exchanger is scaled up the head pressures will increase due to the heat not being removed from the refrigerant due to possible scaling in the heat exchanger.

HOA Switch- The Hand Or Auto switch is the power switch on the motor starter that is used to turn the power to the pump ON and OFF. This switch is referenced as an HOA switch even though the switches used by CHC Systems are marked as ON and OFF only.

Magnesium hardness (Mg): Mg, like Ca, is leached from the soil by rainwater. It contributes to the total hardness but is generally present at much lower levels than Ca. Magnesium hardness is a calculated number based on measured total hardness and calcium hardness:

Magnesium hardness = Total hardness - Calcium hardness

Make Up Water- This is the water that is used to refresh the system water. Make Up can come from city water, reclaimed water, well water, defrost water or most other source of water. Typically, potable water is used for Make Up.

Motor Starter- A motor starter is the box that controls the power to the pump. If the motor starter includes a Power Disconnect, then the motor starter is a Combination Motor Starter. To specify a replacement motor starter the input voltage is required, the HP of a pump is required as well as its configuration if it includes a timer or Control Station.

Motor Contactor- The motor contactor is found within the motor starter box and acts like a relay and upon the instruction of a control signal, will close and pass power to the motor of the pump.

Non-Chemical Water Treatment- The CHC technology uses apposing streams of water that are forced together under high pressure at extreme speeds, as the two streams converge a vortex is created. This vortex places the molecules within the water under extreme stress due largely to the significant vacuum created. The point of intersection of the streams (vortex) exhibits a sudden temperature change as well as pressure change. The temperature rise can exceed 5000^{o} while a vacuum is created at the center of the vortex. These extreme pressure and temperature changes can rip apart the molecular bonds that are found in the majority of waters impurities. This technology can be used to diminish bacteria growth as well as degas the Co2 from the water and promote the

formation of Calcium Carbonate crystals in the free flowing water so that they do not aid in the production of hard layered scale formation on the surfaces of the treated system.

Normally Closed Switch- The term Normally Closed (N.C) refers to a type of switch that when it is in its normal position (not powered) that the switch contacts are closed. Voltage will pass through a normally closed switch as well as it will have continuity when tested with a DVM. Upon turning the Switch ON, or applying power the switch will open, no longer passing voltage or being conductive.

Normally Open Switch- The term Normally Open (N.O) refers to a type of switch that when it is in its normal position (not powered) that the switch contacts are open. Voltage will not pass through a normally open switch as well as it will have no continuity when tested with a DVM. Upon turning the Switch ON, or applying power the switch will close, passing voltage or becoming conductive as tested with your DVM.

Oriface Plate- An orifice plate is a plate placed between two flanges with a fixed orifice (hole of specific size) in it. The size of the hole restricts water and maintains a constant flow at specific pressures. Some CHC systems utilizes orifice plates under the filters on combo skids to maintain the required pressure and flow through the CHC chamber.

Orival Filter- Similar to the Amiad and the Forsta Filters it also is a screen filter that is utilized by EcoWater CHC to remove lighter than water particles from the filter flow. Their housings are always constructed of carbon steel and are orange in color.

pH: The pH is a measure of acidity or alkalinity of water. pH < 7 is acidic, pH > 7 is alkaline and pH of 7 is neutral. As pH increases, water becomes less corrosive but the scaling tendency of some insoluble salts, such as calcium carbonate and calcium phosphate, increases. Each time you descend a whole number (for example: from 7.0 to 6.0), the acidity of solution increases by a factor of 10. Thus, a pH of 6 is 1000 times more acidic than a pH of 9. Normally under standard CHC treatment the pH of the system water will rise above the pH of the makeup water. This standard of operation can be useful when verifying the CHC operation.

PPE- Personal Protection Equipment- Normally EcoWater CHC requires the use of Steel Toe Boots and protective eye wear while servicing our equipment. However, depending upon what is being conducted other appropriate equipment may be required.

Power Supply- A Power Supply is an power converter that creates a different DC (Direct Current) voltage. Most current CHC systems utilize a 24VDC power supply to create the required power for the PLC and control circuits.

Pressure Sensor- A sensor that monitors the pressure and passes the actual pressure as an electrical signal (transducer), or senses the pressure and closes or opens a electrical switch at the specified pressure (Switch)

Pump Savers- These special connecting tubes are designed to isolate the pump from the system piping to minimize vibration, and reduce applied stresses on the plumbing system as the pump

starts, stops, or during continued operation. The piping on most systems will expand and contract with temperature changes and these changes in lengths will pass directly to the pump as applied torque, possibly damaging the wet end if a pump saver is not used.

Pump- The pumps used in CHC systems are centrifugal pumps that may consist of a single stage or multiple stages depending upon the requirements of the system. Pumps are normally identified by being horizontal or vertical in construction, its HP (horse power rating) and size of its impeller. These identifications are used to determine the exact GPM (gallon per minute) flow rate and head pressure. Most pumps if they are leaking can be reworked in the field. Identify the type of pump kit needed and request the kit from EcoWater CHC before proceeding to the customer site.

Purchases- A customer who decides to purchase our system will be responsible for all installation costs as well as the cost of the system. All of our systems are warranted against defects in parts for a period of one year and labor for 90 days. During the first year after installation, EcoWater CHC will support the system by completing maintenance visits to check up on the system's operation.

Purge Valve- The purge valve is an actuated valve that is placed on the drain line of a centrifugal separator. It is opened to purge any solids out of the separator. Normally CHC systems cycle this actuator on for 18 seconds at least once every 8 hours. Also known as a blow down valve.

Quarterly Maintenance- The quarterly maintenance is a more extensive service that is conducted once a quarter and consists of the standard maintenance, but includes a more detailed operational verification, system verification, and maintenance. During the quarterly Maintenance, the motor's amperage should be read and compared to the motor's rating. You should also grease the motor with the required lubricant. And clean and paint any rusty CHC system surfaces. And review the condition of the towers. The customer will receive a copy of the Customer Service Report for their records. This service will only be conducted by a qualified EcoWater CHC Service personnel with few exceptions.

Relay- a relay is an automated switch that when a control signal is present to its coil, it will energize and close the contacts found within the relay allowing power to pass through the contacts. When specifying a replacement for a relay, you must specify the control voltage, number of contacts and any other information shown on the relay itself.

Roof Types- There are many roof types from tin, to rubber, to concrete, to composite, to what ever you might find. You need to understand what type of roof the customer has so you can design an appropriate mounting system. If the customer has a rubber roof, EcoWater CHC utilizes PHP type feet to mount the equipment directly onto the roof. Refer to www.PHP.com for further information on these pedestal feet. Other surfaces may require the use of a platform to support the CHC skids.

Routine Maintenance- Routine Maintenance consists of verifying the operation of a CHC system, basic care and water analysis. Bacteria testing via a Dip Strip Test is conducted during a Routine Maintenance visit. The customer is given a copy of the Customer Service Report that details the findings of the maintenance. The Routine Maintenance can be conducted by a qualified Manufacturing Representative if available. The customer will receive a copy of the Customer Service Report for their records. This service will only be conducted by qualified EcoWater CHC Service personnel who have been trained on the function of the system with few exceptions.

Rydlyme- A buffered acid that is used to remove scale. It is a stable product that can be shipped without problem or sent down the drain once used. It is recommended to use the appropriate PPE when using this product (Eyewear and gloves, if gloves are not available, wash any skid that comes in contact with the Rydlyme with a mild soap and water solution)

Scale - Minerals such as calcium and magnesium are relatively insoluble in water and can form scale deposits when exposed to conditions commonly found in cooling water systems. A layer of scale as thin as 1/64 inch can reduce heat exchanger efficiency by 15%. Scale formation can be controlled by scale inhibitors such as threshold inhibition chemicals and scale conditioners. Chemical treatments include acids, polymers and polyphosphates which prevent scale formation by keeping the scale-forming minerals in solution to prevent deposits from forming. EcoWater's CHC treatment will normally cause a thin soft scale formation on the surfaces of the towers. This inhibition layer should be soft and easily removed with the rubbing of a hand or strong water flow.

Solenoid Valve- A solenoid valve is a valve that is opened or closed in response to an electrical signal sent across the coil. Solenoid valves can come in 2 or 3 way configurations (refers to the number of connections on the valve). It is important to reference the part number on the valve when ordering a replacement, this part number is found on the coil and it specifies the valve size as well as the control voltage requirements.

Sweeper Jet or Nozzle- also called Eductors, The sweeper nozzles come in many sizes from 3 GPM all the way up to 33 GPM. They use this primary flow pushed through a venturi to increase flow and push or sweep debris along the bottom of a tower's basin towards the suction manifold. When ordering a replacement sweeper jet, it is very important to replace it with the same GPM flow. If you do not recognize the size, measure the length as well as the connection size for reference when calling for a replacement.

Thermal Overload- The thermal overload is connected to the motor contactor and its job is to monitor the continuous amperage draw of the pump motor. When the thermal overload identifies that the pump is pulling too much amperage, it will automatically turn off the power. Most systems will automatically reset the thermal overload if the Power disconnect is turned OFF and back ON. The setting of the amperage trip point is calculated by the motor's amperage x 1.15.

Timer- EcoWater CHC systems have used a timer to activate the purge actuator for the evacuation of solids from the centrifugal separator. This timer has controls that allow for the setting of the ON and OFF times, please refer to the reference section of this manual for specific instructions on the set up of the Timers used by the CHC treatment systems.

Toroidal Sensor- The Toroidal conductivity sensor is a sensor that does allow the direct contact of the electrical signal to the water it is monitoring. Non-Toroidal sensors will have two electrical connections that pass a signal directly through the water to monitor the conductivity. A Toroidal probe uses two electrical coils, one with a primary AC signal passing through it and the second is the pick up coil. As water passes between the two coils, the amount of solids within the water allow a portion of the primaries signal to pass to the secondary coil, the actual amount of signal that passes through to the secondary coil is used to judge the amount of dissolved solids in the water.

Total Dissolved Solid (TDS): TDS is the total concentration of dissolved components, such as salts and sugar. Salts, like NaCl, dissociate into ions; while some organic matters, like sugar, do

not break up into ions when dissolved in water. There are different approaches to determine TDS, but it is commonly estimated from conductivity.

Total hardness: This is the sum of Ca and Mg hardness. Fe (Iron), Mn (Manganese), Al (Aluminum) and other metals also contribute to the total hardness but these substances are usually present in such small quantities that they can be ignored. Hard waters are generally considered to be those waters that require considerable amounts of soap to produce a foam or lather, and that also produce scale in hot water pipes, heaters, boilers, and other units in which temperature of water is increased materially.

Transducer or Transmitter- Pressure transducers are also called transmitters and they act like a variable resistor to a DC Voltage that is sent to the PLC. As the pressure increases the voltage that is released by the transmitter increases, while as the pressure decreases the output voltage also decreases.

Transformer- A transformer is used to convert one type of AC voltage to another. You can have step up and step down transformers. Some CHC systems used primarily step down transformers to convert the electrical supply voltage (normally 480V 60 HZ in the US) to a lower stepped down voltage to use for the control circuit's supply (normally 120 VAC). Transformers are rated for a voltage and should only be replaced with equivalent parts. All CHC motor starter boxes with a timer, contain a 100VA, center tapped transformer that creates 120V from the 480 Volt supply. Older Older cabinet style CHC units utilize a 50VA transformer, that creates 24VAC from the 480 Volt supply.

Turbo Disks- Verify similar to ZGF systems these automated filtration systems also strain out debris from the filtration water flow. They also conduct automated back washes to remove debris from the filtration disks.

Uses of the CHC Technology- The technology not only has applications in water treatment, it has also been found to be beneficial in many other possible applications from mixing to treatment of human waste to oil processing. These other uses continue to be researched and will be defined in the future. The strongest use of our technology can be found in the Water Tower Treatment. Cooling towers and Condensers are the primary users of our technology when we talk about Water Towers.

Water Analysis- The water analysis is a chemical analysis of the water sample taken from the customer's location. The results of this analysis will be returned to the appropriate personnel upon completion. The water analysis requires an appropriate water sample to be taken and then sent to EcoWater CHC for analysis. Follow the Water Sampling Procedure to secure appropriate water samples. The water samples can be sent to EcoWater upon acquisition, or can be sent at the end of the week for convenience.

White Rust- White rust is a corrosion of the galvanizing surfaces of a cooling tower. Unlike normal scale, it will not dissolve in acid or Rydlyme and is very waxy in consistency. It also looks like greasy ckicken pox covering a surface, because it is not consistent with a layer type scale over tubes.

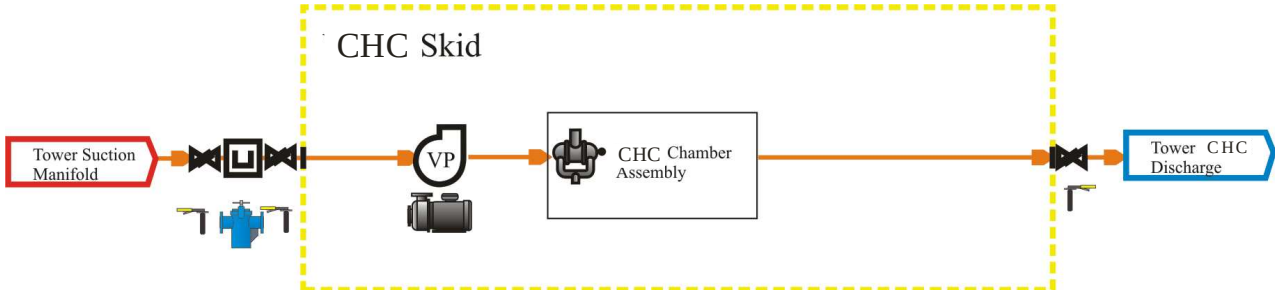
ZGF Systems- ZGF Systems are automated filtration systems that strain out debris from the filtration water flow and then remove debris by conducting a back wash to pass the debris towards the drain. Most ZGF systems require at least 115 TDH pumps to guarantee adequate flow force for back washing. For more information go to www.ZeroGravityFilters.com. EcoWater CHC has used the Easy Clean (single or double element systems), Phoenix (set of 6 elements, they also come in a dual Phoenix systems) and the S-2000 units.

3.0 THEORY OF OPERATION

EcoWater CHC supplies both water treatment and filtration systems.

CHC Water Treatment System-

The CHC Water Treatment System consists of a pump and treatment chamber. As water enters into the main suction pipe it passes through the basket strainer. The basket strainer is designed to remove any large particles from the water before it enters the CHC pump. Isolation valves are located at both the inlet and outlet of the basket strainer and are used to isolate the basket strainer from the water flow during servicing. The pump utilizes a centrifugal pump to pressurize the water to the required pressure for the Hydrodynamic Cavitation to occur in the CHC treatment chamber. The CHC treatment chamber consists of two proprietary nozzles that create a high speed water stream that are aimed directly at the opposing water stream. As these two streams collide, a vortex is created, it is within this vortex that the Hydrodynamic Cavitation cloud is created. The pressure regulation valve located on the discharge of the CHC chamber is used to control the required 2-5 psi back pressure for appropriate operation of the chamber. As water leaves the chamber it then passes through the discharge pipe and back to the tower's sump. A vent may be provided at the top of the discharge pipe, to break any vacuum that could be created as the water suddenly drops into the sump.

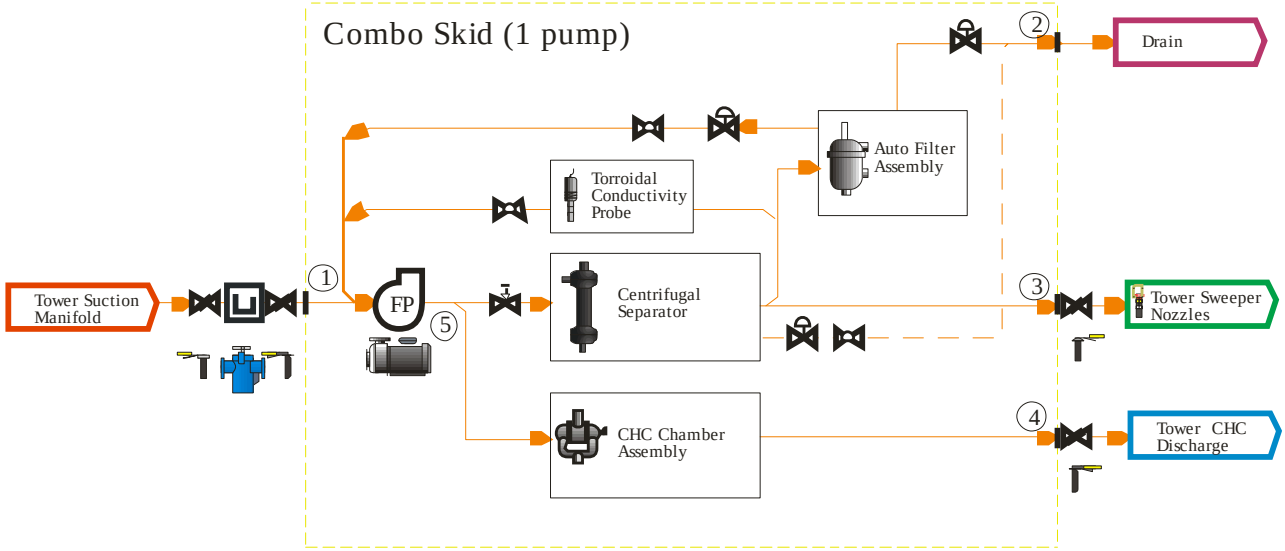


Refer to the CHC web site (www.ecowaterchc.com) for more information regarding the CHC chamber's configuration and the technology behind its operation.

Filtration System-

As water is drawn in from the basin it passes through the main suction pipe and passes through the basket strainer. The basket strainer is designed to remove any large particles from the water before the water passes to the pump. Isolation valves are placed on both the inlet and outlet of the basket strainer to allow for isolation of the basket strainer during the required servicing. The water then enters the skid pump. The skid pump utilizes a centrifugal pump that delivers water to the filtration system. As the water leaves the pump it passes through a centrifugal separator that removes all heavier than water particles. A timed purge cycle, removes the debris from the separator and passes it to the drain as needed. Once past the separator, water then flows back towards the tower while a portion is pulled through a side stream, automated screen filtration unit. This second stage filter, utilizes a fine screen to filter out any particulate out of the water stream that may be lighter than water. As the filter's screen becomes clogged, the differential pressure between Inlet and Outlet increases causing the PLC to initiate a back wash of the filter. When a back wash is initiated, water is driven into the rinse piston at the end of the filter. The rinse piston opens the back wash drain valve, and as water passes out of the drain it crease a Venturi effect that is used to suck off any debris from the filter's screen. Once the

back wash is complete, the controller will cease all water flow to the rinse piston and the filter will return to a home position. At the end of the filtration back wash cycle, the PLC verifies filter cleanliness, and if the filter did not clean it's screen appropriately, a second back wash may begin. The filter's back wash cycle is also controlled by a timer, the timer has been set to automatically clean the filter at least once every 6 hours of operation. All operational failures are shown within the Control Station's Filter Alert Area.



Toroidal Conductivity-
EcoWater has chosen to utilize a Toroidal Conductivity Sensor. Conductivity is a measurement of the dissolved solids within water. This sensor is utilized to help control the overall maximum conductivity of the system water.

The advantage of this technology is measurement without any electrical contact between the electrode and the process fluid. The probe uses two toroidal transformers which are inductively coupled side by side and encased in a plastic sheath. The controller supplies a high frequency reference voltage to the first toroid or drive coil which generates a strong magnetic field. As the liquid containing conductive ions passes thru the hole of the sensor, it acts as a one turn secondary winding. The passage of this fluid then induces a current proportional to the voltage induced by the magnetic field. The conductance of the one turn winding is measured according to Ohm's law. The conductance is proportional to the specific conductivity of the fluid and a constant factor determined by the geometry and installation of the sensor. The second toroid or receiving coil also is affected by the passage of the fluid in a similar fashion. The liquid passing thru the second toroid also acts as a liquid turn or primary winding in the second toroidal transformer. The current generated by the fluid creates a magnetic field in the second toroid. The induced current from the receiving coil is measured as an output to the instrument. The controller converts the signal from the sensor to specific conductivity of the process liquid. Although the toroidal probe is less subject to calibration errors or buildups on the sensor, it is still important that the probe be cleaned and calibrated at least once every three months. Please refer to the appropriate sections of this manual for further information.

pH Monitoring (Optional)-

Ecowater has chosen to utilize an industrial pH probe for this measurement. A pH meter is an electronic instrument used for measuring the pH (acidity or alkalinity) of a liquid. The pH probe measures pH as the activity of hydrogen cations surrounding a thin-walled glass bulb at its tip. The probe produces a small voltage (about 0.06 volt per pH unit) that is measured and displayed as pH units by the CHC Control Station (CHCCS). The pH probe is a combination electrode, which combines both the glass and reference electrodes into one body. It is important that this probe be clean and calibrated at regular intervals, please refer to the appropriate sections of this manual for specific information.

3.3 HOW CHC WORKS

CHC chemical-free cooling water treatment has been in service over 15 years and is unlike all other non-chemical technologies currently available. The technology essentially consists of two side-stream water loops typically connected into the sump or basin of the cooling tower/evaporative condenser. One loop acts as a side stream filter. The second side stream loop is where cooling water passes through a pair of horizontally opposed vortices and is accelerated to a very high velocity at the discharge. At the point of discharge, the two opposing water streams (whose internal rotation is opposite from one another) collide, creating hydrodynamic cavitation, shear force, and vacuum.

This sudden lowering of pressure into a vacuum state forces the release of dissolved carbon dioxide (CO_2) from the water. This release of CO_2 in turn, causes calcium carbonate to immediately drop out of solution into suspension where it is removed by filtration. Unlike other non-chemical technologies, CHC is relatively impervious to alkaline or acidic source water, high or low pH, hardness, TSS or TDS, all of which are parameters that may render other forms of cooling water treatment less desirable. Additionally, it is relatively easy for operational personnel to see if this system is working, because it can be either remotely monitored or monitored on-site by physical observation of the pump status and a vacuum gauge which measures vacuum being created inside the CHC chamber.

System Operation: Water is pumped from the sump/basin of the cooling tower/condenser and into the pressure-equalizing chamber. It is then channeled into precision-manufactured nozzles (vortices) that are configured to impart a specific rotation and velocity to the water streams. The circular motion of the water is accelerated as the stream flows through the nozzles and the resultant discharge is a conical stream. The opposing cones collide in the low-pressure stage (stabilizing chamber) to form a circular zone of very high shear force and high vacuum caused by the collapse of micrometer-sized bubbles and cavities. Essentially, the pressure change causes hydrodynamic cavitation with locally high temperature at the point of collision. This cavitation creates solid particles, and the rapid change in pressure to a vacuum causes the cell walls of microorganisms to burst, thus killing the cell. Finally, the hydrogen-bonding molecular arrays of water are broken down, thereby allowing entrapped gasses (such as CO_2) to be released and off-gassed to atmosphere. The remaining energy dissipates as turbulent flow, and the treated water exits the unit at ambient pressure. Suspended matter is removed from the sump/basin via a second side stream loop designed to sweep the debris from the floor of the sump into the automatic filter or centrifugal separator. The filter is automatically backwashed to remove solid matter on a timed basis and is then sent to waste.

***Biological Control**: CHC* technology is in sharp contrast to chlorine or bromine treatments that degrade over time and require constant additions. During biocide dosage the bacteria cell must ingest chlorine or bromine. This often takes up to 30 minutes if and when the cell comes in contact with a chlorine molecule, and is therefore not always 100 percent effective. CHC technology causes a combination of physical changes to take place in the water that disrupt the cell membranes of biological matter, ultimately destroying the cell. Every cell pumped through the system is subjected to vacuum, high pressure, kinetic energy, high velocity collision, shear energy, and localized high temperatures. The pressure of the fluid inside the cell wall is in balance with ambient water pressure prior to its entrance into the CHC chamber. However, the pressure differential becomes relatively high once the cell enters the low-pressure stage that is in vacuum, resulting in a pressure imbalance between the inside and outside of the cell. The cell wall cannot withstand the pressure differential and the cell wall ruptures, dispersing the cell cytoplasm. After the lowpressure stage, localized high temperature and high pressure at the intersection point of the vortices also kills additional bacteria and cell life.

Scale and Hardness Control: Cooling systems build up scale over time due to the addition and concentration of soluble calcium often in the form of calcium bicarbonate. Calcium bicarbonate can decompose to yield insoluble calcium carbonate and carbonic acid with any changes in temperature and pressure. Carbonic acid can further decompose to carbon dioxide and water. $(Ca(HCO_3)_2) \leftrightarrow CaCO_3 + CO_2 + H_2O$, or (Calcium bicarbonate) ↔ (Calcium carbonate) + (carbon dioxide) + (water). At a given temperature and pressure, this equation is in equilibrium with no chemical reaction taking place. Once the pressure is lowered to a vacuum in the low pressure stage, the CO_2 equilibrium is shifted between aqueous and gas phase, causing dissolved CO_2 to release to the gas phase. This phenomenon, together with the high localized temperature created by the collision of the conical water streams, decreases the solubility of calcium in water and a simultaneous elevation of water pH, which, in turn, causes a massive formation of calcium carbonate precipitate. Soluble calcium carbonate species concentrations are thus depleted (by design) both via de-adsorption of CO_2 and the precipitation of $CaCO_3$. As the water stream leaves the CHC unit it enters the sump/basin where the water pressure is

stabilized (at atmospheric pressure) and the velocity of the water slows down. Submicron particles of calcium carbonate called colloids are formed and flow with the water. These become thermodynamically favored incubation sites to grow crystals composed of Ca^{2+} and HCO_3 ions versus metal surfaces in the system. As the molecules agglomerate, they become heavy and sink to the basin/sump floor. At this point, the resultant calcium scale is removed via the side stream filter or centrifugal separator and collection system. This device is periodically backwashed to remove entrapped calcium and other suspended matter.

Corrosion Protection: Corrosion occurs in a system due to several phenomena mentioned earlier in this report. All waters are corrosive to some degree; however, the level of corrosive tendency will depend upon its physical and chemical characteristics. The materials that a given water supply will negatively affect may differ. For example, water that is corrosive to galvanized pipe may not be corrosive to mild steel. Corrosion inhibitors that protect one material may have no effect on other materials. Biological growth in a piping system can also cause corrosion by providing an environment in which physical and chemical interactions can occur. Several types of system level problems can occur if cooling water systems are left untreated. A major source of corrosion is the addition of the bio-inhibiting chemicals themselves. This is true especially when “shocking” is required as chemicals lose effectiveness over time and a chemical alternative is administered. By the time this new chemical, usually bromine or chlorinebased, is put into service the biological growth in the system has gotten out of control such that a “super concentration” of biocide is required. These chemicals tend to be very corrosive. A layer of biofouling on any surface in the condenser water system acts as a haven for aerobic and anaerobic activity, bacteria formation, scale accumulation and potential corrosion. By eliminating biofouling, the potential for corrosive activity is greatly diminished. CHC operating parameters and the absence of chemicals allow the pH level to be elevated in the range of 8.5 to 9.0. At these values both iron and copper are protected from oxidation corrosion, which cannot operate in an alkaline state. Under these conditions metals are allowed to establish a thin layer of natural protection, which is not penetrated by system water or dissolved oxygen.

4.0 TEST EQIPMENT and PPE

This section has been constructed to define the appropriate usage for a DVM (Digital Volt Meter), Conductivity Pocket Meter ,Ultrasonic flow meter, other equipment as well as PPE (Personal Protection Equipment) and Safety Practices.

4.0 Safety Requirements- (Updated May, 2014)

THE SAFETY OF EcoWater CHC PERSONNEL MUST ALWAYS BE TAKEN SERIOUSLY, AND DONE RIGHT WITHOUT REGARD FOR TIME REQUIRED TO DO THE JOB SAFELY. YOUR LIFE MAY DEPEND UPON IT!

EcoWater CHC REQUIRES you to follow all safety regulations as set forth by EcoWater management and requires you to follow all training and or instruction you have been given by EcoWater. If you are found not following this instruction, you will be warned only once, upon continued failure to follow our requirements, you will be terminated.

All CHC Requirements are superseded by any Customer Safety Requirement. Before doing any work at a Customer Site, you are required to check with the customer to obtain any training and/or safety instructions that may pertain to your work.

You must follow these instructions at all times and are required to contact your supervisor, if any safety requirements are not understood, or you will have any problems performing them.

EcoWater CHC has a Safety Board located in the Hallway to manufacturing for those personnel working within our facility. This location includes the MSDS logs for those products used within our facility. If any field personnel wishes, CHC will provide this same information for your review and or use. It is your responsibility to acquire any MSDS sheets for products that were not provided by EcoWater and use them. Please copy EcoWater on an MSDS sheets that you receive on chemicals used on the behalf of EcoWater.

You must contain a working knowledge of the information found within this document, and be able to show the ability to utilize this information at all times. This information will be covered within your training regime at point of hire. You will also participate in yearly examinations and updates of your working knowledge.

IF YOU HAVE ANY QUESTIONS OR CONCERNS CONTACT CARL STEFFEN AT cell 210-857-5252.

Site Safety-

Site Safety is a very important part of your work ethics when working with EcoWater CHC. Site Safety is required when you go to ANY Customer Site.

You MUST verify the following upon any attempt to work at a customer site:

1. **You must be familiar with the Emergency Notifications systems used at the site.**
2. **You must be familiar with all Emergency Evacuation Routes as assigned by the customer.**
3. **You must be familiar with all Emergency Notification Requirements as set forth by the customer. This includes understanding who to contact upon an Emergency and/or incident.**
4. **If the customer has any required safety training, you must be trained and follow all training while at their location.**
5. **If the customer requires any special PPE, you must comply with that request before any work is conducted.**
6. **You must notify the customer of your intent to work on the equipment at the site, and the customer must know your location at all times, while on the customer's premises.**
7. **You are not allowed to do any work at a site without the customer being aware of your presence at their facility.**
8. **All PPE must be up to date and inspected before use, do not assume that its protection and/or function is adequate and safe. This includes any customer supplied PPE.**
9. **You must utilize the PPE as instructed.**
10. **You must notify the customer of any possible Hot Work, and/or use of Hazardous materials while on site, and make sure you have their approval and have met the site's safety requirements before any work is done. The customer and you must have a copy of any intended use chemical's MSDS sheet.**
11. **You will not enter any Confined Spaces without customer approval or without the use of appropriate ventilation and or testing equipment.**
12. **You will not perform any Hot Work without an appropriate fire suppression system within arm's reach. Any Hot Work inside of a Cooling Tower requires you to have used the appropriate methods of fire control and monitoring. If a penetration is being made in a tower, you must have an observer on the outside of the tower to monitor for fire hazards.**
13. **Never work on electricity if you do not have the appropriate equipment, training, or it is raining.**

14. **Always use appropriate Lock Out and Tag Out procedures when entering a tower or working on a motor starter. Remember the most important item for Lock Out and Tag Out, is notification of the customer.**
15. **Use your brain, it is your most important PPE.**

Personal Protective Equipment-

EcoWater strongly recommends the use of PPE to protect yourself. Equipment on our skids are heavy and we recommend the use of Steel Toe Safety shoes whenever servicing requires the removal or installation of any heavy items.

The use of gloves is recommended whenever damage or cuts may be possible. It is up to you to use the gloves that were provided for your use.

The use of eye protection is recommended whenever you are at a customer site. If you are using any power equipment, you ARE REQUIRED use the appropriate eye wear. If you are using any chemicals, you MUST use the appropriate eye wear. If you have prescription safety eye wear, you MUST use your prescribed eye wear whenever possible.

If using any strong chemicals, refer to the MSDS sheet or contact EcoWater CHC for further PPE requirements that must be used. Respirators, face shields, protective clothing and gloves MAY BE REQUIRED AND MUST be used if recommended by the MSDS sheet or by EcoWater.

NEVER assume you will be alright, ALWAY protect yourself, use the prescribed PPE.

If you will be working on a ladder or scaffolding higher than 10 feet, you must work with another person and you must follow tie off rules and use a safety harness. If you do not have one, one will be provided for you or one can be purchased for your use (Verify that the specifications meet your intended use.

If you are working at a new facility or any other facility where construction is in progress you must wear a bump cap to protect you head.

The customer site may require the use of specific PPE, Always ask what PPE is required, if the customer will not provide it, you will have to obtain it.

If the customer requires you to go through any specific Safety Training, please do.
Contact EcoWater CHC to identify that customer as a customer requiring additional safety training.

Safely using your PPE-

- **Always clean and inspect your PPE.**
- **If your PPE is damaged, you must replace it.**
- **If you are unsure how to use your PPE, then ask.**
- **Protect yourself, your body is the only one you have.**
- **Follow Procedures.**
- **Your brain is the most important PPE.**

Electrical Safety-

This procedure establishes the minimum requirements for any electrical work that will be done on a customer's site. You must comply with these requirements at all times. Failure to do so, may cause death.

You WILL NOT work on any supply connections for power. A licensed electrician or customer supplied electrician is required for any work conducted on electrical supplies.

You WILL NOT do any electrical work in the RAIN, and/or standing water.

You WILL NOT do any electrical work on live circuits. You must verify loss of power through the use of a hand held Multi Meter, and or verified electrical tester before any work on existing wiring or components is conducted.

You WILL use Lock Out/Tag Out procedures when working on electrical systems within the CHC skid.

You WILL inspect your test equipment before use.

You WILL NOT use any test equipment with defective leads.

You WILL use safety glasses when troubleshooting electrical circuits.

Follow all safety guidelines as instructed to you during your electrical safety training.

If any problems are encountered you must notify EcoWater CHC management as well as the customer.

Hot Work Procedure

This procedure establishes the minimum requirements for the safe use of flames, flammables and or spark creating equipment. You must always instruct the customer whenever Hot Work will be conducted. Many customers have Hot Work procedures in place and you must comply with all customer related Hot Work Requirements including the use of Hot Work Permits.

Before any Hot Work is conducted you must have a working knowledge of Safety Reporting and/or Emergency Reaction steps that may be needed. You must be prepared for the work and you must take precautions to minimize any accidents. You must be aware of your surroundings and any possible combustibles that may be affected. If you cannot view all sparks that are generated due to the location your work is being conducted in, then you must use someone to monitor the sparks in their entirety until cool on the other side of the obstruction.

Prevention is always easier than correction of problems created due to Hot Work. This includes understanding that any material you will be working on may be hot and could cause other problems as it falls off your work.

Hot Work Requirements:

1. **Customer Notification**
2. **Permit Completion and Filing when applicable.**
3. **Locate Fire Alarms and Evacuation Routes**
4. **Move an appropriate Fire Extinguisher into your work area**
5. **Control any Combustibles**
6. **Use a Monitor as needed**
7. **Use your PPE**
8. **Prepare Work Space to ensure minimization of damage caused by sparks or direct heat.**

Once the Hot Work is completed you must clean up any debris and or safety gear and make sure the site is better than it may have been when you arrived.

If any problems are encountered you must notify EcoWater CHC management as well as the customer.

Lock Out, Tag Out Procedure

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization or start-up of the machine or equipment or release of stored energy could cause injury.

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure. All employees, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment.

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

(2) The authorized employee shall refer to the company procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.

Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

(8) The machine or equipment is now locked out.

Restoring Equipment to Service

When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken.

(1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

(2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

(3) Verify that the controls are in neutral.

(4) Remove the lockout devices and reenergize the machine or equipment. Note: The removal of some forms of blocking may require re-energization of the machine before safe removal.

(5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for used.

If any problems are encountered you must notify EcoWater CHC management as well as the customer.

Confined Spaces

This procedure establishes the minimum requirements for the safe entry into a confined space. A structure may be indicated as a confined space may be due lack of ventilation (Tank or sump) or the proximity to moving objects (Fan Blades in an Evaporative Condenser). It is imperative that appropriate precautions be taken when entering a confines space to ensure brain damage or death do not occur in a tank or sump due to the lack of oxygen or inhalation of other harmful gasses or loss of limb or life do not occur due to coming in contact with a moving object.

Always consult with a customer when entering a confined space and in most cases, it will require someone to monitor you from a safe distance during your entry.

When entering a tank or sump, gasses can build up that are harmful to your health and it is imperative that appropriate ventilation be given. It is imperative that you require the use of someone to monitor your condition when entering a confined space.

You will be required to monitor the air's oxygen levels with a continuous monitoring meter before and during entry into the space. All workers within the space are required to utilize appropriate PPE and restraints connected to an external surface. Please refer to the instructions on the Oxygen monitor for minimal safe levels for entry, BEFORE entry into the tank or sump.

When entering into a Cooling tower, always stop the water flow and continue the fan operation for a period of at least 5 minutes to evacuate any harmful gasses from the tower.

Utilize Lock Out/Tag Out procedures to secure all controls for the tower's pump and fans before entry.

Notify the customer when all work is done in the confined space and remove any safeties that were added during entry.

Confined Space Entry Requirements:

1. **Customer Notification**
2. **Use Appropriate PPE**
3. **Use Appropriate Ventilation**
4. **Use an Approved/Operational Verified Oxygen Monitor**
5. **Secure all workers with restraints to an outside surface of the tank or sump.**
6. **Use Lock Out / Tag Out Procedures**
7. **Use someone external to the confined space as a monitor.**

Use of Combustibles Procedure

This procedure establishes the minimum requirements for the safe use of Combustibles. Before using any Chemicals make sure and review the MSDS sheets to recognize their flammability. Remember just because the chemicals may not be flammable as a liquid does not mean it isn't flammable as a vapor.

You must always instruct the customer whenever combustibles may be used.

Prevention is always easier than correction of problems created due to the inappropriate use of combustibles.

Hot Work Requirements:

1. **Customer Notification**
2. **Locate Fire Alarms and Evacuation Routes**
3. **Identify Combustibles in an appropriate manner, and container.**
4. **Move an appropriate Fire Extinguisher into your work area**
5. **Control any Combustibles in methods as defined on their MSDS**
6. **Use a Monitor as needed**
7. **Use your PPE**
8. **Prepare Work Space to ensure minimization of damage caused by sparks or direct heat.**
9. **Use appropriate ventilation.**
10. **DO NOT use combustibles in areas where open flames or sparks are present.**

Once the work is completed you must clean up any debris and or safety gear and make sure the site is better than it may have been when you arrived.

If any problems are encountered you must notify EcoWater CHC management as well as the customer.

Use of Corrosives Procedure

This procedure establishes the minimum requirements for the safe use of Corrosives. Before using any Chemicals make sure and review the MSDS sheets to recognize their corrosively. The MSDS Specifies the Safe Handling, usage precautions, cleanup and disposal. You must understand the handling requirements and or usage, before attempting to use the chemicals.

You must always instruct the customer whenever corrosives may be used.

Prevention is always easier than correction of problems created due to the inappropriate use of corrosives.

How Work Requirements:

1. **Customer Notification**
2. **Locate Fire Alarms and Evacuation Routes**
3. **Locate eye wash and other washing facilities.**
4. **Identify Corrosives in an appropriate manner, and container.**
5. **Move an appropriate Fire Extinguisher into your work area**
6. **Control any Corrosives in methods as defined on their MSDS**
7. **Use your PPE**
8. **Use appropriate ventilation.**
9. **DO NOT use corrosives in manners that are not described on the MSDS.**
10. **Ask Customer about any specialized permits needed for disposal.**
11. **Corrosives must be neutralized before disposal.**
12. **Flush all drains for a period of at least 15 minutes after disposal.**

Upon any Spills:

1. **Utilize the instructions as specified within the MSDS sheet, DO NOT assume you know the appropriate methods for cleaning up the Chemicals.**
2. **You must notify EcoWater CHC Management upon any spill.**

Once the work is completed you must clean up any debris and or safety gear and make sure the site is better than it may have been when you arrived.

If any problems are encountered you must notify EcoWater CHC management as well as the customer.

Use of Fire Extinguishers

This procedure establishes the minimum requirements for the safe use of a Fire Extinguisher.

Remember, the use of a Fire Extinguisher requires you to be safe at all times. Do no use the extinguisher in a manner that would allow you to be blocked by flames from your escape route.

Things to remember about Extinguishers:

1. **Make sure your extinguisher is rated for the type of work being done and fire that may be encountered.**
2. **During small fires, the use of a Fire Extinguisher is only for use to aid in your removal from the area. If you have been previously trained with the use of a Fire Extinguisher, then pull the pin, aim the hose at the base of the fire and squeeze the trigger. If the fire is on top of a combustible liquid, do not aim at the base, but rater at the mid to top of the flames to reduce any spreading of the burning material. At any time, if the fire does not want to extinguish to takes more than a couple of minutes, NOTIFY THE CUSTOMER and or Fire Department.**
3. **When a large fire erupts, NOTIFY CUSTOMER IMMEADEATELY and use the extinguisher to aid in your removal from the area. Make sure the fire alarm has been sounded and evacuate to the appropriate location as specified by the customer.**
4. **If you ever have to evacuate, locate the customer representative who is responsible for you, and check in to make sure they know you have made it out of the building.**
5. **Dispose of the extinguisher as instructed by the Customer.**

Contact EcoWater CHC Management.

Incident Reporting

This procedure establishes the minimum requirements for reporting any mishaps and/or injuries to a EcoWater CHC employee.

Upon any mishap, you must contact the customer and any other personnel the customer directs you to IMEADIATELY. You must also contact EcoWater CHC Management IMEADIATELY. If you are unable to contact the customer, call 911 as needed.

Notifications:

1. **Type of Mishap/Incident**
2. **People Notified**
3. **Date of Mishap/Incident**
4. **Injury type and or degree**
5. **Actions taken for Mitigation**
6. **Location, time and name of physician or hospital visit.**
7. **Report from said care giver.**
8. **Updates as requested from EcoWater CHC Management.**

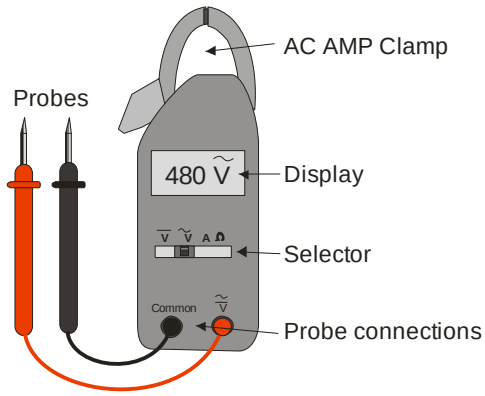
It is our intension that you are taken care of as quickly as possible, if one of the above notifications is delayed due to the requirements of care, please alert us to that standing after the fact.

In most cases a written explanation of the Mishap and/or Incident will be required, please provide as requested.

4.1 Digital Volt Meter-

The DVM is a meter that can be used to Test Voltages, Amperages, component continuity as well as other uses. A DVM should not be used if any physical damage to the device or its probes have been found.

Each DVM is different and its labeling and appearance can change. Here is an example of a DVM and you will see to the right, that there are several possible symbols for each function. (Example only, may not represent your meter)



Voltage DC= V̄,VDC, DC,⎓
Voltage AC= Ṽ, VAC, AC,≃
Amperage = A, AAC, Ã
Continuity =Ω,))),)))

Black Lead = Common
Red Lead = Volts supply

The function of the meter depends upon the function Selector and its position. Here are some examples of when to use each function:

Voltage DC (VDC or V+/-)- Uses the Probes and measures direct current voltages. The black lead will go onto a ground or negative wire or V- connection and the red lead will go onto the power or + wire or terminal. The Display must show the DC Voltage indicator. (Uses can include measuring the voltage of a battery, or DC power supply, or a DC control voltage or Analog transmitter signal.)

Voltage AC (VAC or V~)- Uses the Probes to measure alternating current voltages. The black or red probes must be placed on the powers, or power and neutral, or power and ground to measure the voltage. (Uses can include measuring the voltage on a motor, motor contactor, electrical supply, control voltage if AC)

Amperage (AC)- Uses the AC Amp Clamp and it will measure the AC Amperage passing through a wire to a motor or other power load.

Continuity- Uses the Probes and measures the resistance to power passed through an object from the black probe to the red probe. Most DVMs will also beep as the continuity is verified. This function can be used to verify if a fuse is good (0 Ω on display and beep sounded) or bad 1.__ Ω will be shown on the display and the fuse must be replaced. It can also be used to verify any coil, wire, or connection for continuity. A coil will have an indication of some resistance (2000 KΩ), a wire or connection should indicate 0 Ω and sound the beep. **This function should never be used while power is applied**

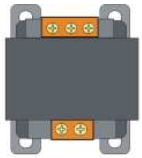
to the circuit and you should never verify the continuity of an object that is placed on a conductive surface.

Safely Using the DVM-

- **Never use any DVM that is damaged or its probes are damaged.**
- **Never measure voltages or amperages if it is raining or you are standing in water.**
- **Always verify if power is applied to the test subject with a known good Voltage Checker before you test it with your DVM.**
- **Never measure continuity with power applied to the circuit.**
- **Never hold a wire with power onto the probe with your fingers.**
- **Never use both hands to measure a voltage, use a self sustaining connection like an clip to maintain one of the probe's connections and then use one hand with the other probe.**
- **Never connect the AC Amp Clip to a powered circuit, always remove power, connect the clip, and then turn the power on to measure amperage.**
- **Never use a DC Amp meter function to measure AC amperage.**
- **Always replace batteries and fuses with those specified by the manufacturer.**
- **If your DVM gets wet, DO NOT USE IT!!**

It is important that you understand what type and voltage you should expect. If you do not set your voltmeter correctly, it will not read correctly. It is important that it is put in the correct measurement mode you are intending to verify. Many times you can see what power is being supplied to a device or refer to its label to verify how to set your meter.

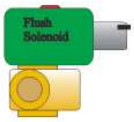
The next couple of pages describe different parts found on our systems as weather they are AC or DC powered:



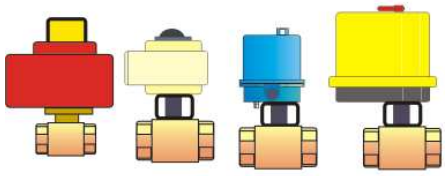
Transformer.. Always Volts AC, V~ on both sides of the unit. Normally one side of the transformer will be 480 and the other is normally 120.

Power Supply. The bottom Inlet is always Volts AC, V~ while the output is always VDC, V+/-. Normally the input is 120VAC or 480VAC as shown on the power supply. The output is always 24VDC V+V-. The smaller white units are 120VAC input while the larger silver one is 480VAC.

TECO controller. Always uses 120VAC, V~ power as connected to the L and N connections and to all (I) Input and (Q) output connections.



Solenoid Valves. Can be VAC or VDC. Refer to voltage marked on the side of the coil for identification



Actuated Valves. Can be both VAC or VDC. Refer to voltage marked on side of motor for identification

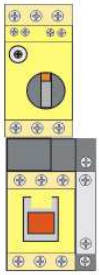
Conductivity Controller. Always VAC 120V~.

Timer, Can be VAC or VDC. You have to look at what the timer is connected to to figure out what its power is.

Relay coils, Can be VAC or VDC or both. The coil could be VAC or VDC as identified on the coil cover. The contacts can be VAC or VDC depending upon what is connected to them.

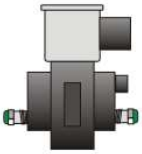
Breakers. Can be VAC or VDC depending upon what is connected to them as a power source or load.

Power Disconnect with fuses. Always VAC, V~ . Normally 480VAC



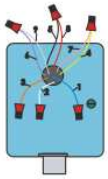
Motor Starter. The power on L1, L2, and L3 are always VAC, V~ while the coil power could be AC or DC as identified on the side of the contactor.

Pressure Transducers. Always VDC, V+/-. Normally 24VDC. Onc wire will be connected directly to a V+ (24VDC) power connection while the other wire is connected to the VCS.

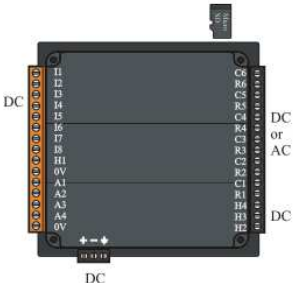


Differential Pressure Switch. Can be VAC or VDC. You have to see where the wires are connected to figure out what the voltages are.

Over Pressure Switch. Always connected to VAC on VRTX equipment.



Motor Connectors. We only use VAC, V~ type motors, normally connected to the Volts HIGH configuration as shown to the left. Normally 480VAC, V~ three phase.

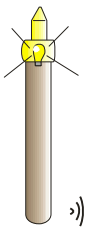


VCS (VRTX Control Station). Always connected to VDC, V+/- on the power connection and Input (orange) block, however the output (large black connection can be VAC or VDC powered and you need to see what is connected to understand if it is AC or DC for testing.

4.2 AC Voltage Checker

The AC Voltage Checker is a pen sized tester used to quickly verify if AC voltage is present without having to make an electrical connection.

AC Voltage Checkers come in many shapes and sizes, but the most common looks like this one:



As the yellow tip is passed close to a wire with AC power applied the tip will light and a sound may be heard.

The checker can be held in one hand and as it comes close to an AC voltage it will light up and sounds a beep if the checker has that function.

Safely Using the Voltage Checker-

- **Never use any checker that is damaged**
- **Never check for voltages if it is raining or you are standing in water.**
- **Always verify if your checker is good by verifying against a known AC power source.**
- **Never use both hands to check for a voltage, The other hand should be behind your back.**
- **Always replace batteries and fuses with those specified by the manufacturer.**
- **If your Checker gets wet, DO NOT USE IT!!**

4.3 Conductivity Pocket Meter

The conductivity meter is a wonderful piece of test equipment, as long as you use it correctly and maintain it. It can be used to measure the conductivity of the make up water, verify a skids conductivity meter's accuracy, as well as check ONE Shot Calibration Solution for possible errors. You must be aware of the units of measure that your tester is using when verifying the skids reading.

Refer to your Operation Manual supplied with your meter for specifics on how to use your meter.

Always Clean and check the calibration of your handheld meter each week before you visit a customer site. You need to make sure the batteries are good and the meter calibrated before you try to use it in front of a customer.

Safely Using the Conductivity Pocket Tester-

- **Always clean and calibrate your tester each week against a new One-Shot calibration solution.**
- **Always verify units of measure when using to validate a Conductivity monitor's values.**
- **Always rinse your tester before submerging it in the water you want to test.**
- **Never use your meter to test Acid or Strong Bases.**
- **Always use the protective cap to cover the probe tip when not in use.**
- **If your meter was provided with a sponge in the test cap, make sure this sponge is wet at all times.**
- **Refer to your meter's manual for cleaning and calibration recommendations.**
- **Use your tester to verify the skids conductivity meter over a large scale (air, make up, One shot, and tower water.)**
- **Always replace batteries and fuses with those specified by the manufacturer.**
- **If your tester gets wet, You must be using it right!!**

4.4 Ultrasonic Flow Meter

The ultrasonic flow meter is a wonderful piece of test equipment, as long as you use it correctly and maintain it. If can be used to measure the actual flow in piping systems to aid in balancing problems when multiple towers are being treated by on treatment system.

Refer to your Operation Manual supplied with your meter for specifics on how to use your meter.

Safely Using the Ultrasonic Flow Meter-

- **Always clean and calibrate your meter before each use. Replace the transducer gel if the gel is no longer clear.**
- **Apply gel to the pipe being tested before you apply the sensor.**
- **Apply the sensor onto the pipe in a manner that lines up the sensor as instructed in the manual (the sensor must be lined up on the pipe according to the direction of the flow within the pipe.)**
- **Never place the sensor on a pipe directly after a turn in flow or restriction of any type, this can cause turbulence in the water flow and may force your meter to measure an incorrect flow value.**
- **Always use the protective cap to cover the probe tip when not in use.**
- **Refer to your meter's manual for cleaning and calibration recommendations.**
- **Always replace batteries and fuses with those specified by the manufacturer.**

4.5 EcoWater strongly recommends the use of PPE to protect yourself. Equipment on our skids are heavy and we recommend the use of Steel Toe Safety shoes whenever servicing requires the removal or installation of any heavy items.

The use of gloves is recommended whenever damage or cuts may be possible. It is up to you to use the gloves that were provided for your use.

The use of eye protection is recommended whenever you are at a customer site. If you are using any power equipment, you ARE REQUIRED use the appropriate eye wear. If you are using any chemicals, you MUST use the appropriate eye wear. If you have prescription safety eye wear, you MUST use your prescribed eye wear whenever possible.

If using any strong chemicals, refer to the MSDS sheet or contact EcoWater CHC for further PPE requirements that must be used. Respirators, face shields, protective clothing and gloves MAY BE REQUIRED AND MUST be used if recommended by the MSDS sheet or by EcoWater.

NEVER assume you will be alright, ALWAY protect yourself, use the prescribed PPE.

If you will be working on a ladder or scaffolding higher than 10 feet, you must work with another person and you must follow tie off rules and use a safety harness. If you do not have one, one will be provided for you or one can be purchased for your use (Verify that the specifications meet your intended use.

If you are working at a new facility or any other facility where construction is in progress you must wear a bump cap to protect you head.

The customer site may require the use of specific PPE, Always ask what PPE is required, if the customer will not provide it, you will have to obtain it.

If the customer requires you to go through any specific Safety Training, please do.
Contact EcoWater CHC to identify that customer as a customer requiring additional safety training.

Safely using your PPE-

- **Always clean and inspect your PPE.**
- **If your PPE is damaged, you must replace it.**
- **If you are unsure how to use your PPE, then ask.**
- **Protect yourself, your body is the only one you have.**
- **Follow Procedures.**
- **Your brain is the most important PPE.**

4.6 Safety Procedures

1. **Always use your appropriate PPE.**
2. **Always Notify the customer when you enter their site, and make sure someone knows where you will be and when you are leaving their site.**
3. **Always use your brain and follow safety practices.**
4. **Always be aware of any customer requirements for safety and follow them, if not, you may get in trouble, may be fired, electrocuted, burned, drown or die.**
5. **Your brain is the most important PPE, use it.**
6. **Never work on electricity if you do not have the appropriate equipment, training, or it is raining.**
7. **Always use appropriate Lock Out and Tag Out procedures when entering a tower or working on a motor starter. Remember the most important item for Lock Out and Tag Out, is notification of the customer.**

Lock Out, Tag Out Procedure

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization or start-up of the machine or equipment or release of stored energy could cause injury.

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure. All employees, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment.

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

(2) The authorized employee shall refer to the company procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.

Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

(8) The machine or equipment is now locked out.

Restoring Equipment to Service

When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken.

(1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

(2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

(3) Verify that the controls are in neutral.

(4) Remove the lockout devices and reenergize the machine or equipment. Note: The removal of some forms of blocking may require reenergization of the machine before safe removal.

(5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for used.

5.0 TROUBLESHOOTING

This section has been divided into sections that reflect the problems that may be encountered. The possible causes discussed may not specify all possible failures (Contact EcoWater CHC Service personnel to discuss your problem for other possible failures to look for). At the end of this section, specific failure alarms are discussed.

The troubleshooting techniques discussed here are placed in a functional order, the actual order used for your troubleshooting may differ.

After each set of troubleshooting instructions you will find a blank area for you use in adding notes and other hints.

5.1Power Issues-

5.1.1 The skid will not power ON (No power LED and No pump operation)-

1. Verify if the power indicator is lit on the motor starter, IF IT IS LIT, skip to #4.
2. Verify that power is available at the motor starter. Open the motor starter and with the DVM (Digital Volt Meter), verify that power is present on all three legs of the power supply. EcoWater CHC recommends the use of the ONE HAND safety technique. This means only one hand should enter the motor starter box at any one time, the other hand should be placed behind your back during testing. You can connect the black lead to any ground location within the motor starter or you can hold both probes with one hand as discussed during training.
3. If power is not at the skid, have the facility maintenance staff verify that the power disconnect breaker is still in the ON position, have the customer verify why power is not available at the CHC equipment.
4. If power is available at the skid, verify that as the power disconnect on the motor starter is turned ON, that power is available at the outlet terminals of the power disconnect. If there is no power at the outlet terminals (must be on all three), replace the power disconnect.
5. If power is available at the outlet terminals of the power disconnect, then verify that power is available through the main fuses. If power is not available through the fuses, replace the fuses and verify operation of the system. Normally if these main fuses have been blown, a secondary system failure may have occurred, and other trouble shooting may be required. Another possible cause for a main fuse failure could also include weather conditions. If lightning in the area occurred at the original time of failure, it is possible that the lightning had struck the electrical supply and caused a sudden surge of power into the skid causing the fuses to fail. Verify all other components for appropriate operation, and replace those items if they have also failed.
6. If the power is available through the fuses then verify that you have 120V at the secondary side of the control transformer. If you do, proceed to “Power at skid, however the pump will not start”. If you do not verify that you have 480 V on the Primary side of the transformer. If there is 480 volts on the transformer’s primary and 0 volts on the secondary, than the transformer has failed and must be replaced.
7. If there was no voltage on the primary of the transformer, then check the smaller control voltage fuses. The control voltage fuses are rated for 4/10 A at 600 Volts. You will need to replace them with an appropriate rated replacement part. You do not want to exceed the 4/10 size, too large of a fuse could cause a fire due to transformer overload. Once the fuses are replaced verify that the system operates without continuously blowing fuses. If the

fuses were blown but after replacement, they will not blow again, then we can assume that a sudden surge in the electrical supply due to weather or lightning strikes.

8. If the fuses continue to blow, remove one of the following at a time until the fuses no longer blow and then troubleshoot or replace that item and continue testing the unit: Relay, Blow Down Actuator, Conductivity Meter, LED or other indicators on the motor starter and finally the motor contactor.
9. If the PLC will not power ON and the pumps will not start and your system incorporates a 24VDC power supply, it is possible that one of the actuated valves is pulling down the 24VDC supply. Open the motor starter box, Turn the Power Disconnect ON, and verify if the power supply LED is fully lit. Disconnect the Din Rails from the actuated valves or remove the relays if the valves are wired directly and then try to turn on the Power Disconnect again. If the PLC then lights, one of the actuated valves is pulling the power down. Connect one valve at a time and verify operation of the system as discussed earlier. When the power will no longer come on, disconnect the last actuated valve and verify it will again power ON. Replace that actuated Valve.

5.1.2 The skid's pump will not power ON (Power LED ON but No pump operation)-

1. The power indicator is a good signal that at least two of the three power lines coming into the motor starter are live. It also indicates that the corresponding fuses, transformer and power breakers are still OK.
2. Verify that the Thermal Overload is not tripped, simply press the Reset button to verify. If the thermal overload was tripped, go to step 8.
3. Verify that power is available at the motor starter on all three legs. Open the motor starter and with the DVM (Digital Volt Meter), verify that power is present on all three legs of the power supply. EcoWater CHC recommends the use of the ONE HAND safety technique. This means only one hand should enter the motor starter box at any one time, the other hand should be placed behind your back during testing. You can connect the black lead to any ground location within the motor starter or you can hold both probes with one hand as discussed during training.
4. If power is not good on all three legs at the skid, have the facility maintenance staff verify that the power disconnect breaker is still in the ON position, have the customer verify why power is not available at the CHC equipment.
5. If power is available at the skid, verify that as the power disconnect on the motor starter is turned ON, that power is available at the outlet terminals of the power disconnect. If there is no power at the outlet terminals (must be on all three), replace the power disconnect.
6. Verify that power is available past all three main fuses within the motor starter. Replace any defective fuse.
7. Verify that as the HOA switch is turned into the ON position that the control voltage is sent to the motor contactor's coil.

8. If you are working on an older style CHC(Cabinet type) it may have the push button ON and OFF power switches, there is an upgrade available to convert this style of switch to a standard HOA switch. To test the push button switches, verify that power passes through the switch as the button is pressed.
9. Verify that the pump motor's amperage is within the specified FLA as shown on its motor's rating plate, if it is, turn the power to the skid off and verify all electrical connections. A discoloration on a wire's insulation will signal a loose connection. Make sure all connections are tight and verify that if any wire nuts are used, their connections are secure as well.

5.1.3 The skid's pump will not maintain power when your release the ON push button (Older cabinet style CHC units only)

1. Verify that the OFF switch is not stuck or defective, the OFF switch is a normally Closed switch, however if it fails the power to the pump will not remain when the ON button is released.
2. Check to see if the vacuum switch has been rewired, if it has, a blue and brown wire will be wire nutted together in the motor starter. If these wires are not connected with the wire nut, contact EcoWater CHC Service for the upgrade procedure.

5.1.4 The skid's pump pops breakers, fuses, or thermal overloads frequently-

1. Verify that the pump motor's amperage is within the specified FLA as shown on its motor's rating plate, if it is, turn the power to the skid off and verify all electrical connections. A discoloration on a wire's insulation will signal a loose connection. Make sure all connections are tight and verify that if any wire nuts are used, their connections are secure as well.
2. Verify that the power coming into the skid on all three legs is the same voltage. If you have one leg that is significantly lower, than there is a problem with the power balancing of the three legs at the facility and you will need to bring this to the attention of the facilities service manager. If one leg gets loaded more than the other two, it can cause a single phase condition of the pumps motor and will cause the amperage to suddenly increase blowing fuses and breakers.

3. Look at the power disconnect and the motor contactor, if any smoke residue is left on the plastic, this can signal that one of the contacts may be failing. EcoWater CHC recommends the replacement of the component to ensure appropriate power distribution. If one of the contacts have failed, the pump will make a humming noise and will not spin.
4. If the Main breaker is weak or too small in rating, the pump can cause the breaker to trip during start ups. This is most noticeable upon repeated starting/stopping of the pump motor. The normal rating of the supply breaker should be at least twice the pump's rated FLA. It is also recommended that the supply breaker be of a time delay type allowing for at least 2 seconds of sudden amperage spikes.
5. If it is the thermal overload that is tripping frequently also verify that the selected trip point is at least 1.15 x the rated FLA of the motor. If it is set correctly and the thermal overload continues to trip, replace the thermal overload.

5.1.5 Indicator lights are non functional (pump is operational but the indicator is not lit)

1. Verify that the control voltage is present on the back of the indicator. If it is, then replace the indicator with an appropriate matched bulb or LED. Be aware that some of the older CHC (Older cabinet style units) utilize a 24V AC bulb, it must be replaced with a like product.
2. Always make sure that the plastic cap covering the bulb is not cracked, broken, or its seal is defective, if water or rain gets onto a bulb, it will cause the bulb to fail, so replace any defective parts found.
3. If there is no control voltage at the back of the indicator, then there may be a faulty wire or connection, contact EcoWater CHC Service to receive the appropriate electrical wiring schematic to verify the wires and connections.

5.1.6 The conductivity meter will not power on (Walchem or LMI only)

1. Verify that power is available into the conductivity meter on the power cable. Both meters require 120V AC power. If no power is available verify the power cable and its connection to the power source.
2. Check the fuses inside of the Walchem or LMI units.
    a. The F1 fuse on the LMI is under the black plate below the control panel. It is rated at 4A, 250V slow blow and should only be replaced with a similar product
    b. The F1 fuse on the Walchem is behind the control panel, you will need to remove the two Phillips screws to access the fuse. It is rated at .125 A, 250V and should only be replaced with a similar product.
    c. If they continuously blow the meter is defective and must be replaced.

3. If the above has been verified and power is available to the conductivity meter and it will not turn ON, then replace the meter.

5.1.7 The CHC Control Station will not power ON (newer style skids only)

1. The control station will power on whenever power is supplied to the skid. If the pump will function and the control station will not come ON, verify that the breaker to the DC power supply has not been tripped.
2. If the breaker is tripped, reset it and verify operation. If the breaker continues to trip, then disconnect one item at a time from this list until the breaker no longer trips: Blow Down Actuator, Relay, Motor Contactor and finally the control station. If the breaker continues to trip after each one of the above is removed from the circuit, then replace the DC power supply. Once the problem has been isolated take the appropriate actions to verify the wiring and connections and then replace the defective parts.
3. If the 24Volts DC is available at the Control Station but the display will not respond, replace the Control Station. To replace the unit, disconnect all wire terminals from the unit and then remove the four mounts from each corner of the controller and remove it from the panel. Once the new controller has been installed, reconnect all terminals and test.
4. Contact EcoWater CHC Service if further assistance is needed.
5. If the PLC will not power ON and the pumps will not start and your system incorporates a 24VDC power supply, it is possible that one of the actuated valves is pulling down the 24VDC supply. Open the motor starter box, Turn the Power Disconnect ON, and verify if the power supply LED is fully lit. Disconnect the Din Rails from the actuated valves or remove the relays if the valves are wired directly and then try to turn on the Power Disconnect again. If the PLC then lights, one of the actuated valves is pulling the power down. Connect one valve at a time and verify operation of the system as discussed earlier. When the power will no longer come on, disconnect the last actuated valve and verify it will again power ON. Replace that actuated Valve

5.2 Pressure Issues with the CHC skid-

The following chart represents the normal CHC pressures. Some pressures may differ from those shown below due to water height in relation to the CHC chamber as well as pump specifications.

CHC Pressures- The CHC chamber requires the following pressures:

Vacuum –	**(all) -25 ~ -30 (When applicable)**
Pump Pressure-	**(10 and 20 GPM units only) 72-84 psi**
	(40, 60, 80, 125 and 250 GPM units) 85-102 psi
Back Pressure-	**(all) 3-6 psi, normally set using the sound**

5.2.1 Gauge Problems-

If the gauge is reading high or low, turn off all power to the device the gauge is connected to and allow the pressure to stabilize. The gauge should return to 0 psi. If it does not, open the vent at the top of the gauge and allow it to return to 0 psi (this may take several minutes). If the pressure still remains above or below 0 psi, replace the gauge. Replace the gauge

5.2.2 Low Pump (s) Pressures-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. Verify the strainer basket is clean. You will have to verify the sides of the basket are clean, and not just the bottom. If the pressure remains low, verify that the isolation valves around the pump as well as the towers are open. If the pump appears to be cavitating, verify that there is no o-ring or seal failures in the pump suction line. If air is ingested the pump pressure could be low. If the pressure remains low, verify that no blockage exists within the tubing to the gauge. If the pressure remains low, rebuild or replace the pump or motor.

5.2.3 High Pump Pressures-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. Verify the isolation valves at the unit as well as the towers are open. High pump pressures, if not caused by a defective gauge, are normally caused by an obstruction to flow. If all the valves are open, the obstruction will have to be located and removed. The obstruction may be within the CHC chamber itself. Open the chamber and make sure that all nozzle inlets are clear of debris. Be aware that some systems with a high head pressure due to the location of the pump as compared to the height of the water level may increase the performance of the pump causing higher pump pressures. In these cases, verify that the pump pressures reflect the initial installation pump pressures and if so, disregard the current gauge reading as being high.

5.2.4 Back Pressure Problems-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. If the back pressure of the CHC chamber is not appropriate the effectiveness of the CHC treatment may be affected. Increase low CHC back pressures until within range or CHC sound appears. If the back pressure is too high then decrease the pressure utilizing the back pressure valves on the discharge of the CHC all the way to any tower isolation valves. Verify that the CHC chamber is at least within 10' of the water height as long as the back pressure does not exceed 5 psi.

5.2.5 Vacuum Pressure Problems- (When Applicable)

Most vacuum problems are associated with leaks or blocked vacuum tubes.

a. Leaks- To verify the location of a leak, if you run your hand over the connections of the tubing and fittings of the vacuum system while the system is running, as you move a location that is leaking the vacuum will increase, you can then rework that connection or replace it to fix the problem. In some cases the gauge may be the source of the vacuum leak. If the gauge has the valve on the back of it, simply close off the valve during operation of the CHC skid and then turn off the power to the pump if the reading remains constant then the gauge is not leaking, however, if the pressure decreases quickly, the gauge or valve will required replacement.
b. Blocked tubing- To verify if the tubing is blocked, first turn off the CHC pump, if the vacuum changes quickly, there is no blockage. However if the vacuum responds very slowly or does not change at all, remove the hose from the vacuum gauge and see if the gauge then responds, if it does the gauge is good and the blockage is somewhere else. The most common location for blockage is in the vacuum tubes within the chamber, these tubes will need to be removed and cleaned or replaced. You can also verify that the elbows that attach to these tubes are free from any buildup, use a descaler (e.g. Rydlyme or equivalent) to remove the buildup or replace the elbow to correct the problem
c. If you could not find a blockage or leak, you will need to verify the pump pressures and if correct, the problem is likely associated with the CHC chamber itself. Contact EcoWater CHC Service Department.

5.3 Issues with the Filtration skid-

Filter Pressures can vary widely depending upon the construction of the installation. However there are several key things you must be aware of.

1. **The filter pressure should never exceed the dead head (DH) pressure of the pump. To verify slowly close down the discharge valve on the filter until the pressure reaches it maximum point. This is the dead head pressure. If the valve is Opened, the pressure should be at least 2 psi below the dead head pressure.**
2. **The filter pressure should be set so that the pump is operating at its designed flow and pressure. There are three basic pressures to be aware of for the pump:**
    a. **Older pumps with a rating of 75 TDH (Total Dynamic Head) should be operated at 32 psi.**
    b. **Pumps with a rating of 95 TDH should be operated at 41 psi.**
    c. **ZGF pumps with a rating of 115 TDH should be operated at 50 psi.**
    d. **Utilize the Filter discharge valve or Sweeper jets to maintain this operational pressure.**

5.3.1 Gauge Problems-

If the gauge is reading high or low, turn off all power to the device the gauge is connected to and allow the pressure to stabilize. The gauge should return to 0 psi. If it does not, open the vent at the top of the gauge and allow it to return to 0 psi (this may take several minutes). If the pressure still remains above or below 0 psi, replace the gauge. Replace the gauge

5.3.2 Low Pump (s) Pressures-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. Verify the strainer basket is clean. You will have to verify the sides of the basket are clean, and not just the bottom. If the pressure remains low, verify that the isolation valves around the pump as well as the towers are open. If the pump appears to be cavitating, verify that there is no o-ring or seal failures in the pump suction line. If air is ingested the pump pressure could be low. If the pressure remains low, verify that no blockage exists within the tubing to the gauge. If the pressure remains low, rebuild or replace the pump or motor.

5.3.3 High Pump Pressures-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. Verify the isolation valves at the unit as well as the towers are open. High pump pressures, if not caused by a defective gauge, are normally caused by an obstruction to flow. If all the valves are open, the obstruction will have to be located and removed. The obstruction may be within the CHC chamber itself. Open the chamber and make sure that all nozzle inlets are clear of debris. Be aware that some systems with a high head pressure due to the location of the pump as compared to the height of the water level may increase the performance of the pump causing higher pump pressures. In these cases, verify that the pump pressures reflect the initial installation pump pressures and if so, disregard the current gauge reading as being high.

5.3.4 Differential pressure too High or too Low-

Verify that the gauges are operating and return to 0 psi as the pump is stopped. Systems with centrifugal separators require at least 4 psi differential pressures between the inlet and outlet pressures. If the pressures are too low <4 psi, verify that there is no obstruction to the flow of the sweeper nozzles, this can also be seen by having a closed valve on the discharge of the filter. If the differential pressures are to high (normally seen in an automated filtration system including Filtomat, ZGF and Turbo disk systems) this indicates that the filter media is not being cleaned appropriately during a back wash. See Filter Back Wash Failures.
Conduct a Power Clean procedure and then clean the Filter element as specified.

5.3.5 Filter Back Wash Failures-

These types of failures may be seen from a visual alarm on the controller or recognized by the DP switch indicating a pressure that is higher than the set point continuously. Please refer to the appropriate service manual attached for each specific type of filter. There are several types of failures to verify:

1. Is the back wash function working when the manual BW start switch is pressed? Make sure that all of the appropriate valves are being controlled to implement a back wash. See specific troubleshooting requirements for ZGF, Filtomat, and Turbo disc filters.

2. If the valves are responsive, verify that purged water is passing to the drain during a back wash cycle. If no water is passing to the drain, then look for clogged piping associated with the drain.
3. If water is present at the drain during a back wash, then clean the filter element. A stainless steel brush can be used with Rydlyme to clean the Filtomat and ZGF filters. EcoWater CHC also recommends polishing the outside surface of a ZGF element. Once cleaned verify that the filter again back washes effectively. Normally when the elements are plugged you will need to discuss your findings with CHC Service Personnel to see if any changes to the system are required. If the filter element becomes plugged frequently changes to the DP switch set point, filter back pressure or other items may need to be adjusted to diminish failure occurrences.
4. Verify the DP switch as its pressure increases to see at what pressure the filter responds with a back flush routine. If an automated back flush is not started, the DP switch may be defective and you will need to verify the switches signal to the controller, if the signal is available at the controller, replace the controller, if the signal is not present at the controller, replace the DP switch and or repair/replace the wiring from the switch to the controller.
5. Make sure the required back pressure is set with the valve down stream of the filter. The ZGF requires 45 psi outlet pressure under normal conditions, the Turbo disc requires minimally 32 psi outlet pressure and the Filtomat requires minimally 35 psi.

ZGF Filters- Refer to the appropriate service manual but here are a few thing to look for.

d. Air is required on the majority of the ZGF units. It requires minimally 80 psi to operate the system. Make sure that air is available for the unit and that as the failure occurred that air was present (if the failure occurred while you where not on site)
e. Holding down the Reset button can be used to reset a displayed alarm.
f. The air operated actuators must move freely, if they are sluggish make sure that a moisture separator is on the air line at the filter to remove any water from the air supply.
g. Phoenix- If the Home Position Not Found message appears, then verify all electrical connections from the controller to the filter itself, we have found many of the filter's yellow interface cable to the black filter cable connections to be defective. We normally rewire the yellow and black cables directly into the DP switch where we solder the connections directly to their corresponding mates. You will be required to set the foot valve back to home position before you can continue using or testing the filter.
h. Phoenix DP Switch- The DP and High DP switches are normally closed, so that when testing them you should have a 12V DC signal passing through the switches with the filter pressures normal. Use the electrical schematic to verify which wires to measure or call CHC Service Personnel.

i. Phoenix Home Position Switch- The home position switch sends a 12 VDC signal back to the controller as the foot valve reaches its home position. If your filter is not recognizing Home Position, first verify the connections of the cables, then measure the voltage at the controller with your DVM to see if the signal is returning from the switch. We have also seen one failure where the restraining clip on the center shaft of the foot valve was missing and the foot valve shaft would allow the switch's signal bolt to move too low for the switch to see it. Make sure that the signal bolt is within 1/8" of the home position switch as the foot valve rotates 360 degrees.
j. Phoenix Foot Valve- If water is found inside of the Foot Valve area where the home position switch is located, an o-ring kit will need to be installed on the Foot Valve. This kit includes smaller o-rings that will be placed inside of the valve against the shaft itself. Without replacing these smaller o-rings water will most likely continue entering the home position switch area. Always make sure the Foot Valve rotates freely throughout its 360 degrees of rotation. If it does not, make sure no debris is longed in one of the internal ports that the valve rotates against. We have seen large debris in this are that can keep the valve from turning.
k. Phoenix Control PLCs- If you have a TECO controller it has been modified from the original ZGF controller. The Teco controller will indicate that a BACK WASH FAILURE has occurred, you will need to verify the appropriate steps if this message appears. You could also find a SCREEN CLEANING REQUIRED message. This message indicates that greater than 5000 back washes have occurred. To reset this message, Press the ESC button, select STOP and press the OK button, then select RUN and press the OK button. Now when you press the ESC button the display should revert back to the initial screen and the BW counts should indicate 00000. Of you find any other error codes, you will be required to replace the controller.

Turbo Disk Filters- Refer to the appropriate service manual but here are a few thing to look for.

a. Air is required on the majority of the Turbo Disk units. It requires minimally 80 psi to operate the system. Make sure that air is available for the unit and that as the failure occurred that air was present (if the failure occurred while you where not on site)
b. The DP switch is used to manually initiate a back wash by rotating the gauge's knob until the striker comes in contact with the red pressure indicator.
c. The air operated actuators must move freely, if they are sluggish make sure that a moisture separator is on the air line at the filter to remove any water from the air supply.

d. The filter elements ride inside the element cassette. As a back wash is conducted this cassette releases pressure on the disks, improving the back wash capability. Make sure this cassette opens and squeezes against the disks easily, if not, clean and replace the o-rings on the cassette.
e. The filter elements can be cleaned with Rydlyme or by hand, each side of each disk has small groves that will need to be clean. Each disk should be free to move, if disks are stuck together, clean or replace them.

Filtomat/Amiad/Forsta Filters- Refer to the appropriate service manual but here are a few thing to look for.

a. The back pressure on the filter is required as specified above.
b. Under normal operation (no back wash in progress) the rinse piston will be pressurized and if you remove its hose from the end of the filter water will aggressively pass through the hose, in most cases it will travel several feet away from the hose. If it does not, then there is an obstruction in the solenoid valve that will either need to be removed with cleaning or replace the solenoid.
c. The DP switch used with the Filtomat and Orival systems have two switches in them, on older Filtomat systems only one switch is used, so upon a failure of the DP switch you can utilize the spare switch to repair the system. On newer Filtomat and Orival systems you will notice that both switches are utilized. In this case you must replace the DP switch if it fails. To adjust the set points of the DP Switch, utilize the supplied allen wrench to loosen the screw on the switch slider, move the switch towards the HI side to decrease the DP setting and towards the LO side to increase its setting pressure. See attachment “New Style DP Switch”.
d. No back pressure on the drain is allowed. If the customer has installed a blow down meter on the drain, contact EcoWater CHC Service to discuss further requirements.
e. If you have an older style Filtomat controller it will have a TECO controller. The Teco controller will indicate that a BACK WASH FAILURE has occurred, you will need to verify the appropriate steps if this message appears. You could also find a SCREEN CLEANING REQUIRED message. This message indicates that greater than 5000 back washes have occurred. To reset this message, Press the ESC button, select STOP and press the OK button, then select RUN and press the OK button. Now when you press the ESC button the display should revert back to the initial screen and the BW counts should indicate 00000. Of you find any other error codes, you will be required to replace the controller.

Centrifugal Separators- Refer to the appropriate service manual but here are a few thing to look for.

a. There are no moving parts to a Centrifugal Separator, if during operation you hear strange noises from the separator, then the baffle plate has failed and the separator must be replaced.
b. The separator requires at least 3 psi differential pressure from its inlet to its outlet, refer to filter problems for more information.
c. All separators remove solids from the water stream. Thereby requiring some way to remove the solids from the filter. Most systems utilize a timed actuated purge valve, this valve is controlled by a timer normally set at 18 seconds ON and 6 hours OFF. Refer to "Adjusting the Purge Valve Timer" for more information on about adjusting and reading the timer settings.
d. If a separator is clogging frequently decrease the OFF time and increase the ON time. One example may be moving the ON time from 18 seconds to 24 seconds and the OFF time from 6 hours to 4 hours. Trial the new settings for a month to see if the clogging has ceased. Make further adjustments as needed.
e. Other Separators utilize a continuous drain flow through a bag filter back to pump suction. Make sure that the flow restriction valve after the bag filter housing is adjusted so that only a loss of 3 psi is seen on the discharge pressure of the separator as this valve is opened. You will also need to verify that the customer is cleaning the bag in a timely manner. Some of the systems in the field using this technique also have a flow meter built in line with the flow restriction valve. You can use this meter as a gauge as to when the bag is plugged and requires replacement. You can also use this meter to regulate the flow through the bag.

Bag Filters-

Many of the systems that contain a centrifugal separator also have a bag filter. This bag filter is used to remove the lighter that water particles from the water stream. Some filters are in line with the separator while others remove a portion of the filters flow in a side stream application.

In-Line Bag Filters

a. The inline bag filter housings are placed in line with the discharge flow from the separator. As the bag starts to blind off (clog up) the overall pressure on the separator's discharge will increase until it reaches the set point (BELOW THE PUMPS DH PRESSURE) where it will operate a bypass valve. Some of the bypass valves are Manual in design while others utilize a switch an electric actuated valve. You will need to make sure the switch closes below the pump's DH pressure then opens the valve. If it does not open the valve, check the switch to make sure it's setting pressure is appropriate, and that it electrifies the valve as it's setting pressure is reached. Refer to testing actuated valves for further assistance. Once the bypass pressure is reached and the valve opens you will be required to press the white "RESET" push button on the top of the switch to close the valve and return to normal operation.
b. There are two possible sites for gauges on a Bag filter housing, make sure any gauges that are installed are functional. If the gauge is ported into the housing above the top of the filter bag, its pressure will rise as the bag blinds off. If the gauge is ported into the housing below the top ring of the bag, its pressure will fall as the bag blinds off.

Side Stream Bag Filters

c. Side Stream Bag Filters have one advantage over In-Line filters, no moving parts to trouble shoot. If the bag becomes blinded off, then no flow will be pulled through the bag and away from the filtration system. However it is very important that you only open its flow regulation valve only so that 10-15% of the filtration's flow is pulled though the bag filter. To make sure this flow requirement is met, utilize an ultrasonic flow meter, or only open the valve so that a 3 psi pressure drop from the discharge pressure of the centrifugal separator is seen (pressure with valve open versus pressure with valve closed). There are two possible sites for gauges on a Bag filter housing, make sure any gauges that are installed are functional. If the gauge is ported into the housing above the top of the filter bag, its pressure will rise as the bag blinds off. If the gauge is ported into the housing below the top ring of the bag, its pressure will fall as the bag blinds off.

Cartridge Filters-

All CHC filter systems that contain a cartridge filter utilize a side stream flow through the filter.

Side Stream Cartridge Filters have one advantage over In-Line filters, no moving parts to trouble shoot. If the cartridge becomes blinded off, then no flow will be pulled through the filter element and away from the filtration system. However it is very important that you only open its flow regulation valve only so that 10-15% of the filtration's flow is pulled though the bag filter. To make sure this flow requirement is met, utilize an ultrasonic flow meter, or only open the valve so that a 3 psi pressure drop from the discharge pressure of the centrifugal separator is seen (pressure with valve open versus pressure with valve closed). There are two possible sites for gauges on a cartridge filter housing, make sure any gauges that are installed are functional. If the gauge is ported into the housing above the top of the filter cartridge, its pressure will rise as the bag blinds off. If the gauge is ported into the housing below the top ring of the cartridge or at the discharge piping, its pressure will fall as the cartridge blinds off.

5.4 Frequent Pump Seal Failures-

If the pump seal continues to fail frequently (once every 3-4 months or more frequently) check the following:

1. **Is the pump operating at it original design pressures and flows? Verify that the pump is not operating above or below its specified pressure. Adjust the pressures using the filter discharge valve or sweeper jets to maintain the appropriate pressures.**
2. **Is the pump cavitating. If you see air bubbles moving past the flow meter continuously, this indicates that there is an air leak on the suction side of the pump. This air can cause the seal to prematurely fail. Find the air leak and fix and replace the defective parts.**
3. **If the debris within the water is too great, it can damage the seal more frequently, EcoWater CHC recommends the use of a Hard faced seal in these type debris conditions.**
4. **Running the CHCsystems without water. If water did not flow to the pumps due to the towers being dry or the customer not opening a valve after cleaning the basket, these actions can cause the pump seal to fail. Replace the seal.**
5. **Bearing failure on the pump motor, if there is excessive noise coming from the pump motor during operation, this can cause the movement in the shaft and can cause the seal to fail, if there is excessive noise, replace the pump.**
6. **Impeller blocked or clogged with some type of debris. This can cause an impeller imbalance and will cause the seal to fail. Remove any debris from the impeller and replace the seal.**
7. **Extended period of Off time with water on seal. It is important if the pump will not be used for extended periods of time > 4 weeks that the pump be started from time to time to allow the seal to clean itself and to move the stagnant water out of the pump. If there is no water in the system, drain the pump during storage.**
8. **If the Motor shaft is bent or the impeller is damaged, this can cause a vibration in the wet end that can damage the seal. Replace the impeller or the entire pump if needed.**

5.5 Issues with Actuators and Solenoids-

5.5.1 Actuator Failure-

Most actuator failures are caused by the failure of the actuated valve. As the actuator is removed for servicing, make sure the valve is easily opened and closed. Some valves can become to difficult to move by the actuator and can cause actuator failure. Verify that the fuse or breaker controlling the timer circuit is still functional, If the fuse and/or breaker is still good, the failure could be related to the actuator itself, timer, relay and/or the conductivity controller.

Other than the ground there are normally three wires that pass to an actuated valve. A neutral wire that normally goes to pin 1, and two power wires. If an actuator is not functioning verify the following pins and if the signals are there, and the actuator is not moving then the actuator must be replaced.

Signal	VSI Pin	Jordan Pin	Apollo Pin	Valcor Pin
Neutral	1	1	1	1
Open	2	3	3	2
Close	3	4	4	3

Some of the actuators are 120 VAC while others may be 24VAC or 24VDC. It is important to look at the nameplate to define what voltages you will be using for your troubleshooting. Use your DVM and verify the signals coming into the actuator is the signal is present and the valve does not open or close, replace the actuated valve.

If your actuated valve is operated by 24 VDC. Then you will see one ground wire and two power wires. The power wires will reverse their voltage (wire 1= 24 VDC V+, and wire 2=0VDC V- when opening, and then wire 1= 0 VDC V- and wire 2=24 VDC V+ when closing) normally controlled by a relay.

When ordering a replacement valve you must specify the valve size, and actuator type and voltage. If the signal is not present refer to Issues with Conductivity Controller for further information.

5.5.2 Actuator Leaks-

If the actuated valve is leaking (could be internal and if so, you will see a continuous flow down the drain) than that is an indication that the solids that are being purged from the separator may have damaged the seal on the actuated valve. In this case, replace the valve.

5.5.3 Non- Functional Solenoid Valves-

A solenoid valve utilizes a control signal to activate a valve. Once the single control signal is present on the coil of the solenoid, the valve should respond. To verify if a solenoid has power you will need to understand that when power is applied most solenoids will hum (noise), vibrate or get hot. You can verify that the control signal is being sent to the solenoid, and if it is and the solenoid does not respond, turn the power OFF, and then with the use of your DVM in the continuity mode, you will see some resistance in the solenoids coil (normally between 500 and 2000 ohms). If power is present then verify it gets water pressure from its source tube, if not verify the in line strainer is not clogged. If you have good water flow but not through the solenoid, then most likely the solenoid is clogged. Clean or replace it.

5.5.4 Stuck Solenoid Valve-

If you are getting a control voltage to the coil and the valve appears to not open, then this could signal a clog of debris in the valve itself. You will need to open the valve and clean it or replace it to fix the problem. If a solenoid valve continues to clog, you may want to consider the use of a strainer up stream (pressure source) from the valve to stop debris from entering the valve itself. If you find a strainer on the up stream side, make sure that the strainer is cleaned as appropriate to make sure the system is functional.

In most cases the lack of response to the solenoid reflects a defective coil or valve. Replace the defective solenoid valve. When ordering a replacement valve you must specify the valve size, and actuator type and voltage.

5.6 Issues with Conductivity Controllers-

CHC systems have utilized may brands of conductivity meters. The gray Walchem units, the yellow LMI units and most recently the CHC Control Stations. Each conductivity meter utilizes a temperature compensated probe as well as controls the Blow down Valve through the use of an on-board relay (bleed NO). The following information reflects each model:

5.6.1 Probe Cleaning and Calibration-

Always verify that the probe is clean first, do not just look and decide it is clean, always clean it with a Rydlyme like product. Some scale on the tip may be clear, and so you will not be able to see it. If there is any exposed metal on the probe tip, replace the probe. Always refer to the manual or Conductivity Reference found within this manual before you clean a probe. Some probes can only be cleaned in one direction.

5.6.2 Bleed Set Point-

The Bleed Set Point has been chosen ahead of time and will not reflect the current COC. This set point has been chosen against the worst case water analysis given for that customer. DO NOT adjust it each time to control the COC. If water quality is better this month, than the COC will increase, if it is worse than the original bleed set point chosen the COCs may decline, however this set point was chosen to ensure that the system does not scale up, so Adjustments to the set point must be cleared with EcoWater CHC Service Personnel.

5.6.3 Dead Band Control-

The Dead Band should be adjusted to achieve 10% difference from the Bleed Set Point. If the Bleed Set Point is 2000, then the Dead Band should be 200, however if the Bleed Set Point is 500 then a Dead Band of 50 will suffice.

5.6.4 Walchem-

Most of the Walchems used are the WCT300 and WCT400 series controllers. Please refer to the attached service manual for information regarding the screen layout and specifics about the controller. Some of the sites may utilize a WebMaster controller. Please refer to the attached service manual for information regarding the screen layout and specifics about the controller. Here is some basic information about the controller that will aid in troubleshooting.

- The blow down valve is connected to the bleed function of the controller. Each controller allows you to manually initiate the valve, refer to manual.
- A LOW ALARM indicates that the current conductivity is too far away from the bleed set point. If this alarm occurs, verify that the conductivity probe is calibrated, the bleed set point is within its specifications and that the alarm set point is reasonable. Normally the alarm set point should be at 30-40% for appropriate indication.
- The blow down valve will only open if the current conductivity exceeds the bleed set point.
- All conductivity probes except for the toroidal must be verified once a week for accuracy.
- All models utilize a 5A, 240 Volt fuse on F2 that controls the power to the Bleed Relay.
- The Webmaster unit requires programming via a USB cable to set the configuration of the Bleed Relay.
- Most Walchem units are wired directly into the 120V relay found in the motor controller that will remove the control of the blow down actuator away from the Timer. The 120 Volt signal from the NO Bleed relay in the controller passes directly to the coil on the relay found in the motor controller.
- If the controller is wired directly into the Actuated valve, then the NO signal passes to the OPEN pin on the actuator and the NC signal passes to the CLOSE pin on the actuator.
- All Walchem units have a test feature built in to test the meter as well as the probe, refer to attached manual.
- If the conductivity meter reads “BLEED” even if the current conductivity is blow the set point and dead bands, then someone may have adjusted the control direction of the bleed function. Go into the Bleed screens and look under Control Direction it should be set to HI.
- If someone has placed a password into the controller and the password is not “5850” or one that the customer has added, you can reset the password on each Walchem product. Please refer to the operation manual for the controller. The WCT series requires the unit to turned OFF and then press and hold the UP and DOWN keys while turning it on. The password will be modified back to “1995” as shown on the screen during the keys being held in.

5.6.5 LMI-

The only LMI unit used was the DC4000 series controllers. Please refer to the attached service manual for information regarding the screen layout and specifics about the controller. Here is some basic information about the controller that will aid in troubleshooting.

- The blow down valve is connected to the bleed function of the controller. Each controller allows you to manually initiate the valve, refer to manual.
- The blow down valve will only open if the current conductivity exceeds the bleed set point.
- All conductivity probes must be verified once a week for accuracy.
- All models utilize a 4A, 240 Volt fuse on F1 that controls the power to the Bleed Relay.
- Most LMI units are wired directly into the 120V relay found in the motor controller that will remove the control of the blow down actuator away from the Timer. The 120 Volt signal from the NO Bleed relay in the controller passes directly to the coil on the relay found in the motor controller.
- If the controller is wired directly into the Actuated valve, then the NO signal passes to the OPEN pin on the actuator and the NC signal passes to the CLOSE pin on the actuator.

5.6.6 CHC Control Station-

The newer CHC skids utilize the CHC Control Station to monitor the conductivity of the system and control the blow down valve. It utilizes a toroidal sensor that needs to be verified each month as well as cleaned at least once every quarter. If the conductivity probe fails the conductivity reading will indicate 0 or 32000. You can use the hidden screen to monitor the raw analog signal from the sensor, when in air it should read 60K-100 and when in water it should read 200-4000. If the raw signal does not change verify the presence of the resistor and check the voltage at the A1 connector. If the voltage does not change, then replace the sensor. If the raw readings are normal but the meter is not stable, verify calibration or change the sensor over to the A2 connector and change the VCS software accordingly. The Control Station controls a relay within the motor starter that is used to control the blow down valve. If you enter the Bleed screen, you can adjust the set points for the bleed function as well as press the Bleed Test button to initiate a valve test (reverses current state for a period of 20 seconds). Refer to the manual in this document for further assistance. If the Control Station Fails, it must be replaced. Refer to “CHC Control Station Error Codes” for more information

5.7 CHC Control Station Messages-

5.7.1 No Filter Backwash (BW Failure shown on Control Panel's screen)-

When the Filter's Backwash has failed this indication will be shown, there are several possible causes:

Screen Plugged- If the filtration screen becomes plugged the outlet pressure of the filter will be below 20 psi after a Backwash. If you continue to manually initiate a back wash and the differential pressure never falls, then the screen may need to be removed and cleaned. Refer to Filtration Screen Cleaning.

Solenoid Failure- If the solenoid fails, the controller will try to initiate the Backwash cycle, but no Backwash will occur. To verify disconnect the tubing from the end of the rinse piston and initiate a back wash. Water should flow (strongly) from the tubing. If no water flows to the Rinse piston, then verify the solenoid is being energized, if it is the valve must be replaced or cleaned. Without water being directed to the Rinse piston, the Backwash will not be completed. This failure could be caused by debris clogging up the screen in front of the solenoid or a failure of the solenoid itself. If the solenoid has failed, it is recommended that the screen be cleaned.

DP Switch Failure- If the filter's back wash can be initiated with the Manual BW button but does not respond to the DP switch, then it is possible that the switch within the DP switch has failed. With a volt meter, verify that the switches within the DP switch are closed during operation (this requires the DP switch gauge to be indicating over 8 psi. If power is not applied to the skid, the pressure will be reduced and each DP switch should be open as tested with a conductivity meter.

Transducer Failure- If the filter's back wash can be initiated with the Manual BW button but does not respond to the low trigger pressures as set in the CCS settings, verify that the appropriate pressures as shown on the CCS. If no pressures are shown, then the CCS will not backwash the filter as needed and you will have to troubleshoot the transducer signals.

5.7.2 Screen Cleaning Required Message-

This message indicates that the filter has completed 8000 Backwashes and it is recommended at that point to remove the screen from the filter, clean it and inspect the screen and suction manifold for damage. To clear this message, Turn ON the power disconnect, and as the initial screen is indicated on the Control Station, press the F1 (Set UP) button. A password screen will appear, press the screen where the password is shown and a numerical keypad will appear. Enter 1000 and press the Enter/Return button, the screen will revert back to the Password screen and then press the F3 button to clear the memory. Press the Main button (F4) to return to the main screen. You will notice that all counters will be cleared with this action.

5.7.3 Control Panel Message of "Power OFF"-

No action required, this indicates that the motor controller's HOA power switch is in the OFF position.

5.7.4 Control Panel Message of "Pressure LO"-

This indication is shown when the pressures of the Filter or CHC have not reached the appropriate pressures. Verify that the strainer baskets are clean, and that no isolation valves are closed. Other problems may be associated with a pump failure or clog in suction piping. Contact EcoWater CHC Service for further assistance.

5.7.5 Control Panel Message of "Power Failure"-

This indication is shown when the motor starter has recognized a loss of a Supply Phase, or the motor as caused the failure of the thermal overload. Turn off the power to the motor starter by turning OFF the power disconnect. Open the motor controller and reset the Contactor's Reset knob. Close the motor starter and try to initiate the pump again. If the pump fails to start, contact the appropriate personnel to verify the power phases as well as monitor the motor's amperage. In many cases, problems with the power system due to weather may cause the thermal overload to fail, if resetting the overload works, please verify the pump motor's amperage, if it is within range, monitor the function of the system to see if the failure continues. Contact EcoWater CHC Service for further assistance.

5.7.6 Control Panel Message of "Conductivity HI"-

This indication is shown when the conductivity value is exceeding the upper alarm limits as set in the Set Up screens. This is normally an indication that the blow down or its piping is plugged or non functional. It can also be an indication that the make up water source has lost is supply pressure and make up is not being added to the system fast enough to keep up with the blow down rate. If the water supply system has failed, take appropriate actions with regard to the supply, and you may need to turn the Filter skid's power OFF while the tower's water level increases.

5.7.7 Control Panel Message of "Conductivity LO"-

This indication is shown when the conductivity value is below the lower alarm limits as set in the Set Up screens. This is normally an indication that a problem with the blow down or filter back wash system has occurred. Please verify the operation of the blow down valves and filter back wash functions. This message could also be shown if low load conditions with the water system are occurring (as in winter) if the load to the system is too low, the conductivity of the water system may not cycle up to the appropriate COC levels. This message may continue until the load increases on the water system. Monitor the system routinely to verify that this condition is associated with the load.

5.8 Leaks-

The majority of the leaks will require the replacement of the defective parts. However, always verify that the hardware does not need to be tightened first to correct the issue.

5.8.1 O-Ring Leaks or Failure-

Replace defective O-Ring, and lubricate with appropriate silicone lubricant.

5.8.2 Flange gasket Leaks-

Tighten the flanges or replace the gasket.

5.8.3 Plumbing Leaks or Failure-

Contact the appropriate personnel to make corrections to plumbing.

5.8.4 Valve Leaks or Failure-

Contact the appropriate personnel to make corrections to plumbing.

5.8.5 Internal Valve Leaks-

In some cases you may find that the blow down actuator has a continuous leak, even in the closed position. If you find this you will need to replace the blow down valve.

5.8.6 Vacuum Leaks-

Vacuum leaks on the CHC system can be a cause for concern, because they can cause a decrease in the efficiency of the CHC treatment, it is always important to make sure that the vacuum leaks are corrected with the appropriate actions.

5.9 Algae and Biofilms-

5.9.1 Algae growing in tower in sunlit areas-

This is not a failure. The CHC system can only retard water- borne algae. The use of a chemical algaecide to treat the algae is recommended unless requested by the customer. You can also recommend covering the affected areas with a sun screen to reduce the algae growth rate. Many of our customers have used a cover made out of corrugated fiberglass to cover the exposed ends of a tower next to the fill, these covers have been shown to be very efficient at reducing algae growths on the ends of the towers. The use of a Biodispersant has also been shown to be affective against Algae. The Biodispersant will in most cases release the Algae so that it can be destroyed by the CHC chamber and removed by filtration. CHC has some experience with an Ultrasonic Algae killing systems as well as Copper Silver Ionizers. If you are interested about this system contact EcoWater CHC Service for further information.

5.9.2 Biofilms-

This is not a failure. The CHC system can only treat water- borne growths it cannot treat films growing in the piping or on other surfaces. The use of a Biodispersant has also been shown to be affective against Biofilms by releasing its grip on the surface until it can be treated by the CHC chamber. We have seen accounts where they were next to a farm and fertilizer (manure) was being ingested into the tower and causing a food source for the biofilm. I am also aware of a food plant that also uses their cooling water to cool a process, where product was getting into the cooling tower water causing a biofilm growth. It is important that you not only treat the symptom, but you must also find and treat the source.

5.10 Scale-

Scale formation within a system can occur for many reasons. This section outlines the items to do and check to aid in CHC's determination of possible causes for scale formation .

There are three major types of scale that can form within a treated system. They include Hard Scale (like glass), Soft Scale (reformed granular or sandy sludge), Silica Scale. Some other forms of scale have also been discussed.

5.10.1 Hard Scale

Hard Scale is an indication that either the CHC treatment is not working as well as it should, or that the cycles of concentration are too high. Thing to verify are as follows:

1. CHC function:
    a. Is the pressure on the CHC unit appropriate (78-85 psi for a CHC 20, 88-105 for all other CHC units.). Some causes for pressure loss may include suction side vacuum leak, plugged strainers, incorrect valve positioning, plugged suction manifold or line, loss of system power, defective pump, plugged CHC nozzle channels or loss of pump prime due to air entrapment in pump or piping. Verify the cause and take appropriate action. All gauges must be verified by turning the system off and the pressure should decline back to 0, and then back on to measure the pressure.
    b. The vacuum must be at least -25 inHg.(may vary depending upon elevation of the site). Loss of vacuum may be associated with a leaky gauge, tube, connection and or fitting, low pump pressure, plugged nozzle and or too much back pressure on the chamber.
    c. Back Pressure too high or too low. Back pressure must only be 2-5 psi. if it is too low or too high make sure to adjust.
    d. Alignment of Nozzles. As the water enters the end bells it should not enter one of the nozzle's channels directly. It should however, pass directly to the blank area between two channels. This verification requires a visual inspection of the nozzles.
    e. Inappropriate Venting of discharge. If the discharge of the CHC discharge drops and is not vented, a siphon can occur causing an abnormal backpressure on the cavitation cloud, it is important that the gasses are released to the atmosphere, and that the back pressure is controlled within acceptable limits.
    f. Inappropriate distribution of treated water. When one CHC unit is treating multiple towers or sumps and you have a scaling problem on one of the towers, this is a possible indication that the treated water is not being dispersed to all towers equally. You will also want to verify that the suction from the tower is equal to the others as well.
    g. The CHC nozzles may be blocked. Open the chamber and make sure the nozzle ports are open and free from any large debris.
    h. The CHC is undersized. This can occur when the initial quotation information was gathered. It is possible that if the system water volume was underestimated, the quoted CHC treatment required can be undersized and will require an upgrade. This can also be the result of a significant change in Make-Up water hardness or Silica levels.

2. Cycles of Concentration too High
    a. Conductivity Meter is out of calibration- The meter may not have been routinely calibrated to ensure accuracy. The calibration may have been affected by using an out of date calibration standard, once the standard is used passed 50% or is brown in color, EcoWater CHC recommends discarding the standard and opening a new one. Verify the correct units of measure are used from the calibration standard label. The probe may be dirty or scale may have formed on the tip affecting calibration (use Rydlyme and or a mild soap solution to clean the probe tip as instructed in the manual). The probe may be defective (normally seen by a probe that is out of calibration by more than 100 points routinely (complete self test of probe on all Walchem units)). A defective meter can also cause an out of calibration situation, if the meter will not calibrate to match a calibration solution or it fails the self test function (Walchem only) replace the meter. Always compare the readings of the conductivity meter against a known good meter.
    b. Inappropriate or inadequate flow across conductivity probe. If there is not enough flow across the conductivity probe, its readings can be lower than normal causing the system to cycle up and scale. It is important to have at least 5-8 GPM flow across the probe to ensure accurate measurements. EcoWater also recommends that a submerged probe is not placed into the tower, these types of applications can also give an erroneous measurement value causing cycles to climb.
    c. Suction piping too close to Make-Up water distribution. If the suction piping is too close to the Make-Up water's valve, you can get a conductivity reading that is diluted with the lower Make-Up water's conductivity. This will cause the actual tower water's conductivity not to be measured and the blow down will not occur when expected causing high cycles of concentration.
    d. Incorrect Bleed Set Point. Verify that the Set Point value is appropriately selected to match the desired cycles of concentration as compared to the conductivity to the Make-Up water, or as specified by water analysis.
    e. Inoperative Blow Down Valve. Verify that the valve opens and closes as instructed by the conductivity meter as well as the combo timer, failures could be associated with a defective valve, relay, timer or conductivity meter. You must verify that water is drained from the system as the valve is opened and closed. The drain flow must be strong and represent pump pressure during the opening of the valve. Inappropriate flow may be an indication of an incorrect setting of the flow regulation valve, plugged separator drain or plugged piping.
    f. Scale can also be caused by flow problems within the customers system. If the water is suddenly stopped or weakened in flow within the heat exchanger or condenser, the temperature at those sites can suddenly increase causing scale to form.

5.10.2 Soft Scale

Soft Scale formation and or accumulation is an indication of filtration system inadequacies. Two primary types of this scale include reformed granular and sandy sludge. Reformed granular scale becomes compacted and hard as it accumulates, while sandy sludge scale remains mud like as long as it remains wet. Things to verify are as follows:

1. Inadequate sweeping of the tower or basin floor. Check for placement on nozzles to verify that debris is being swept towards the filtration suction and not the system suction. If debris passes into the system suction, it can be ingested by their pumps, ground up and then deposited into the fill or other areas creating reformed granular scale. If the scale is not ingested by the system pump and remains in the basin, it can form the sandy sludge that remains until removed. If the sweeping system is to strong so that it stirs instead of sweeping the debris towards the suction manifold, this action can also make the debris pass up the suction manifold and enter the system pump.
2. Placement and or design of the suction manifold. Check the placement of the suction manifold, it should be located between the normal water flow within the sump or tower and the system suction. If debris passes into the system suction, it can be ingested by their pumps, ground up and then deposited into the fill or other areas creating reformed granular scale. If the suction manifold does not create an adequate flow velocity, debris will not be removed from the basin floor, so verification of the design of the suction manifold is required.
3. Frequent Cycling of towers. If the towers are cycled on and off frequently, water will remain in the fill and as evaporation occurs, its solids will deposit in the fill. It is important that if the system is cycled frequently, that the fans be left on for a period of a few minutes to draw any remaining water from the fill there by decreasing any possible formation of this type of scale.
4. Restricted suction piping. If the suction piping has become clogged with debris, its ability to pass water to the pump is diminished. Cleaning or replacement of the clogged pipe will be required.
5. Inappropriate DP of Separator. Separators require a minimal 3 psi pressure drop across the incoming and outgoing lines. If there is not enough pressure drop across the separator, this indicates that the wrong separator has been installed, or that the flow has been compromised within the system. A weak pressure drop is an indication that the water is not spinning within the separator fast enough to ensure separation of heavy particles from the water.
6. Bags or cartridges not being replaced or cleaned as needed. Many systems are designed with the use of bag or cartridge type filter systems. If they become full of debris and not replaced as needed the debris will not be removed from the system as needed and will remain in the water possibly causing scale to form.
7. Bag filter Bypass Failure. As in line bag filters become full they are designed to increase the pressure in the system causing a pressure sensor to open a bypass valve and allow the water to bypass the full bag. If the bypass system does not open, the flow of filtered water back to the tower or sump will be compromised and possibly causing scale to form.
8. Low pressure within filtration system. Low pressure within the filtration system can be caused by clogging of the basket strainer, clogs or restrictions in the piping, pump failure or valve positioning problems. Low pressure normally means that filtration will not be appropriate and that the unit will not remove enough debris from the system to stop scale formation.

5.10.3 Silica Scale

Silica Scale is a type of scale caused by dissolved Silica levels in the basin increasing above the point in which they can no longer sustain solubility. This type of scale will be deposited on heated surfaces and is not affected by acid and must be removed my manual means. Things to verify are as follows:

1. Cycles of Concentration too High
    a. Out of calibration- The meter may not have been routinely calibrated to ensure accuracy. The calibration may have been affected by using an out of date calibration standard, once the standard is used passed 50% or is brown in color, EcoWater CHC recommends discarding the standard and opening a new one. Verify the correct units of measure are used from the calibration standard label. The probe may be dirty or scale may have formed on the tip affecting calibration (use Rydlyme and or a mild soap solution to clean the probe tip as instructed in the manual). The probe may be defective (normally seen by a probe that is out of calibration by more than 100 points routinely (complete self test of probe on all Walchem units)). A defective meter can also cause an out of calibration situation, if the meter will not calibrate to match a calibration solution or it fails the self test function (Walchem only) replace the meter.
    b. Inappropriate or inadequate flow across conductivity probe. If there is not enough flow across the conductivity probe, its readings can be lower than normal causing the system to cycle up and scale. It is important to have at least 5-8 GPM flow across the probe to ensure accurate measurements. EcoWater CHC also recommends that a submerged probe is not placed into the tower, these types of applications can also give an erroneous measurement valve causing cycles to climb.
    c. Suction piping too close to Make-Up water distribution. If the suction piping is too close to the Make-Up water's valve, you can get a conductivity reading that is diluted with the lower Make-Up water's conductivity. This will cause the actual tower water's conductivity not to be measured and the blow down will not occur when expected causing high cycles of concentration.
    d. Incorrect Bleed Set Point. Verify that the Set Point is appropriately selected to match the desired cycles of concentration as compared to the conductivity to the Make-Up water, or as specified by water analysis.
    e. Inoperative Blow Down Valve. Verify that the valve opens and closes as instructed by the conductivity meter as well as the combo timer. You must verify that water is drained from the system as the valve is opened and closed. The drain flow must be strong and represent pump pressure during the opening of the valve. Inappropriate flow may be an indication of an incorrect setting of the flow regulation valve, plugged separator drain or plugged piping.
    f. Scale can also be caused by flow problems within the customers system. If the water is suddenly stopped or weakened in flow within the heat exchanger or condenser, the temperature at those sites can suddenly increase causing scale to form.
    g. Changes in Make-Up water chemistry or source can affect the ability to form scale. If the source for Make-Up water changes or chemistry changes it is possible that the Cycles of Concentration could be affected and promote scale formation.
2. Cycles of Concentration did not reflect current Silica levels in the Make-Up water. If the Silica levels within the Make-Up water suddenly increase, it is possible that the sump levels

of Silica may increase above the level of sustained solubility. At this level Silica can scale out on the hot surfaces..

3. Frequent Cycling of Equipment. If the system pump is stopped before the heat has been removed from heat exchanges, compressors, or other hot items, Silica scale can be formed on the hot surfaces.

5.10.4 Ingestion Scale

Ingestion Scale is normal, if the environment has many forms of airborne debris that can be ingested into the towers. This type of scale can look very rough and in many cases can look like feathers or stalactites that hang onto the fill. You will also see ingestion scale on the louvers or under the drip guards at the mist illuminators. The buildup on the tubes is normally only on the lower tubes and are soft to the touch. They normally break very easily and can be removed with a pressure washer under normal tower cleaning. If Ingestion Scale is found, the use of alternate types of filtration may be warranted. Examples of Ingestion Scale forming material: Concrete dust, sand, dirt as well as other airborne debris.

5.10.5 Overspray Scale

Overspray Scale is normal, if overspray reaches areas where there is not adequate water flow to keep the surface clean. This light misting can evaporate and deposit its solids as a formation of scale. This type of scale formation is normal and should be addressed during routine maintenance

5.10.6 System Cycling Fill Scale,

If scale appears in the fill of systems where the pumps and fans are routinely cycled, water is left in the fill, and as it evaporates, its solids will be deposited in the fill. To diminish this effect, instruct the customer to leave the fans on for an additional five minutes after the pumps stop to draw out any remaining water from the fill. This action will reduce the amount of debris that will be available for scale formation.

5.10.7 Cotton like Fill Scale

Cotton like Fill Scale is normal and occurs on the leading edge of the fill, it occurs because of the high evaporation rate at this leading edge and the diminished flow that is normally found at this area of the fill as well. This type of scale is normally very soft and can be removed with a manual spray nozzle cleaning as needed.

Example Pictures:

Soft Sandy Scale buildup

Mud like buildup of Soft Scale

Soft Scale that is granular but hard from basin

Soft Scale from tubes that is very granular

Hard Scale from tubes that is hard like Glass

6.0 REFERENCES

The references attached to this document represent the specific CHC products and the literature prepared by CHC all other reference material including service manuals are included on this CD for your use.

6.1 Corrosion Coupons

All CHC Equipment is supplied with Corrosion Coupon Racks installed. These racks allow for the use of Corrosion Coupons to measure corrosion rates within the cooling system.

Normally, EcoWater CHC recommends allowing at least 90 days from date of installation before the initial coupons are installed. These 90 days allow for the system to become accustomed to non-chemical water treatment, as well as gives the required time to bring the cycles of concentration to their specified value.

Once the coupons are installed they will be removed and sent to a lab for analysis. The lab will then issue a report stating the corrosion rates as measured from the before and after coupon weights.

Coupons come in many different metals. They are intended to be placed into our PVC coupon rack for at least 60 days to yield accurate corrosion rates. CHC's coupon racks allow for the use of any three coupons at one time. We recommend selecting a coupon choice that will best represent the metal content of the cooling system. The coupons that are available from EcoWater CHC include the following:

Aluminum
Galvanized Mild Steel
Mild Steel
Copper
Stainless Steel
Scale Coupon

EcoWater will supply Maintenance Agreement customers with two sets of coupons per year. The normal coupon selection depends upon the tower type and its use.

Examples:

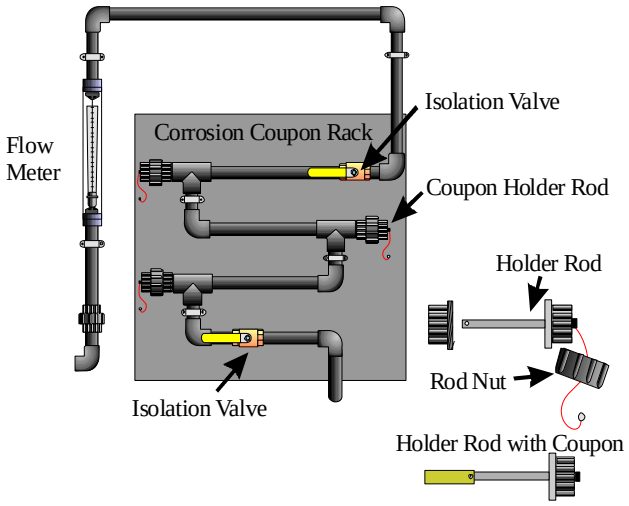
If a customer has an Evaporative Condenser with a Galvanized basin, EcoWater CHC will supply a Scale coupon and a Mild Steel coupon.

If a customer has an Evaporative Condenser with a Stainless Steel basin, EcoWater CHC will supply a Scale coupon, a Mild Steel coupon and a Stainless Steel coupon.

If a customer has a Cooling Tower with a Galvanized Basin or a Stainless Steel basin, EcoWater CHC will supply a Scale coupon, a mild Steel coupon and a Copper coupon.

Other coupon configurations are available upon the request of the customer.

Installing the Corrosion Coupons
Most systems includes the provision for conducting Corrosion Coupon Testing. To conduct this test you will first need to request coupons from EcoWater CHC. **These coupons will be installed for no less than 60 days before they are removed and weighed. The coupons can be installed up to 120 days before removal. This installation requires the use of Nitrile Gloves to insure no contamination of the coupons occur.**



To install the Corrosion Coupons follow these steps:

1. Acquire the coupons, the configuration of coupons will depend upon the type of cooling system you are using. Refer to the statement on the first page of this document.
2. When placing coupons, the Copper coupon will be first coupon that the water will come in contact with and the Scale coupon will be the last.
3. Turn off the two isolation valves at the rack to stop all water flow.
4. Loosen the nut securing the coupon holder.
5. Remove the coupon holder rod from the coupon rack.
6. Remove the coupon installation screw from the coupon holder.
7. Place a coupon over the holder and secure with the installation screw.
8. Place the holder back into the rack so that the coupon is extended into the water flow tube in a vertical position. Do not place the orientation of the coupon in a horizontal position, if horizontal, the coupon can act like a shelf and support debris that maybe detrimental to your test results.
9. Secure the holder into place by tightening the holder nut.
10. Open the rack's isolation valves.
11. Verify that the flow across the coupons is between five and eight GPM as shown on the flow meter.
12. Mark the coupon envelopes with the date of installation and place in a secure location for use upon the completion of the testing.

Removing the Corrosion Coupons

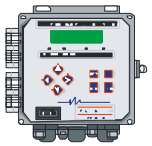
1. Turn off the isolation valves at the rack to stop all water flow.
2. Loosen and remove the holder nuts.
3. Slide out the holders, exposing the coupons.
4. Remove the coupon retention screws.
5. Remove the coupons, wipe them clean with a damp cloth.
6. Place each coupon back in its original envelope.
7. Place the retention screws back into the coupon holder rods.
8. Slide the coupon holder rods back into the rack.
9. Secure all rods by tightening their corresponding nuts.
10. Open the isolation valves and make sure no leaks are present.

11. Adjust the flow meter until the five to eight GPM flow rate is achieved.
12. Return the coupons to EcoWater CHC for examination and analysis.
13. A report will be generated and returned to you with the results.

6.2 Conductivity Controllers (Walchem and LMI)

VRTX Technologies, LLC 5807 Business Park San Antonio, TX 78218 (210) 661 8800 800 722 0476

Conductivity Controllers
As used in VRTX Installation



Walchem

VRTX has used two types of conductivity meters, you will see both types in existing installations. The Walchem WCT-300 is our current model, while the LMI DC4000 was used for many years.

All conductivity meters serve two purposes in VRTX installations. They include displaying the current basin TDS conductivity, and controlling the blow down valve if those conductivity levels rise beyond the blow down setting.

LMI

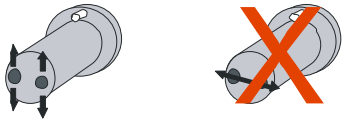
Calibration Verification:
Both systems require you to verify calibration at least once every two weeks.

To verify calibration, complete the following steps:

1. Isolate the conductivity probe by closing the appropriate valves.
2. Remove the probe from the sample tee.
3. Clean the probe as shown below.
4. Insert the probe into the ONE-SHOT calibration standard.
5. Verify that the displayed conductivity value is within 50 points of the conductivity as labeled on the ONE-SHOT. If the readings are greater than 50 points off, calibrate the controller as shown on the next page.
6. Open the isolating valves to allow for water to come out of the sample tee for at least 5 seconds.
7. Insert the probe back into the sample tee making sure that the alignment stud or tab is within its mate and tighten the ring.

8. Adjust the flow rate through the sample tee to achieve from 6 to 8 GPM flow rate.
9. Verify no leaks are present. If leaks are present, you will need to clean or replace the O-ring seal on the sample tee.

Probe Cleaning:
Once the probe is removed from the sample tee, use a soft cloth to remove debris from the sensing elements. ONLY rub the sensing elements in the following directions, damage can occur if the directional force of the rubbing is not as shown. If buildup cannot be cleared, use RYDLYME to remove excess buildup.



Adjustments:

> Note: Pay close attention to the units being displayed by the Conductivity Controller. Most calibration standards include calibration values for Microsiemens/cm as well as ppm. Use the appropriate value when calibrating your controller.

Calibration Walchem-

If calibration of the Walchem is required, follow these steps:

1. Verify that the probe is cleaned appropriately.
2. Insert the probe into the ONE-SHOT calibration standard and allow the readings to stabilize. May take up to three minutes to stabilize.
3. Once the readings on the primary screen has stabilized, push the "ENTER" button twice to advance to the Calibrate screen as shown below:

4. Press the (UP) or (Down) buttons until that digit closely matches the labeling on the calibration standards label. To change the next digit, you will need to press the < or > buttons until the appropriate digit blinks and allows adjustment. Once all digits match the calibration standard press the "ENTER" button to save the calibration settings. The screen will change as shown below to signify the acceptance of the change:

5. Press the "EXIT" button TWICE to return to the main display.

Blow Down Settings-

Once the Calibration is verified you can adjust the blow down control settings. These settings allow the controller to control the maximum conductivity of the basin water. The actual set point will reflect the calculated conductivity value for your required Cycles of Concentration.

To change the settings, follow these steps:

1. From the main screen, press the "NEXT" button TWICE and the following screen will appear.

2. Press the "ENTER" button and the screen will change to the following.

3. Adjust this set point for your maximum basin conductivity limit. As this limit is reached, the blow down valve will open and drain some of the water from the basin to lower the basin's conductivity. To change this settings value, use the ∧, ∨, < and > buttons to select the appropriate value and then press the "ENTER" button to save the changes. Once the value is accepted the following screen will appear.

4. Press the "NEXT" button ONCE until the Dead Band screen appears as shown below.

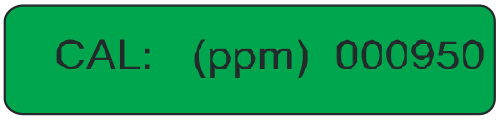
5. Adjust the Dead Band setting so that it is about 10% of your blow down setting value, and then press the "ENTER" button to save your selection.

6. Press "EXIT" until the main screen appears.

Calibration- LMI

If calibration of the LMI is required, follow these steps:

1. Verify that the probe is cleaned appropriately.
2. Insert the probe into the ONE-SHOT calibration standard and allow the readings to stabilize. May take up to three minutes to stabilize.
3. Once the readings on the primary screen has stabilized, push the "ENTER" button ONCE to advance to the Calibrate screen as shown below:



4. Press the ▲ (UP) or ▼ (Down) buttons until the value as shown matches the appropriate value on the ONE-SHOT label. Press "ENTER" to save your changes and return to the main screen.

Blow Down Settings-

Once the Calibration is verified you can adjust the blow down control settings. These settings allow the controller to control the maximum conductivity of the basin water. The actual set point will reflect the calculated conductivity value for your required Cycles of Concentration.

To change the settings, follow these steps:

1. From the main screen, press the ▼ button ONCE, and the "ENTER" button ONCE until the cursor appears. Press the ▲ and the ▼ buttons until the appropriate value to the nearest tenth is shown on the screen. Press the "ENTER" button to save your settings.

2. Press the button ONCE, and the differential (Dead Band) setting screen will appear. Press the "ENTER" button ONCE until the cursor appears. Press the ▲ and the ▼ buttons until the appropriate differential value is shown on the screen. Press the "ENTER" button to save your settings.

6.3 Timed Power ON/OFF Cycling of CHC Treatment

Not all customers require 24/7/365 operation of the CHC Treatment. The CHC treatment system is designed to treat the water within the system whenever there is a load present on the system, as well as periodically treat the water on a non-loaded system to enhance the calcium removal and control bacteria growth.

So when a customer asks "Do we have to operate our CHC unit and Filtration units 24/7?". And the answer may surprise you. "Yes and No."

Let me explain:

Evaporative Condenser Customers-
For a customer who has an Evaporative Condenser and runs their system dry for extended periods of time throughout the winter. We can help.. These types of customers frequently use an indoor drain down sump, and it is that sump that our CHC and Filtration systems treat. We can work with each customer to customize a schedule to power ON and OFF the systems to maintain treatment of their sump while minimizing the Bacteria growth. We have also suggested the use of Bleach (we have an application formula) to increase the OFF time of the systems. These types of customers can greatly save on energy if they use this approach.

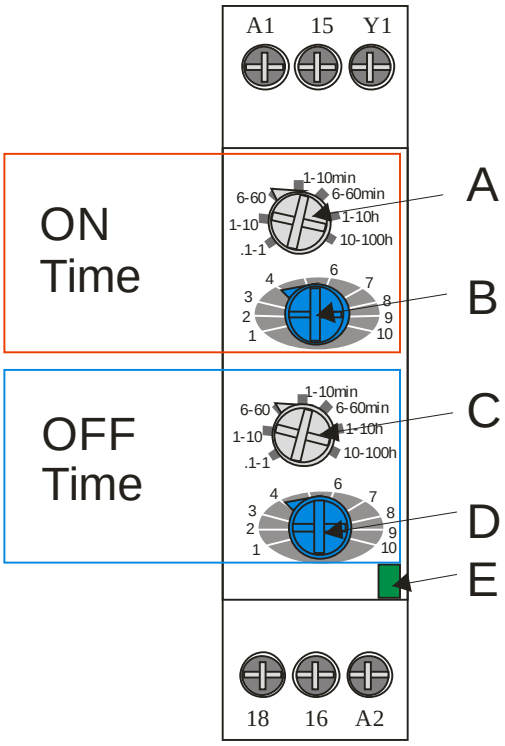
Other Evaporative Condenser Customers do not use a drain down sump, but may also be able to utilize this Power Cycling approach. Only customers who have a heated basin, and have insulated and heat taped the CHC systems can use a similar approach. Other customers may not need to utilize this approach if they currently drain their systems during the winter and leave our systems Off anyway. If the customer stops the CHC and Filtration systems and does not have them winterized or drained, the system may freeze and could possibly destroy gauges, pipes, strainers and even pumps. So we are very selective about who we share this ON/OFF Power Cycling approach with.

Cooling Tower Customers-
Most Cooling Tower customers utilize a chiller and would never qualify for the use of the above mentioned approach to energy conservation. However, there are customers who do not use their chillers in Winter, and move towards the use of a heat exchanger instead or only use the Cooling Tower on the work days and not on the week ends. These type of customers could utilize this approach and save money.

New Customers-
As we qualify each new customer, we need to keep in mind the types of towers they have as well as their current usage through out the year. If that information is sent to CHC for quote with any further information about the customer's desire to be energy efficient, EcoWater CHC can look at this information and suggest the use of energy efficient pumps (cost premium), or the use of a Power Cycling Schedule or both. In any way, the customer should feel that EcoWater CHC offers more than just water treatment, it offers the engineering, sales coordination and care about our customers to make their application a success.

6.4 Separator Purge Timer

Adjusting the Separator Purge Timer



Dial A adjusts the range values of B

Dial C adjusts the range values of D

If A is adjusted for 6-60 than the range for B will be 6-60 seconds with 1 on B representing 6 seconds and 10 representing 60 seconds. So if you want 18 seconds ON you will need to adjust A to 6-60 and B will need to be set on 3 (3 x 6 = 18)

If C is adjusted to 1-10h than the range for D will be 1-10 hours with 1 on D representing 1 hour and 10 representing 10 representing 10 hours. So if you want 3 hours OFF time, you will need to adjust C to 1-10h and D to 3.

As long as you remember that the white dial above the blue dial sets the range of the blue dial, and you carefully set the white dial you can adjust the timer's ON and OFF times

The rate of Flashing of the indicator E represents the status of the timer. If E flashes quickly than the timer is in the ON state, while if it flashes slowly, it represents the OFF state.

Whenever power is turned OFF and the back ON the timer will initiate the ON state for the period selected by the ON Time dials. Once that period is complete it will start the OFF state time as selected by the OFF Time Dials.

6.5 Freeze Protection Options

Freeze Protection is normally the responsibility of the Customer. EcoWater CHC does recommend the use of Freeze Protection in locations where freezing can occur with power outages. Due to the geographical location or system usage, EcoWater CHC reserves the right to require Freeze Protection and may adjust the Maintenance Agreement pricing to ensure such protection is taken.

Under normal conditions, if the system is powered, the piping will not freeze as long as the flow in the piping is maintained. Most customer systems contain water that is heated by the use of a heater or from the load on the system. Under these conditions the system will not have a problem unless power is lost or upon pump failure.

Some customers do not require Freeze Protection due to their geographical location, physical installation area (indoors) or they may have chosen to run the systems dry in the winter and drain the CHC system during those months.

There are several levels of protection that can be used to protect the system. The cost of each level differs depending upon the overall systems complexity and customer's needs. Here are several levels and their associated advantages and disadvantages arranged for the least expensive to the most expensive:

1. Not-Recommended
    a. AS-IS from factory with normal power- This level although the most cost effective, has several disadvantages. The first and strongest is loss of power, if power is lost or the pump fails, water stops to flow within the system and freeze damage can occur. If the pump fails for any reason or power is lost, the customer must become aware of the failure, and then take action to isolate and drain the piping to ensure against freeze damage.
    b. AS-IS from factory with uninterrupted power- This level although cost effective, also has several disadvantages. The first and strongest is pump failure. If the pump fails for any reason the customer must become aware of the failure, and then take action to isolate and drain the piping to ensure against freeze damage.
2. Conditionally Recommended (Requires Customer Service Personnel Diligence)
    a. Upgraded at Factory with Pump Indicator and using uninterrupted power- Same as that found in #2, however an indicator is added to the system that allows the customer to be notified of a pump failure with the use of an external indictor placed in an appropriate location or interfaced into the site's monitoring system. The customer's service personnel would then be responsible to isolate and drain the system upon failure to ensure against freeze damage.
3. Recommended
    a. Upgraded at Factory with Pump Indicator and AUTO Isolation and Drain. This modification to the system allows for the system to monitor the power of the pump and pressures and then AUTOMATICALLY closes the isolation valves located at the towers, and then opens the drains at the skid when a pump failure is detected. The system then notifies the customer through a separate indicator as in #3. This type of protection requires the use of an uninterrupted power source.

b. Heat Tracing and Insulation- Heat Tracing and Insulation only helps in instances where the customer has the CHC and Heat Tracing on an uninterrupted power source. If the system is installed without uninterrupted power, and a power failure occurs the temperature of the piping and system will fall allowing for possible freeze damage. Here again, the customer's service personnel will be responsible to isolate and drain the system to protect against freeze damage if the power stays off for extended periods. Heat Tracing and Insulation also requires for the piping of the skid itself to be protected.

c. Upgraded at Factory with Heated Skid Housings- This level utilizes a heated skid housing that protects the piping within the skid upon pump failure. The design of the skid will be modified to internalize the Flow Meter, Conductivity probe and Corrosion Coupon Rack It requires the use of Heat Tracing and Insulation to protect the piping from the skid to the towers. This option yields the cleanest installation maximizing serviceability, however is the most costly of the options.

If you have any questions about Freeze Protection, you can contact EcoWater CHC Technical Services at 800-722-0476.

6.6 Routine Maintenance Procedure

This procedure covers all CHC systems

All Systems, although they may look different, are generally made up of the same parts. This procedure utilizes examples of item locations that may differ from those found on your skid. Please refer to the Service Manual that is specific for your customer's site for detailed equipment explanation.

Each section reflects the type of unit you have in front of you. Make sure that the section you are using reflects the equipment that is at that customer site. Some examples of different types of equipment and their gauge locations are shown at the end of this section and can be used for reference. However, not all equipment may look like the examples, so they should only be used as examples.

This procedure reflects those sections of the Customer Service Report (CSR) as they appear from top to bottom. Each section is important and you should take your time and make sure the corresponding information is complete and accurate. If you have questions about so of this content, please contact EcoWater CHC Service Personell.

Steps to be taken during a Repair are shown in Red.
Steps to be taken during a Mechanical visit are shown in Blue.
Steps to be taken during a Quarterly Service are shown in Green.
Steps to be taken on every visit are shown in Black.

- Make sure the customer (end user) understands the Service offering and their responsibilities (PM's)
  - Define the customers care requirements (PM's)
  - Define the outlay of information and reports from EcoWater CHC
  - Initiate chain of communication:
    - Know who is the contact person?
    - Know who requires the reports and water analysis?
    - Know and understand the site (customers) policies and procedures while on their site.
    - Know what days and times are better for the customer for site visits.
- Scheduling
  - Notify the customer of scheduled visit.
    - Request and provide the following information
      - Are there any issues, concerns and or comments?
      - Are there any new hires that need to be trained on the system?
      - Explain what type of service you will be performing.
- Conduct Service according to the Specified Service Flow

SERVICE FLOW

1. Choose one of the following CSR Types
   a. Regular
   b. Mechanical *performed by* EcoWater CHC *Service Technicians*
   c. Service by EcoWater CHC (any repairs)
2. **Service by EcoWater CHC (REPAIRS)**
   a. **Enter the date of the service repair request**
   b. **Enter the creator of the service repair request**
      i. **Customer**
      ii. **Service Rep**
      iii. **On Site Service Tech**
      iv. **Other EcoWater CHC Personnel**

c. **Enter the reason for the Service Repair Request**
d. **Record all parts used to make the repair**
e. **In NOTES enter the cause of the problem and any notes relevant to the issue.**

3. Perform a walk-around while visually inspecting the entire skid and plumbing
    a. Looking for any issues, such as leaks, broken items, general condition
    b. Make sure indicator lights are functioning properly.
4. Record CHC Chamber gauge pressure /transducer display
5. Record Separator inlet and outlet pressures/transducer display
6. Record Auto Filter inlet and outlet pressures/transducer display
    a. Verify DP less than 3
7. Record Conductivity controller conductivity reading
8. Record Conductivity controller conductivity unit of measure
9. Record Conductivity controller Blow Down set point
10. Record Backwash count
11. Auto Filtration – Initiate an "Manual Backwash"

12. Record Separator Purge Timer/Blow down settings
    a. Timer ON/OFF
13. Turn off power to the pump (COMBO)
14. Turn off power to the CHC Chamber and Filter pumps
15. Verify that the CHC gauges/transducer display returns to zero
16. Verify that the Separator gauges/transducer display returns to zero
17. Verify that the Auto Filter gauges/transducer display returns to zero
18. Turn off main power disconnect (COMBO)
19. Turn off main power disconnect to the CHC Chamber and Filter pumps
20. **Open the Motor Starter box (MECHANICAL)**
21. **Check all electrical connections (MECHANICAL)**
22. **Grease Pump(s) (MECHANICAL)**
23. Cycle all Butterfly and Ball Valves
24. Valve off the strainer(s)
25. Check and clean the strainer(s)
26. **Remove, check and clean Auto Filtration Screen (MECHANICAL)**
27. Clean any inline strainers (found on ¼" tube associated with Auto Filters)
28. Remove and clean the conductivity probe leave in the open air.
29. **Remove Coupons (MECHANICAL)**
30. **Install Coupons (MECHANICAL)**
31. Turn main power disconnect on (PLC)
32. Confirm that the Conductivity reading is at zero
33. Reinstall the Conductivity probe.
34. Calibrate Transducers (if Needed)
    a. Refer to REFER TO "CHC PLC Sensor Calibration Procedure" instructions
35. Calibrate Conductivity probe
    a. Refer to REFER TO "CHC PLC Sensor Calibration Procedure" instructions
36. Open all valves to their operational settings
37. **Turn Main Power Disconnect ON to all skids (MECHANICAL)**
38. **Turn ON Pump(s)**
39. **Record Amperage reading and Pump FLA rating for: (MECHANICAL)**
    a. **Single pump (COMBO)**
    b. **Filtration Pump**
    c. **CHC Chamber Pump**

40. **Turn OFF Pump(s)**
41. **Turn OFF Main Power Disconnects (MECHANICAL)**
42. **Close Motor Starter Box(es) (MECHANICAL)**
43. **Turn ON Main Power Disconnect (MECHANICAL)**
44. **Enter F1 Set Up Screen (MECHANICAL)**
45. Turn ON Pump(s)
46. Verify and record CHC Chamber gauge Pressure /transducer display
47. Verify and record Separator inlet and outlet pressures/transducer display
48. Verify and record Auto Filter inlet and outlet pressures/transducer display
    a. Verify DP less than 3
49. Record Conductivity controller conductivity reading (AFTER CALIBRATION)

50. Water samples are to be taken from *each* sump and make up source.
    a. The samples are to be shipped to EcoWater CHC.
    b. Each sample must be labeled with the following information:
        i. Location
        ii. Date
        iii. Type Sump (CHC) or Make up
            1. Include the sump number or identifier when multiple sumps are being treated.
51. **Water Samples and Biological Testing (MECHANICAL)**
    a. **Water samples are to be taken from each sump and make up source.**
    b. **The samples are to be refrigerated and shipped to EcoWater CHC OVERNIGHT for biological testing**
52. Dip Slides are to be taken from each sump sample and results recorded and reported to EcoWater CHC after 48 hours
    a. All results greater than 10,000 need to be photographed and submitted to EcoWater CHC.
53. 2nd Verification that all valves are in their normal operating position.
54. **Touch up painting of EcoWater CHC and Filtration components (MECHANICAL) <FSA>**
55. Repeat the above for Filtration Systems #2 and #3 if applicable
56. Meet with Customer to discuss findings
57. **Review and photograph the following tower elements (MECHANICAL+)**
    a. **I would like this to happen on all MECHANICAL visits**
    b. **Tube bundle condition**
    c. **Basin condition**
        i. **CHC nozzle function**
        ii. **CHC suction manifold function**
        iii. **Tower pump suction screen (Customer to clean if needed)**
    d. **Tower spray nozzle function (Customer to clean if needed)**
58. **Make recommendations to customers (EcoWater CHC Employee)**
59. NOTES:
    a. Each section in Ulysses will have a “Notes:” section. Add any pertinent notes to the appropriate section.
    b. Record ANY notes that do not meet the parameters above.
    c. Note ANY customer concerns and or comments.
    d. Copy all customer concerns and comments into EcoWater CHC only notes.
60. EcoWater CHC ONLY NOTES:
    a. Record any notes that you feel need to make EcoWater CHC aware of. These notes are only visible to EcoWater CHC.

- Customer evaluation and training.
- Timely delivery of accurate reports.
- Timely shipment of water samples for analysis.
- Discuss Service Visit with the appropriate customer contact.
- Verify follow up with regards to notes and customer comments.
- Refine schedule as needed.
- Your EcoWater CHC Field Technician will be contacting the customer upon receipt of the submitted CSR in Ulysses.
- Notify Carl Steffen via email SteffenC@ECOWATER.COM of any items that need to be addressed. Please use the following phrase in the subject line of the email "SERVICE ACTION REQUESTED"

6.7 CYCLES OF CONCENTRATION

What are **Cycles of Concentration**? Cycles are not the flow cycles of water in the system. It is a comparison of the concentrations of dissolved salts in makeup water and basin water. Because of evaporation, H_2O left water to evaporate and leave the dissolved salts in cooling water. So the concentration of the dissolved salts in the cooling tower water will increase. Cycles of 2 means the concentration of certain species (like sodium or chlorides) in the cooling tower water are 2 times the concentration in the makeup water.

How do you calculate cycles? The easy, and most popular method is to use TDS (Total Dissolved Solids). Cycles are equal to the TDS (or conductivity) ratio of basin to makeup. This is based on the assumption that all dissolved constituents in makeup will still be in basin water. The evaporation is the only source for changes in concentration. This is true for systems with a successful chemical treatment. But for water treated by CHC, parts of the dissolved calcium and bicarbonate are transformed into calcium carbonate solids. TDS is only good for estimating the cycles, EcoWater CHC recommends the use of chloride concentrations to calculate the actual cycles.

If the makeup and blow down rates are known, cycles can also be calculated by the ratio of makeup volume to blow down volume. This method will give an average cycles over a certain time period, instead of a snap shot value when using TDS or chloride.

TDS vs. cycles: When we tell customers we are going to reduce blow down significantly, the customers may think there will be a huge bump up in cycles and TDS. Yes, cycles will go up, but not necessarily TDS. Let's look at this in detail:

When using chemical treatment, acids or scale inhibitors are used to prevent the precipitation of calcium carbonate, so all the dissolved solids from makeup will stay in the water. Therefore the TDS of the cooling water is linearly proportional to the makeup TDS and cycles:

*TDS (basin) = TDS (makeup) * cycles*

Actually, the TDS (basin) may be even higher, **because** of the addition of treatment chemicals. This is usually negligible; but for some water having very low TDS, such as water from the Pacific North West, the contribution could be noticeable.

When water is treated by CHC, reactions in the CHC chamber will force some dissolved Calcium and

bicarbonate to form $CaCO_3$ colloids. These colloids are very small and are still suspended in water, but they are not dissolved anymore. They are in a solid state, instead of a dissolved state. All other species, such as chloride, sulfate and potassium will not be affected by CHC treatment. Formed $CaCO_3$ may also contain a small percentage of Mg, but most of Mg will be in water. So the TDS (basin) will not linearly increase with cycles. The increase of TDS (basin) will be slower with cycles than in chemical treatment. Let's look at an example:

The is the makeup water analysis:

Calcium =100 ppm as $CaCO_3$
Magnesium =30 ppm as $CaCO_3$
Sodium =7 ppm as ion
Bicarbonate = 100 ppm as $CaCO_3$ (for most water, alkalinity = bicarbonate)
Chloride = 25 ppm as ion
Sulfate = 10 ppm as ion
The TDS of this water is 89 ppm

When using chemical treatment, at a cycles of 3, the water chemistry will be like this:

Calcium = 300 ppm as CaCO3
Magnesium = 90 ppm as CaCO3
Sodium = 21 ppm as ion
Bicarbonate =300 ppm as CaCO3
Chloride = 75 ppm as ion
Sulfate =30 ppm as ion

So everything is increased 3 times, including TDS: TDS = 267 ppm.

However, when one uses CHC treatment, some Calcium and bicarbonate are converted to $CaCO_3$ colloids, so at a cycles of 3, the water chemistry will be the same **except** Calcium will be ~ 150 ppm as $CaCO_3$ and bicarbonate will be ~ 150 ppm as $CaCO_3$. e.g., magnesium, sodium, chloride, sulfate increase 3 time, but calcium and bicarbonate increase less. This water has a TDS of 208 ppm. See the difference? TDS only increased to 2.3 times. So cycles measured from conductivity is 2.3 whereas the real cycles are 3.0. Substantially less water was blown down than what the conductivity based cycles indicate.

6.8 Basic Water Chemistry and Understanding the Water Analysis Results

The water analysis provided by EcoWater CHC can be difficult to understand. However, by understanding the terms shown in that analysis, you can make sense of your water analysis.

Example of Water Analysis provided by EcoWater CHC

Water Analysis Results for

VRTX 40 gpm unit started 12/27/05

Sample #	Sample Date	T (°C) (Field)	pH (Field)	pH (Lab)	Alkalinity (mgCaCO3/L)	Hardness (mgCaCO3/L) Total	Ca	Mg	Chloride (mg/L)	TDS (mg/L)	Conductivity (microseimens/cm)	Cycles of Concentration (Cl)	Bacteria CFUs/mL
make up	06/20/06	28.0	8.5	7.45	91	216	171	45	138	757	1136		
sump	06/20/06	27.5	9.3	8.32	110	631	385	246	415	2190	3285	3.0	

Laboratory Comments and Recommendations

A standard water analysis includes pH, alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, TDS, conductivity, cycles of concentration and bacteria population. Other analyses, such as silica, zinc, copper, iron are also performed for some cases.

Terminology

pH: The pH is a measure of acidity or alkalinity of water. pH < 7 is acidic, pH > 7 is alkaline and pH of 7 is neutral. As pH increases, water becomes less corrosive but the scaling tendency of some insoluble salts, such as calcium carbonate and calcium phosphate, increases. Each time you descend a whole number (for example: from 7.0 to 6.0), the acidity of solution increases by a factor of 10. Thus, a pH of 6 is 1000 times more acidic than a pH of 9.

The pH Scale

Range	pH	H^+ Concentration	OH^- Concentration	Substance Examples
Acid	0	1	0.00000000000001	
	1	0.1	0.0000000000001	Battery acid
	2	0.01	0.000000000001	Lemon juice
	3	0.001	0.00000000001	Vinegar
	4	0.0001	0.0000000001	Orange juice
	5	0.00001	0.000000001	Coffee
	6	0.000001	0.00000001	Normal rain water
Neutral	7	0.0000001	0.0000001	Distilled water
Alkaline	8	0.00000001	0.000001	Milk
	9	0.000000001	0.00001	Salt brine
	10	0.0000000001	0.0001	Baking soda
	11	0.00000000001	0.001	Milk of magnesia
	12	0.000000000001	0.01	Ammonia
	13	0.0000000000001	0.1	Chlorine bleach
	14	0.0000000000001	1	Lye

Alkalinity (Alk.): Alkalinity is a measurement of the buffering capability of water with the addition of acid. With the addition a certain amount of acid, pH can lower dramatically for water with low alkalinity, but pH only decreases slightly when its alkalinity is high. The main contributors of alkalinity are carbonate ions, bicarbonate ions, hydroxide ions, and dissolved CO_2 present in water. For most of waters, bicarbonate (HCO_3^-) is the dominant contribution to alkalinity. Alkalinity affects both corrosion and scaling tendencies.

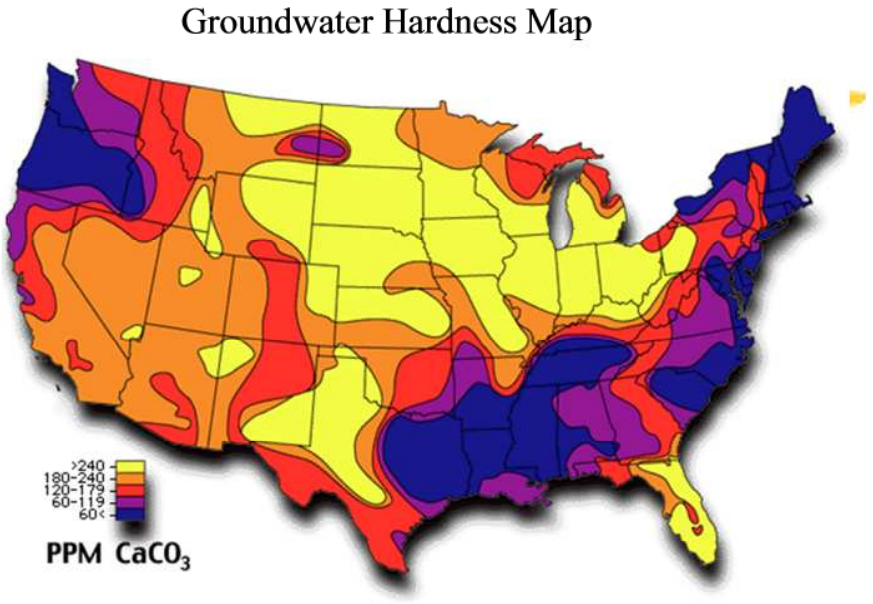
Calcium Hardness (Ca): Calcium is one of the principle elements making up the earth's crust. Calcium normally gets into water when rain water causes calcium carbonate to leach from limestone deposits in the soil. It is the major contribution to water hardness. Calcium aids in the formation of soap curds during cleaning and in some instances can form hard scale.

Magnesium hardness (Mg): Mg, like Ca, is leached from the soil by rainwater. It contributes to the total hardness but is generally present at much lower levels than Ca. Magnesium hardness is a calculated number based on measured total hardness and calcium hardness:

Magnesium hardness = Total hardness - Calcium hardness

Total hardness: This is the sum of Ca and Mg hardness. Fe (Iron), Mn (Manganese), Al (Aluminum) and other metals also contribute to the total hardness but these substances are usually present in such small quantities that they can be ignored. Hard waters are generally considered to be those waters that require considerable amounts of soap to produce a foam or lather, and that also produce scale in hot water pipes, heaters, boilers, and other units in which temperature of water is increased materially.

The hardness of water varies considerably from place to place. In general, surface waters are softer than ground waters. The hardness of water reflects the nature of the geological formations with which it has been in contact. The following illustration shows the general character of the water supplies in the United States. The softest waters are found in the New England, South Atlantic, and Pacific Northwest states. Iowa, Illinois, Indiana, Arizona, New Mexico, and the Great Plains states have the hardest waters.



Waters are commonly classified in terms of the degree of hardness. There are different standards, as listed in the following Table:

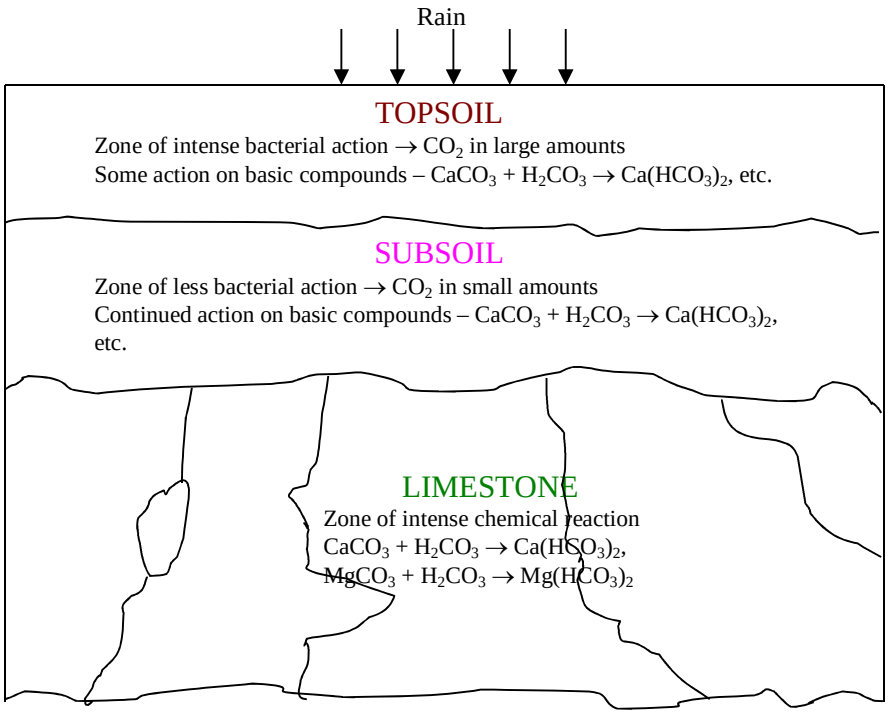
Table: Water hardness Classification

Developed by Water Quality Association

Term	ppm as $CaCO_3$
Soft	< 17.1
Slightly hard	17.1 – 60
Moderately hard	60 – 120
Hard	120 –180
Very hard	> 180

The hardness of water is derived largely from contact with the soil and rock formations. Rain water as it falls upon the earth is incapable of dissolving the tremendous amounts of solids found in many natural waters. The ability to dissolve is gained in the soil where carbon dioxide is released by bacterial action. The soil water becomes highly charged with CO_2, which, of course, exists in equilibrium with carbonic acid. Under the low pH conditions that develop, basic materials, particularly limestone formations, are dissolved. The Figure below shows where this originates and how it attacks carbonate minerals. Since limestone is not pure carbonate but includes impurities such as sulfates, chlorides, and silicates, these materials become exposed to the solvent action of water as the carbonates are dissolved, and they pass into solution too.

In general, hard waters originate in areas where the topsoil is thick and limestone formations are present. Soft waters originate in areas where the topsoil is thin and limestone formation is sparse or absent.



Chloride (Cl^-): Like Sodium (Na), most chloride salts are very soluble in water. They can cause corrosion at high levels. Chloride is used to calculated cycles of concentration because it is stable in cooling water systems.

Total Dissolved Solid (TDS): TDS is the total concentration of dissolved components, such as salts and sugar. Salts, like NaCl, dissociate into ions; while some organic matters, like sugar, do not break up into ions when dissolved in water. There are different approaches to determine TDS, but it is commonly estimated from conductivity.

Conductivity: Conductivity is defined as the ability of an aqueous solution to carry an electric current and can be easily measured by a conductivity meter. It is used to estimate Total Dissolved Solids (TDS).

Cooling water problems

Scale - Minerals such as calcium and magnesium are relatively insoluble in water and can form scale deposits when exposed to conditions commonly found in cooling water systems. A layer of scale as thin as 1/64 inch can reduce heat exchanger efficiency by 15%. Scale formation can be controlled by scale inhibitors such as threshold inhibition chemicals and scale conditioners. Chemical treatments include acids, polymers and polyphosphates which prevent scale formation by keeping the scale-forming minerals in solution to prevent deposits from forming.

Corrosion - Most metals used in cooling water systems are very susceptible to corrosion. Keeping surfaces clean is the most important aspect of preventing corrosion, since under-deposit corrosion can take place and result in serious damage. Corrosion can be uniformly distributed throughout the system or it can be localized, causing severe pitting and rapid equipment failure. There are various corrosion inhibitors used in chemical treatment.

Microbiological deposits - More cooling water treatment programs fail due to lack of microbiological control than any of the other two problems mentioned above. Scale, corrosion, and fouling often are symptoms of an unsuccessful program, but the root cause is inadequate microbiological control. Makeup water and wind can carry microorganisms into a cooling water system. Uncontrolled microbiological fouling can lead to problems at every point in the cooling water system. Corrosion occurs under the bacterial slime layer. Inorganic foulants are trapped in this slime layer, compounding the problem. Microbiological chemicals often used include chlorine, chlorine alternatives, and appropriate biocides

Rarely do corrosion, scale and fouling occur independently of one another. Usually two or all three develop together to cause loss of heat transfer and premature metal loss. For example, microbial fouling can cause scaling and corrosion to occur; corrosion can contribute to iron fouling and encourage more corrosion to occur. To break this cycle, proper problem identification is important for selecting and applying a practical, economical solution to any deposit problem.

Indicators for concern

1. Cycles of concentration are too high or too low: For each installation, there is a recommended cycles of concentration. This is achieved by properly setting the blow down conductivity point. If cycles are too high, water quality deteriorates and may exceed the treatment capability, causing performance problems. If cycles are too low, there will be too much blow down, thus reduced water saving. Also, cooling water may not get enough CHC treatment at low cycles.

   Examples of causes for changes in cycles of concentration: a). Conductivity meter is out of calibration and not working properly. The Conductivity meter should be cleaned and calibrated for each visit. b). Changes in evaporation rate due to system load or weather. c). Changes in makeup water chemistry.

2. Changes in makeup water chemistry: This is usually caused by changes in the source of makeup water. Well water (ground water) is generally quite stable for each well but could change significantly from other wells nearby. Surface water changes with seasons. Some cities use a combination of different water sources for municipal water.

3. Changes in hardness and alkalinity in makeup water will changes the scaling tendency. Changes in chloride also changes water's corrosivity. Changes in conductivity (TDS) directly affect cycles of concentration. Therefore, conductivity set-point may need to be adjusted.

4. Relative calcium concentrations of sump water and makeup: When makeup water chemistry and cycles of concentration are stable, changes in sump water calcium hardness may indicate changes in the performance of the CHC system.

5. Significant increase in bacteria population: Often this is caused by contamination. Follow-up sample is recommended. Survey the system and find out the cause.

CHC-INSIGHT

6.9 INSTALLATION CERTIFICATE

The undersigned hereby certifies that all items described below, leased/rented to the undersigned pursuant to the lease/rental agreement between the Lessor/Seller and the undersigned (the "Equipment"), have been delivered, and that this Equipment has been accepted by the undersigned and is now operational.

DESCRIPTION

Unit Serial #: _____ **Chamber Serial #:** _____

Equipment Located at _____ _____

In the City of _____ **County of** _____ **State of** _____

Company Name _____

INSTALLATION INFORMATION

Subcontractor Information

Plumbing/Installation Contractor: _____

Telephone #: _____ **Date:** _____

Electrical Contractor (if applicable): _____

Telephone #: _____ **Date:** _____

Operational Information

Date System Operational: _____

_____

Customer Signature

EcoWater CHC Tech/Rep Signature)

_____

6.10 Water Sampling Instructions

Water Sampling - Field Instructions

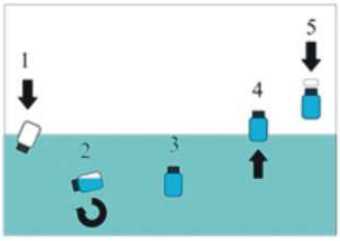
When collecting samples, you must follow these steps:

- Water samples should be collected from the following locations if accessible:
  Make-up water, basin, and any other points of interest.
- Normally one make-up sample should be taken for each site, each tower being treated should have its own basin sample taken.
- Make sure the collected sample represents real water chemistry. When you collect samples from non-flowing lines, open the valve and let the water flow for a few minutes before you fill the bottle.

- Always rinse sample bottles, if it is a new bottle, two rinses will be fine. However, if it is a used bottle, three or more rinses are recommended.
- Sample bottles should be completely filled to the top (no air space left), tightly seal the lid and make sure the bottle is marked correctly.

- A correctly marked bottle will include the customer's name, state, sampling date, location, pH, TDS and temperature.

- If sampling a basin, you will want to remove the lid, turn the bottle upside down and then emerge the bottle at least two inches below the water level. Then turn the bottle over, allowing it to fill completely, and then remove the bottle and place and tighten the lid.



- The collected samples should be shipped in the provided padded envelope back to EcoWater CHC. Attn: Chemistry Lab, 5850 Corridor Parkway, Schertz, TX 78154. If this sample is for bacteria testing, please follow the proper guidelines for submitting, which can be found on Bacterial Water Sampling-Field Instructions.
- If sample bottles or padded envelopes are needed, contact CHC Customer Service with quantity needed.

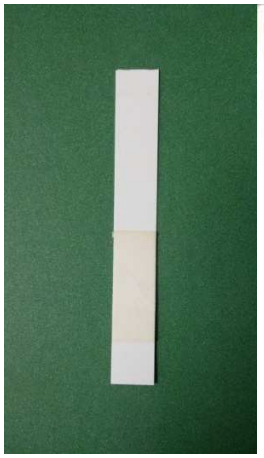
6.11 Dip Slide Testing

Dip strip testing – Field Instructions:

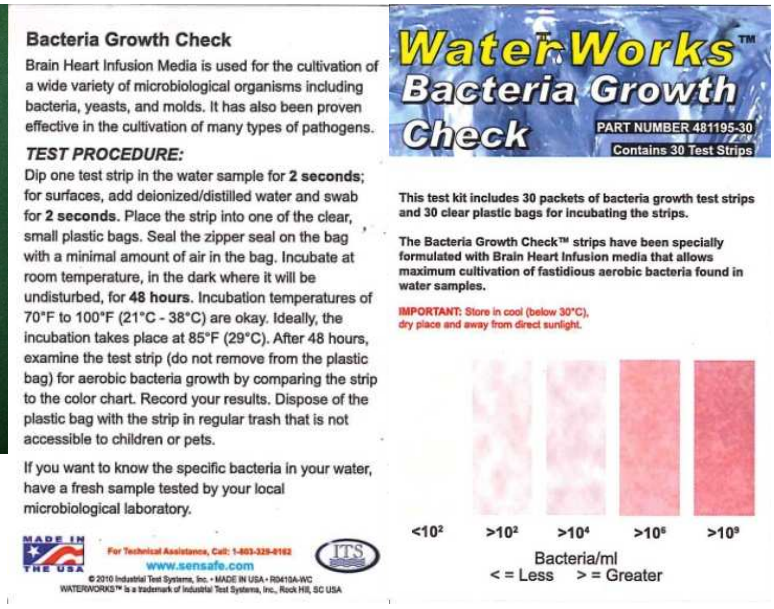
Dip strip testing must be performed for **each and every** non-make up water sample taken.

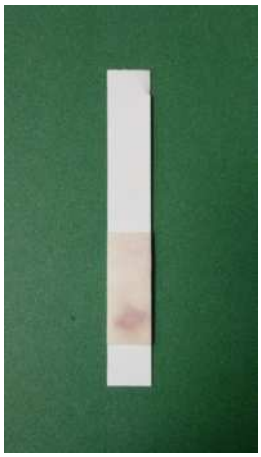
Procedure:

1. You will need one Dip Strip per tower being treated by CHC.
2. Open the Dip Strip and remove the test strip from the foil package.
3. Submerge the test strip in the water from the tower for three (3) seconds, being careful not to submerge in a high turbulence stream; this could damage the test strip.
4. Remove the test strip from the water and sling off any excess water by waving the strip from side to side.
    a. DO NOT ALLOW THE TEST STRIP TO TOUCH ANYTHING AT THIS POINT!
5. Place the test strip into the supplied zip-lock bag.
6. Label the bag with location, sump and date.
7. Place the test strip in a location out of direct sunlight for a period of 48 hours. This location must have a stable temperature in the range of 77-95 degrees F.
8. After 48 hours, compare test strip to the results comparison page supplied with the Dip Strips.
9. Record the test results in Ulysses.
10. EcoWater CHC requires pictures of any Dip Slide that shows a count larger than 10,000
11. Samples that have a count greater than 100,000 will require a more in-depth test.
    a. These tests can only be performed at our lab.
    b. The samples will need to be refrigerated and shipped overnight to EcoWater CHC.
12. Dispose of the Dip Slide.



<1,000





<100,000

6.12 CSR Form (Blank)

The CSR forms for each account are specific to that account. Please request the appropriate forms from EcoWater CHC Service.

6.13 Procedure for Chemical Passivation

In order to chemically passivate a cooling system, an inhibitor (WR-6035) will need to be added and the pH of the system controlled between the range of 6-7. In order to accomplish this, EcoWater CHC uses a Walchem pH/Conductivity controller. Water from the cooling system flows across the probes for conductivity and pH, after which citric acid (first) and WR-6035 (second) are injected. The discharge from the injectors returns directly back to the sump. Two chemical pumps will be used to inject WR-6035 (EZB10D1-VE – Clear Plastic) and the citric acid (EZB10D1-TC – White Plastic). The citric acid pump should be plugged into the electrical pigtail labeled "pH" off the controller, while the WR-6035 pump will be put on a slow continuous feed.

In order to get started, the pH probe and the conductivity probe must be calibrated. Refer to the Walchem manual on how to perform calibration. In order to calibrate you will need pH 4 and pH 7 standards for the pH probe and a bottle of "One Shot" calibration solution for the conductivity probe. Once calibrated, the range for pH control needs to be programmed. It is recommended that the upper limit be pH 6.8 and set the span for 0.4, which will shut off the acid pump when the pH gets below 6.4. We recommend operating the system at < 2.0 cycles of concentration based upon the conductivity of the make up water. Consult the Walchem manual on how to set these parameters.

Prior to starting the passivation process we recommend you blow down the system to well below the conductivity set point so when you start adding chemicals they do not immediately trigger a blowdown. Pictures of the tubes (condenser) or basin (cooling tower) should be taken prior to passivation and then again after. The process is successful if the color of the galvanized metal goes from a shiny aluminum to a dull gray color.

At start-up, you will need to prime the chemical pumps with the respective fluids; consult the pump manual on how to do this. Once you are ready to go you will need to have available a WR-6035 test kit and should have 1 gallon of Antifoam AF in case foaming becomes an issue. The test kit will have the procedure on how to determine how much WR-6035 is in the system. Should foaming be an issue, you will need to pour in 8 ounces of antifoam at a time into the system in order to kill the foam (a little anti-foam goes a long way).

The controller will bring the pH of the system in line automatically. As stated earlier, the acid pump (EZB10D1-TC – White Plastic) gets plugged into the "pH" electric pigtail on the controller. Typically a good setting for the acid pump speed will be 300. You will need to put in a slug does of the WR-6035 to get the residual into the 40-100 ppm range. This can be accomplished by turning the pump up to a speed setting of 325 and let it run for about 10 minutes, and then pull a water sample to run the WR-6035 test. The WR-6035 pump (EZB10D1-VE – Clear Plastic) should be plugged directly into a power outlet so it can run continuously. Once you get into the recommended WR-6035 dosage range

(40-100 ppm per the test), you can then start backing the WR-6035 pump speed setting down until it is in a range where the residual dosage is specified (40-100 ppm). You will probably find that you will step the WR-6035 pump down a couple of times until the dosage comes in range. Typically the final setting of the 6035 pump will be around 150. Once set up, the system should take care of itself until the chemicals are consumed.

Once the system has been passivated, prior to disconnecting the chemical pumps, they should both be flushed by pumping water through them for a couple of minutes. Also, if there is any chemical left in the drums, it should be carefully poured into a drain with flushing water, and the drums should be rinsed out a couple of times as well. Also, you must replace the bung hole caps. When done, remember to take "after" pictures of the same locations as the "before" pictures.

Some helpful points:

1. Mark the chemical level in the drum by time every so often in order to gauge how much material you are using on a daily basis. The process should take 3-5 days, so if you are over feeding, you may run out of chemical too quickly.
2. It is okay to overdose with the 6035 (better to overdose than under dose). It is not okay to get the pH much below 6 in the system.
3. Use standard precautions when handling the chemicals. You should be wearing safety glasses and rubber gloves and be aware of where the nearest eye wash station is in case needed. Also, you should have a source of water available so you can rinse your hands or the area in case acid is spilled.
4. If the chemical injection points are to remain on the system, install pipe plugs into the female bushings after removing the chemical feed lines.
5. Tubing for pumps is 3/8" OD ¼" ID Polyethylene. If needed, you can get a 25 ft roll at Home Depot.
6. You need 1/2'" female bushings for the injection nozzles from the pumps.

6.14 CHC Control Station Manual

CHC
Control Station
Technical Manual

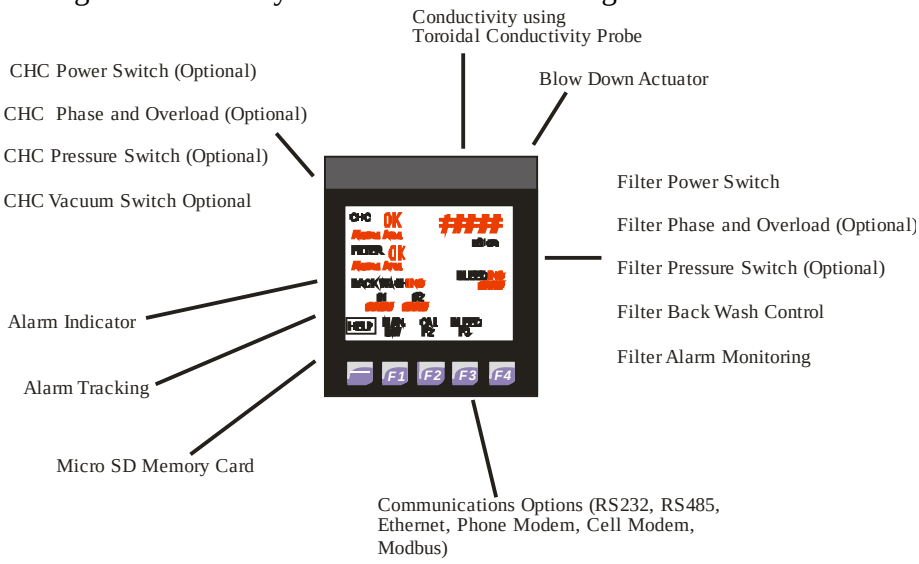
For Distribution to EcoWater CHC Representatives only
7/12/14 Rev C

Forward

This manual has been written for the sole use of the EcoWater CHC Representatives to aid in the understanding, and technical application of the CHC Control Station. This manual is not intended as a supplement to the Operation/Service Manual and should not be released for customer use. If the customer has purchased the system and they request information that is shown herein, please request the appropriate documentation from EcoWater CHC Service Department.

Control Station Description

The Control Station has been designed to monitor and control the CHC treatment system. It utilizes a PLC (Programmable Logic Controller) that has been programmed by EcoWater CHC to meet the operational requirements. Its screen layout has been designed to minimize the need for customer interaction as well as minimize confusion in screen function and layout. There are User Screens as well as Set Up screens. The Set Up screens will be configured at the time of installation and do not require configuration by the user, for this reason, the Set Up screens are Password protected. The control station is integrated into the system as shown in this diagram:



PLC Basic Specifications

The Control Station operates on 24 Volt DC Power
The Input signals are required to be 20-24 Volt DC
The Outputs utilize relay contacts and can handle up to 120V, 2A power control for each
The display is a monochromatic 3 ½" LCD that is direct sunlight readable.
The operational temperature range for the product exceeds our CHC system specifications.
PLC Make- Horner APG XLT, model number- XE-XT102AB. (www.heapg.com)
Refer to the Electrical Schematic for wiring specifications.
There are several Communication Options, refer to EcoWater CHC Service Department for more information.

Mounting

The Control Station must be mounted in an appropriately rated enclosure. This enclosure could include a motor starter box or could be enclosed in a separate box to the side. The front panel is rated for Nema 4X (IP65) use. Please refer to the PLC's Manual for further specifications.

Basic Functions

Power Recovery- If the power fails the system will automatically reboot, and continue its operation upon the return of the supply power. No user settings will be lost. No Alarm History will be lost.

The User Interface- The user interface has been constructed to allow soft touch screen button use as well as Fkeys to minimize the operator's interaction requirements. Refer to Screens for further information.

Multiple Language Ability- The user interface was constructed to allow multiple languages as selected in the set up screens. The Initial and Set Up screens will always be shown in English no matter what language is chosen.

Conductivity- The conductivity of the system is monitored continuously with the use of the supplied Toroidal conductivity probe placed in a continuous water flow on the filtration skid that bypasses the filter. Allows for control of conductivity based blow down as well as HI and LO alarms placed around the normal conductivity levels. Functions have been added to allow the calibration of the conductivity sensor to AIR as well as to a higher known conductivity value liquid.

Blow Down Control- The blow down is controlled by a blow down set point that is selectable within the user screens. The blow down utilizes the conductivity valve against the selected blow down settings to control and maintain the conductivity within the system water. A dead band (found within the Set Up screens) is utilized to reduce valve opening and closing frequency to lengthen valve life. A simple test has been added to the Bleed screen that allows for the easy verification of Blow Down Valve operation.

Filter Control- The filters are monitored continuously and their cleaning routines are controlled by the Control Station. The number of back washes are shown on the main screen for easy viewing. A Manual Back Wash initiate feature has been added to the main screen to allow your testing of the back wash ability of the filter. The filter control interfaces with a differential pressure switch (DP) as well as the back flush solenoids to aid in the control and monitoring of the filter.

Pump Monitoring- The control station can be configured to monitor the power system of the pump, this includes the power status of the pump, its thermal overload condition as well as monitor the Power Phase condition of incoming power. The system can be configured to monitor the pump's pressure if required.

Alarm Indication- Alerts are shown under their corresponding labels, the alarms have been prioritized to minimize nuisance alarms. Upon an alarm activation, an output of the controller can be utilized to send a 24VDC signal to an indicator for the customer's use.

Alarm Storage- As alarms occur, they are stored in the control station's memory for future use. They can also be stored continuously onto a Micro SD memory card if it is installed in the controller.

Optional Features- As shown above many of the monitoring features of the pumps can be turned ON and OFF as required. The station also has the ability to communicate in other ways with building control systems and other communication systems, contact EcoWater CHC for further information about the communication abilities.

Set UP Screens- The Set up screens contain the basic system settings needed to configure the operation of the system.

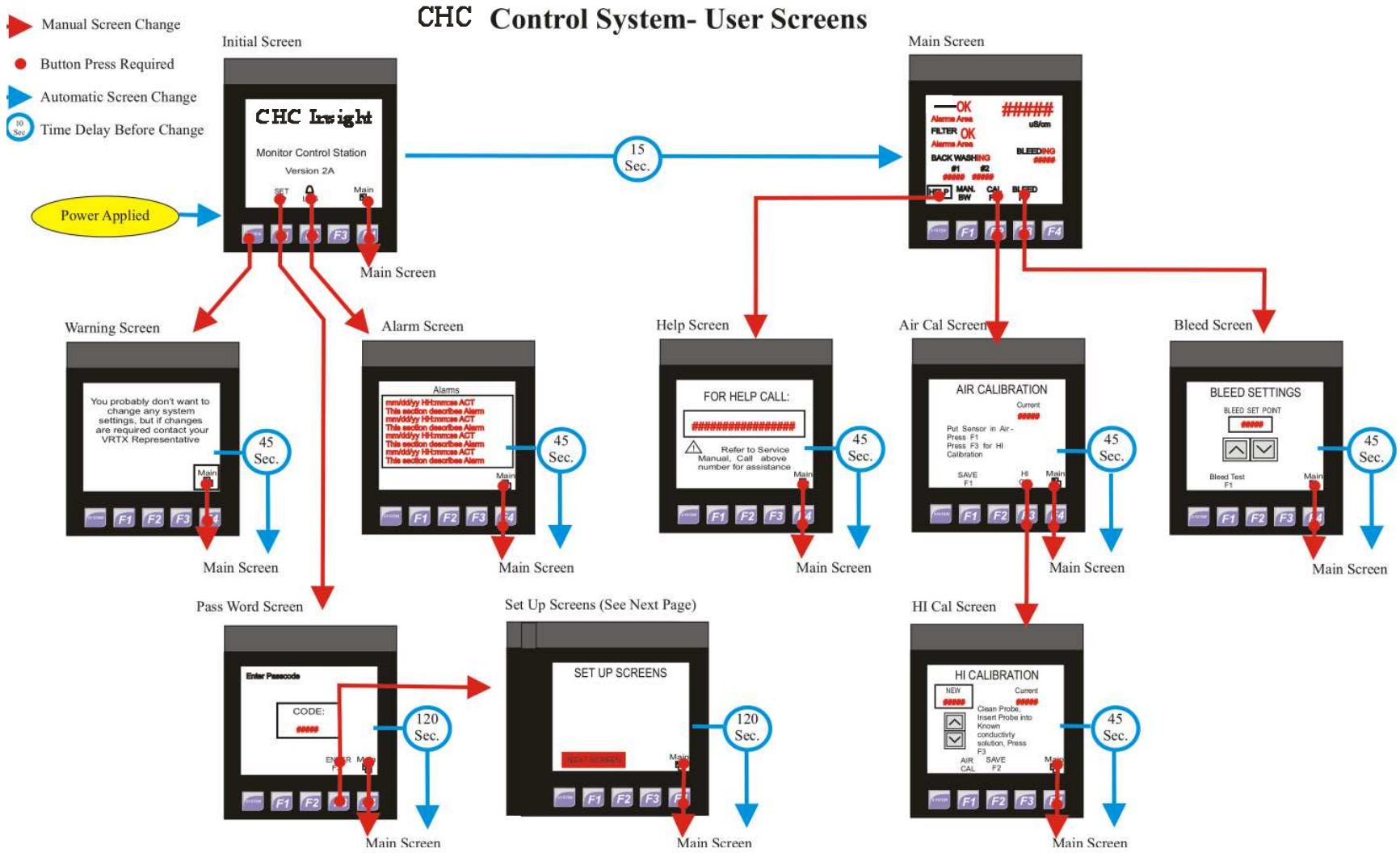
Password Protection- All sensitive configurations of the system have been password protected. From the initial Start Up screen, you can press the SET UP button that will change the screen to the Password screen. As the appropriate password is entered and the Enter (F3) button is then pressed the system will conduct several possible items. These items could be entering into the Set UP screens (password 5850) or Conducting a Factory Default on all system settings (password 8789), clearing the counter memories (password 1000), or simply restoring the user setting to User Defaults (passwords 112 or 977). If any of the defaults are completed all counter memory is reset to 0. This means that the back wash counts, secondary back wash counts, current conductivity calibration, ect will be lost.

System Screen- Within the system screen, basic controls of system functions can be changed. The functions include: Changing the Date and Time, Adjusting the Screen Contrast, Memory Card Deleting and Formatting, and Program uploads from memory card (used for updating program).

Screens

There are several screens that can be used within the Control Station this section looks at all of the possible screens, their hierarchy and display and control options for each screen.
From each screen several Fkeys have been constructed to allow operational, and screen changed function. All screens have been designed to utilize soft keys (buttons on LCD) as well as the hard keys (Fkeys) to control the features and actions of the system.
All Return to Main keys (

), change the screen being shown back to the Main User Screen.
All screens except the Alarm Screen automatically will revert to the Main User Screen. The time it requires for each screen is shown in the screen flow hierarchy as shown within this manual.
There are two basic types of screens that can be accessed by the Control Station software, there are USER screens as well as SET UP or SYSTEM screens. All SET UP and SYSTEM screens are protected by passwords and EcoWater CHC recommends that the user is only made aware of those passwords that are appropriate to them. That means that if the customer is a Full Service Agreement (FSA) customer they should only be made aware of the pass words for resetting the User Defaults and that NOTHING MORE. However if the customer has purchased the CHC Treatment system, we are allowed to pass on the required information to the customer about all possible passwords. Please refer these customer's to EcoWater CHC Service so that the appropriate documentation can be given to them.
Anyone can view and change the settings of the User Screens as desired. The user screen language will reflect that language chosen in the Set UP Screens. The Set UP and SYSTEM screens will always be shown in English no matter what language is chosen in the Set Up Screens.
The following pages discuss the screens in more detail:


CHC Control System- User Screens
Manual Screen Change
Button Press Required
Automatic Screen Change
Time Delay Before Change
Initial Screen
CHC Insight
Monitor Control Station
Version 2A
Power Applied
15 Sec.
Main Screen
Main Screen
Warning Screen
You probably don't want to change any system settings, but if changes are required contact your VRTX Representative
45 Sec.
Main Screen
Alarm Screen
Alarms
45 Sec.
Main Screen
Help Screen
FOR HELP CALL:
Refer to Service Manual, Call above number for assistance
45 Sec.
Main Screen
Air Cal Screen
AIR CALIBRATION
Put Sensor in Air - Press F1
Press F3 for HI Calibration
45 Sec.
Main Screen
Bleed Screen
BLEED SETTINGS
45 Sec.
Main Screen
Pass Word Screen
Enter Passcode
CODE:
120 Sec.
Main Screen
Set Up Screens (See Next Page)
SET UP SCREENS
120 Sec.
Main Screen
HI Cal Screen
HI CALIBRATION
45 Sec.
Main Screen

User Screens in Detail

Initial Screen

Once Power is applied, this screen appears to indicate the Software Revision number and allow access to the Set Up screens and Alarm Screens. If no actions are taken the unit will revert to the Main screen in 15 seconds. The user can also pass directly to the Main screen by pressing the Return to Main soft key or the F4 Hard key.

Warning Screen

This screen appears when the customer tries to enter the System Screen. The system screen is pass word protected. The System Screen allows the user to change the date, time, start and stop the program, etc.. To continue to the Pass Word Screen you must go back to the initial screen and then enter into the Set Up screens

Password Screen

This screen appears when the customer tries to enter the System or Set UP Screens. By pressing the box, an alpha numeric key pad will be shown to allow for input of CODE. Once the code is entered it will be shown on this screen, and if the F3 key is pressed with the appropriate Code being shown, the screen will change to the Set UP Screen. If the Code is correct and you press the F1 key, the screen will change to the System screen. If a button is pressed and the code is incorrect, no action will be taken.

Alarms Screen

This screen is only available from the Initial Screen. It allows the user to review the date and time of each Alarm occurrence. Alarms are considered as failures as well as power ON and OFF occurrences.

User Main Screen

This is the Main User Default screen for monitoring. All screens except the Alarm Screen automatically default back to this screen with a time frame. If any of the MAIN (F4) keys or soft keys are pressed this screen will appear. This screen indicates all current system status alarms and values.

Within this screen there are several key areas of interest:
CHC area- Appears if selected for monitoring in the Set Up screens.
If any Alarms are active- They are displayed under the CHC label.
If the system is operating within specification an OK will appear as shown.
FILTER area- Within the filter area, if the systems are operating within specification the OK will appear. If an alarm is active the filter # will be shown to the right of the FILTER label and its corresponding Alarm will be shown, in this example PUMP OFF is indicated. The current Back Wash Counts for each filter are also shown, if only one filter is selected, only its Back Wash Count will appear. During a back wash an "ING" will be shown to the right of the BACK WASH label, as shown. Conductivity HI an LOW alarms are also shown in this area.
Conductivity area- The current conductivity value from the Toroidal probe is shown here. The units of measure will change from uS/cm to ppm as selected in the Set-Up screens.

BLEED area- The current Blow Down Bleed limit is shown in this area. if the unit is currently blowing down, an "ING" will be placed to the right of the BLEED label

The Soft keys at the bottom allow the user to pass to other corresponding screens

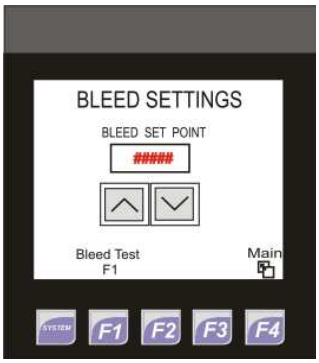
Air Calibration Screen

This screen allows the user to insert an Air Calibration point (LOW) into the scaling of the Toroidal conductivity probes scaling. Once the sensor is cleaned, the user will leave the probe in open air and as the current conductivity's reading stabilizes, the F1 key will be pressed to insert the Low (0) calibration point

HI Calibration Screen

This screen allows the user to insert a High Calibration point into the scaling of the Toroidal conductivity probe's display. The user can clean the probe and insert it into a known calibration solution, or they can choose to leave the probe in the system water if the conductivity value has been verified. They will then enter the known conductivity value into the NEW box. They can incrementally increase or decrease the value with the UP and Down buttons, or they can press the New box on the screen to insert the value directly with a numeric key pad that will appear. Once the New value has been selected, the SAVE F2 key can be pressed to insert the new value into the calibration scaling of the conductivity probe.

Bleed Screen



This screen is used to insert the appropriate BLEED Set point to control the cycles of concentration. The Bleed Setting can be increased or decreased incrementally by pressing the UP or DOWN buttons. If the value box is pressed on the screen a numeric key pad will appear allowing the user to directly insert the appropriate value.

If the Bleed Test F1 key is pressed, the current state of the blow down actuator will invert (Close > Open or Open >Close) for a period of 20 seconds to allow for actuator function verification.

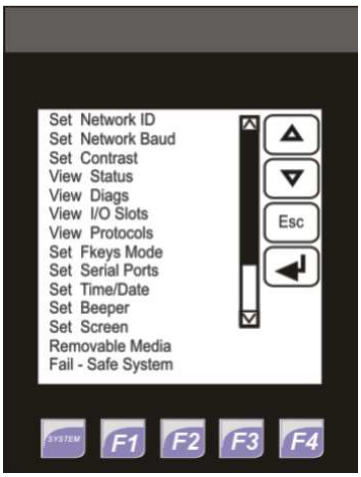
Help Screen

If the HELP soft key is pressed on the Main screen the HELP Screen will be shown. The phone number shown on this screen can be installed in the Set Up screens.

SET UP Screens
This Section is currently being rewritten

Other Screens

SYSTEM Screen



The System Screen can be accessed while indicting the First Set UP screen.
While this first Set Up screen is shown (Select Language screen), if the F2 key is pressed the System screen will appear. Within this screen you have the option of selecting several settings that may be of interest. Use the up and down buttons to move the cursor over your desired setting and press the return button to enter that settings screen. Settings of interest may include the CONTRAST screen where you can change the contrast of the LCD, as well as the Removable Media Setting, that allows you to format, save, or Update the systems software with the use of the Micro SD card.
Contact EcoWater CHC Service for more information if needed about the Svstem

Alphanumeric Input Screen

This screen automatically appears if you select any of the boxes on the screens that require an input. (Bleed Set Point, Passcode, Help Set Up, Controller Set Up, etc.

You can select the appropriate input by pressing the corresponding keys. Once the input is correct press the return soft key and the input value will appear in the box you first pressed.

You can use the Left and Right soft keys to move the cursor over an area you need to correct on you input value, or you can press the ESCape soft key to return to the previous screen without an input value.

Updating The Software

The Control Station's Software can by updated at the factory or at the customer site. This section refers to the procedure needed to update the software in the field (customer site). **IT IS VERY IMPORTANT TO FOLLOW THIS PROCEDURE EXACTLY AS SHOWN BELOW.**

1. Turn the power OFF to the Control Station, by turning off the power disconnect.
2. Open the Motor Starter and insert the supplied memory card into the memory slot on the top of the PLC. **DO NOT** force the card into its slot, it will simply slide into its connections and click once it is in place. The card's electrical connection will face the Control Station's Face plate.
3. Turn the Power back ON.
4. Once the Initial screen appears, Press the Set UP soft key or F2 hard keys.
5. The Password screen will appear and enter 5850 into the passcode area.
6. Press the Enter soft key or F3.
7. The Set Up Screen #1 (Select Language) screen will appear.
8. From this screen, and this screen only press the F2 hard key. It is not labeled on the screen, but it will allow you to enter into the SYSTEM screen.
9. Press the Down arrow until the cursor is shown over the Removable Media setting.
10. Press the Return button (looks like an arrow going down and to the left) to enter into the Removable Media screen. The screen should look like this one shown below:

11. Select the DEFAULT.PGM file by moving the cursor with the Up and Down soft keys.
12. Press the Return button and the following screen should appear:

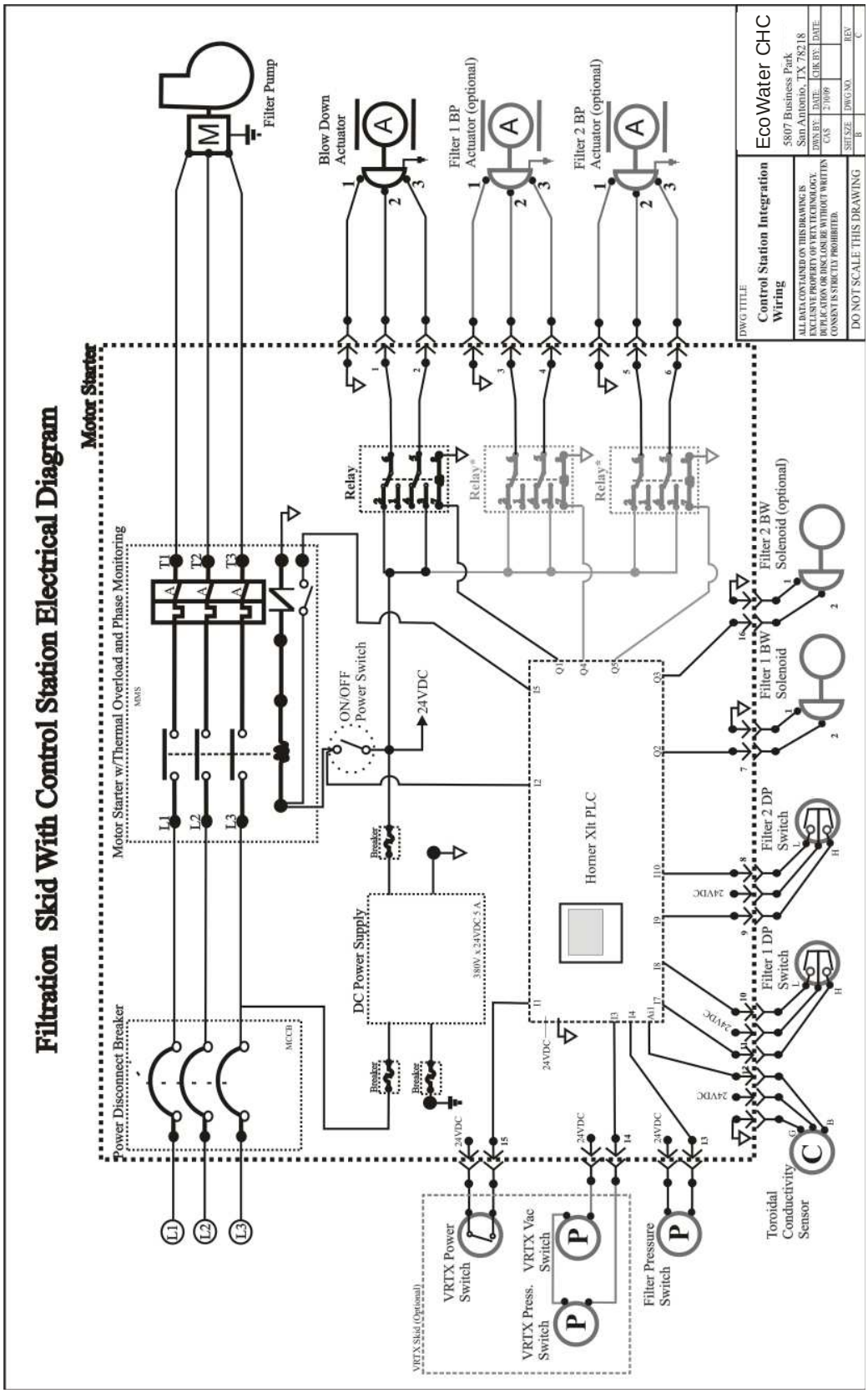
13. Press the OK button on the Load Application window.
14. As the software is being up loaded this screen will be shown indicating that progress of the upload:

15. Once the software is installed the screen will change with a window and it then asks you if you would like to place the unit in the RUN mode. Press the OK button and the unit should revert back to the initiation screen.
16. If any problems occur or the system does not start operating with the Initiation screen, call EcoWater CHC Service for help. The software was designed to check its own Check Sum upon power on and if the Check Sum of the running program does not match the stored program, the unit will indicate this failure with a “CRC Error”.
17. Once the software is loaded, all settings will need to be verified in the User and Set Up screens.
18. Once all settings are correctly made and verified, enter back into the Set Up screens and continue to the Load as Defaults screen and press the Load Defaults button.

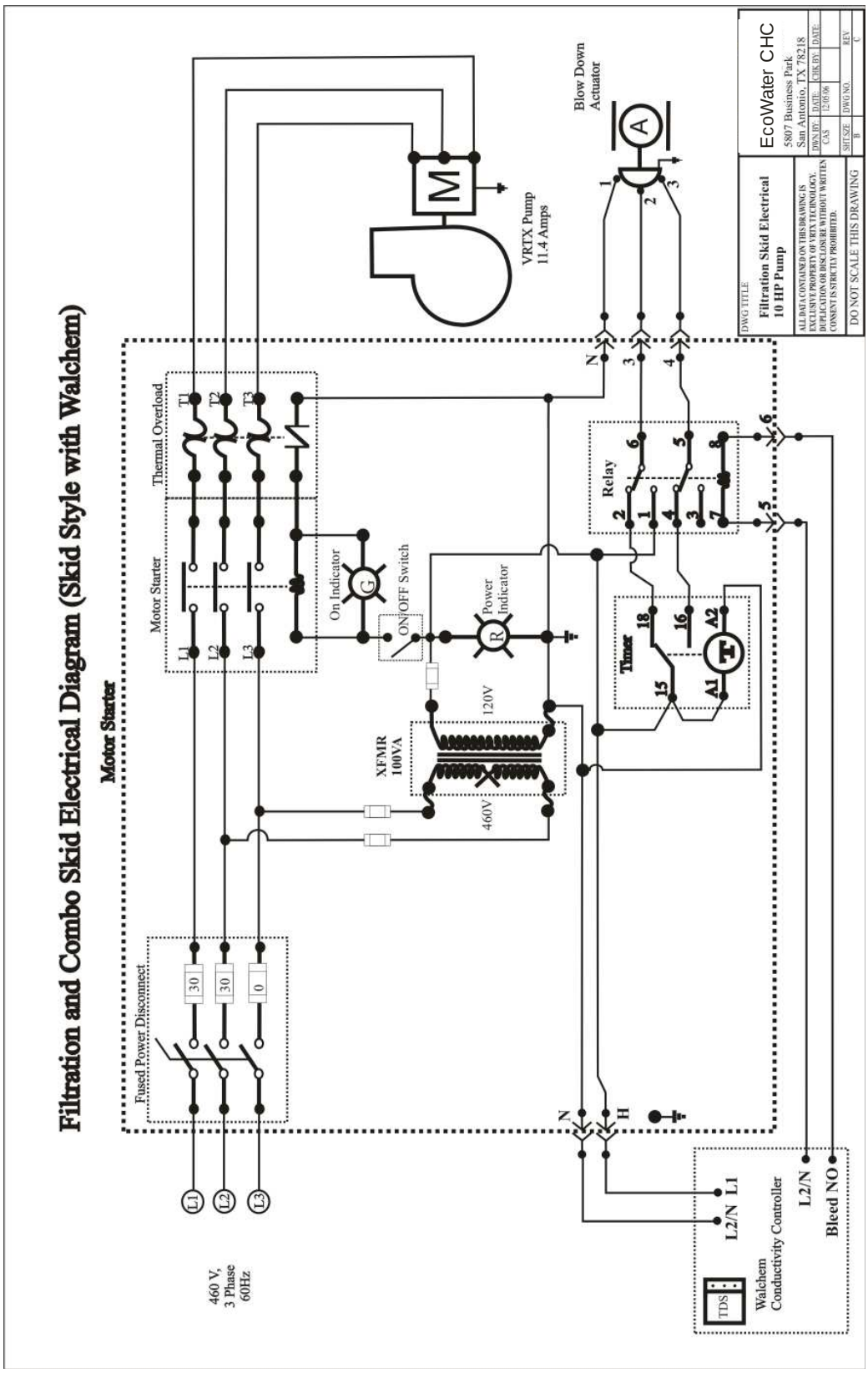
Control Station Connections

The Control Station has been designed to allow the interface to serve many versions of CHC, Filtration, alert, function and communication options. Most of the options are build directly into the system and only require connection to the hardware and Setting Screen Configuration to implement their use. However the optional communication formats require software modification and are not discussed in this section.

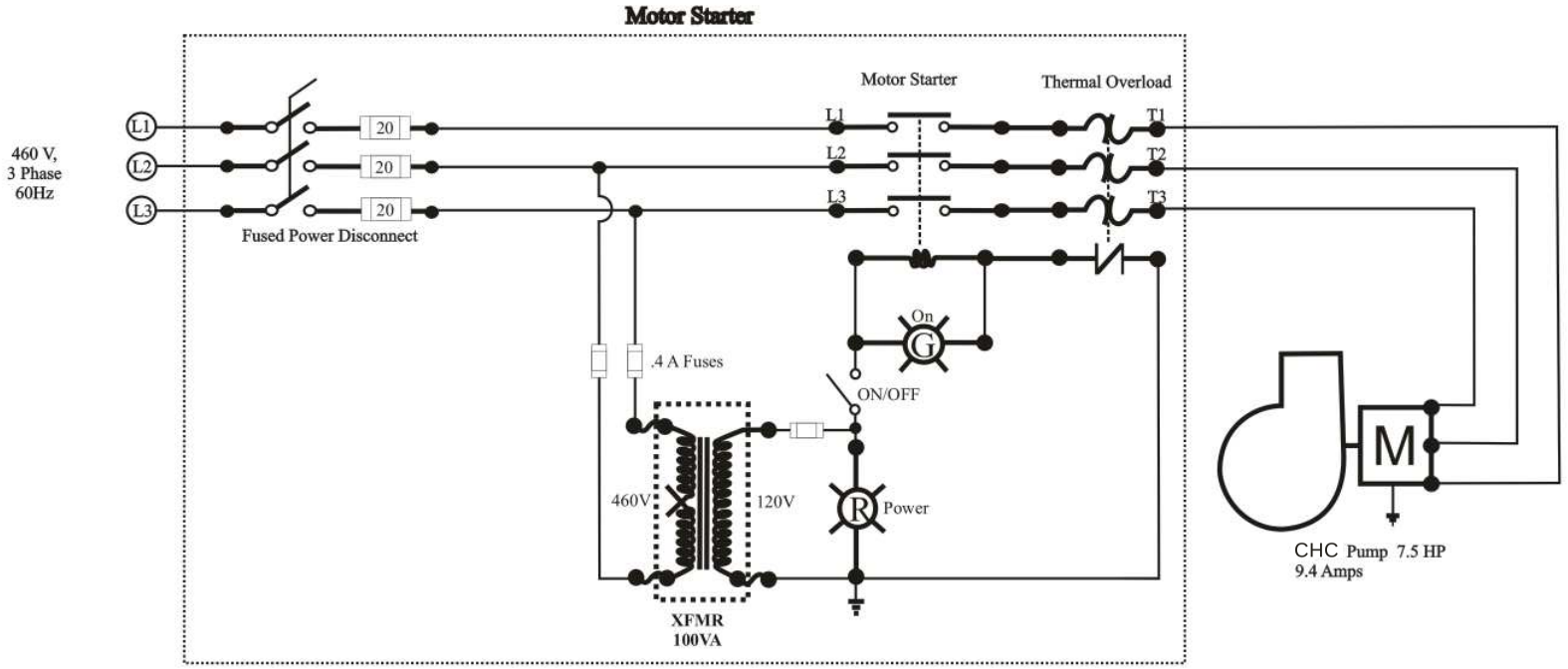
Pins	Name	Function
+	24 VDC Power	Supply Positive Power Input
-	Negative	Supply Negative Power Input
G	Ground	Earth Ground
0V	Negative Ref.	Supply Negative Reference Input
A1	Conductivity	Conductivity Sensor Input (Black wire)
A2	Analog Input	Not Used
A3	Analog Input	Not Used
A4	Analog Input	Not Used
I1	CHC Power	CHC Power Input (24 VDC Signal)
I2	Filter Power	Filter Power Input (24 VDC Signal)
I3	CHC Pressure	CHC Pressure Input (24 VDC Signal)
I4	Filter Pressure	Filter Pressure Input (24 VDC Signal)
I5	Filter Electrical	Filter Electrical Failure Input (24 VDC Signal)
I6	CHC Electrical	CHC Electrical Failure Input (24 VDC Signal)
I7	Filt 1 BW High	Filter 1 BW switch high Input (24 VDC Signal)
I8	Filt 1 BW Low	Filter 1 BW switch low Input (24 VDC Signal)
H1	Filt 2 BW High	Filter 2 BW switch high Input (24 VDC Signal)
H2	Digital Input	Not Used
H3	Digital Input	Not Used
H4	Digital Input	Not Used
C1	Common (R1)	Common for Relay 1
R1	Relay Out 1	Blow Down Relay Control Signal
C2	Common (R2)	Common for Relay 2
R2	Relay Out 2	Filter 1 BW Control Signal
C3	Common (R3)	Common for Relay 3
R3	Relay Out 3	Filter 2 BW Control Signal
C4	Common (R4)	Common for Relay 4
R4	Relay Out 4	Filter 1 Back Pressure Relay Control Signal
C5	Common (R5)	Common for Relay 5
R5	Relay Out 5	Filter 2 Back Pressure Relay Control Signal
C6	Common (R6)	Common for Relay 6
R6	Relay Out 6	Alarm Relay (for Indicator light or BCS integration)


Filtration Skid With Control Station Electrical Diagram
Motor Starter
Power Disconnect Breaker
Motor Starter w/Thermal Overload and Phase Monitoring
Filter Pump
Blow Down Actuator
Filter 1 BP Actuator (optional)
Filter 2 BP Actuator (optional)
Relay
Relay*
ON/OFF Power Switch
24VDC
DC Power Supply
380V X 24VDC 5 A
Horner Xlt PLC
Filter 2 BW Solenoid (optional)
Filter 1 BW Solenoid
Filter 2 DP Switch
Filter 1 DP Switch
Toroidal Conductivity Sensor
VRTX Power Switch
VRTX Vac Switch
VRTX Press. Switch
Filter Pressure Switch
VRTX Skid (Optional)
DWG TITLE
Control Station Integration Wiring
EcoWater CHC
5807 Business Park
San Antonio, TX 78218
DO NOT SCALE THIS DRAWING

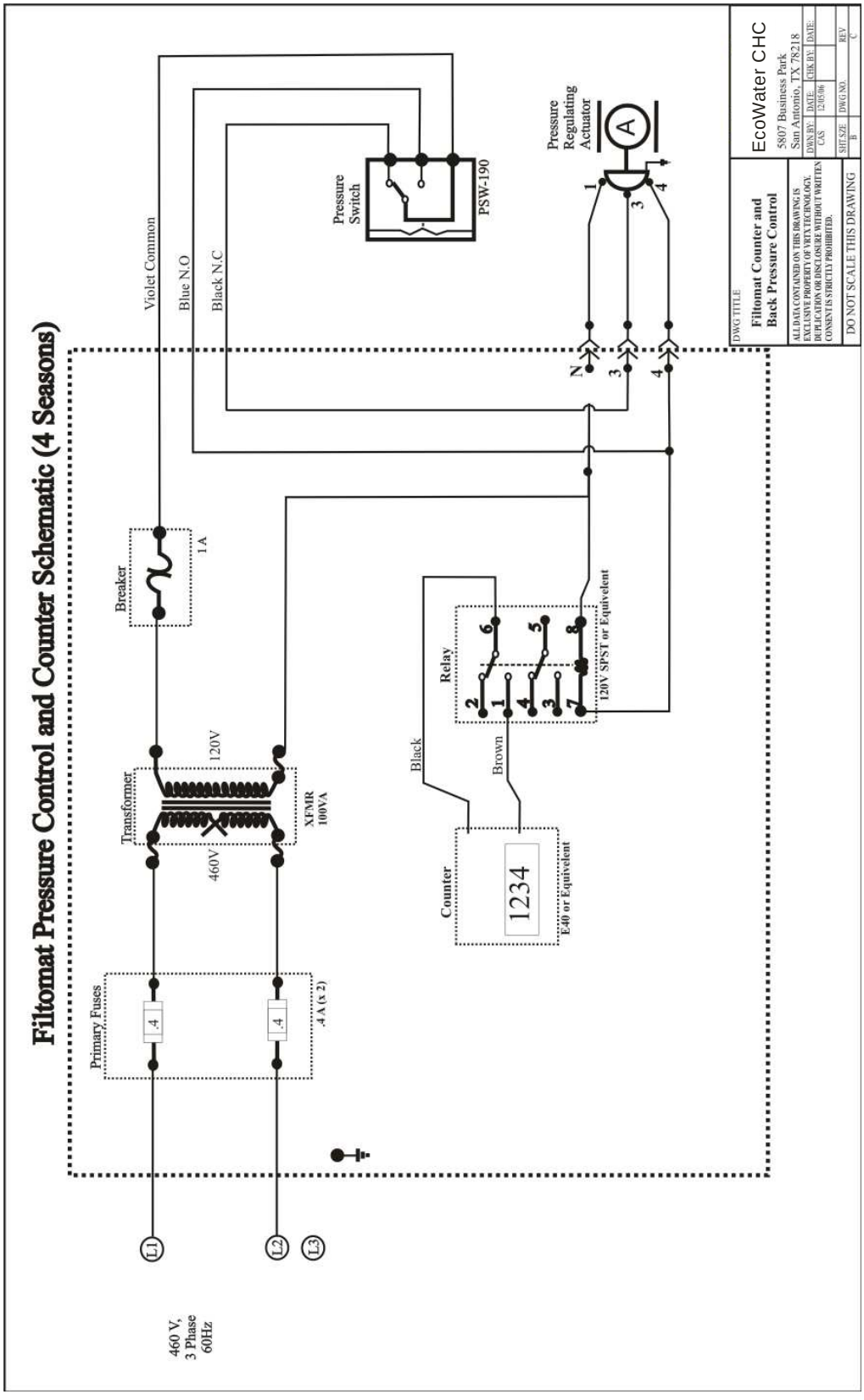
6.15 Electrical Schematics

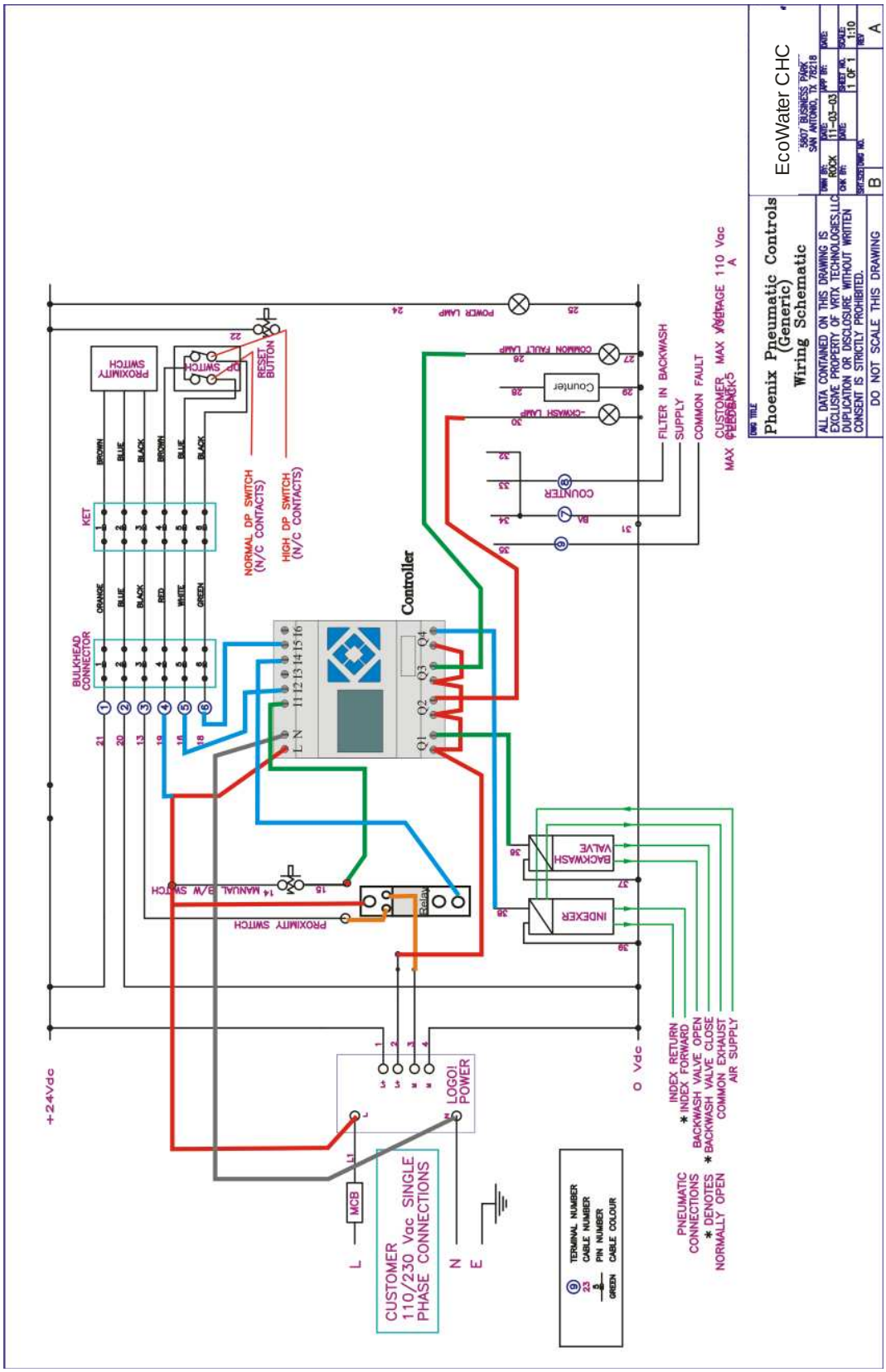


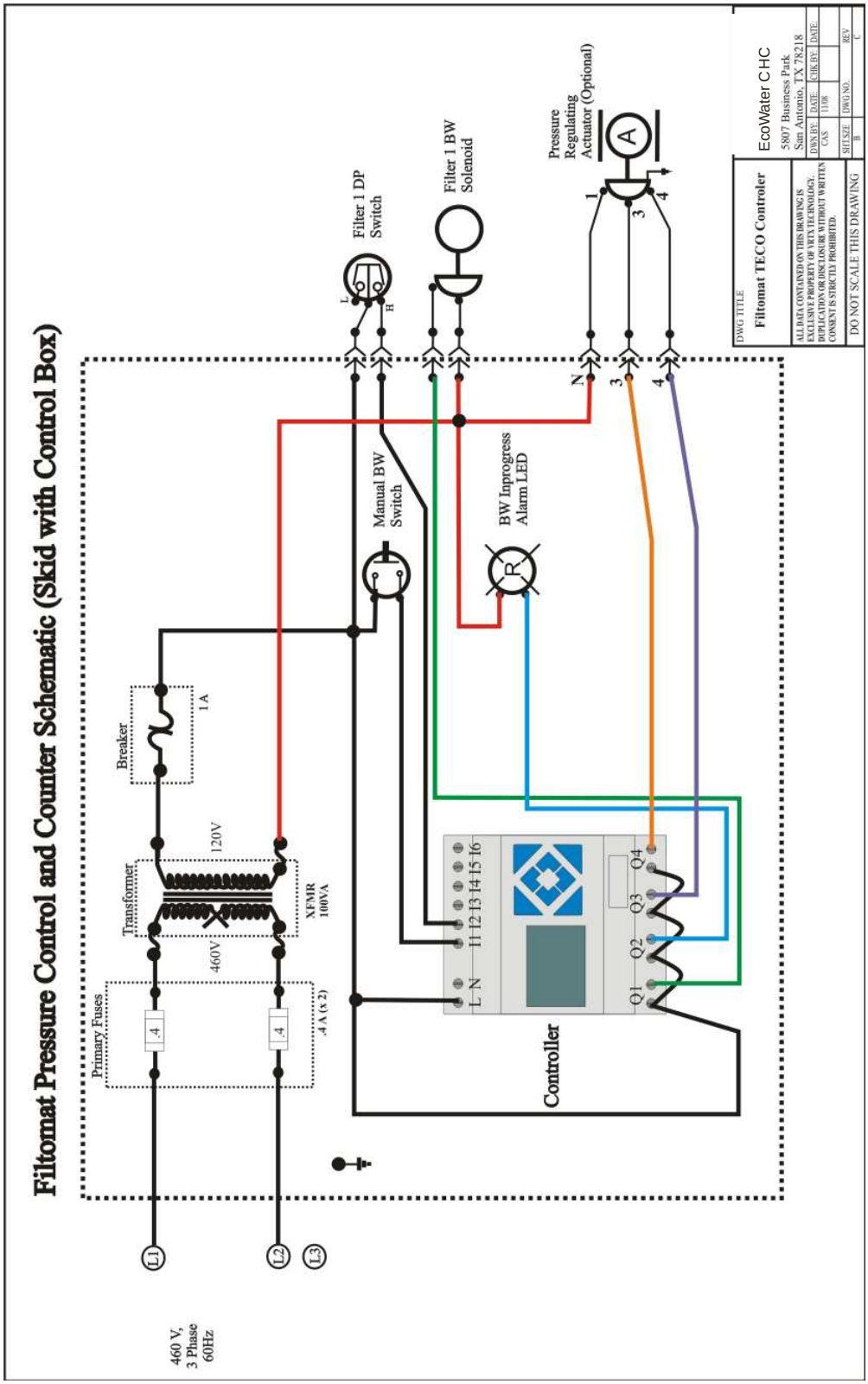
CHC **Skid Electrical Diagram (Skid Style)**



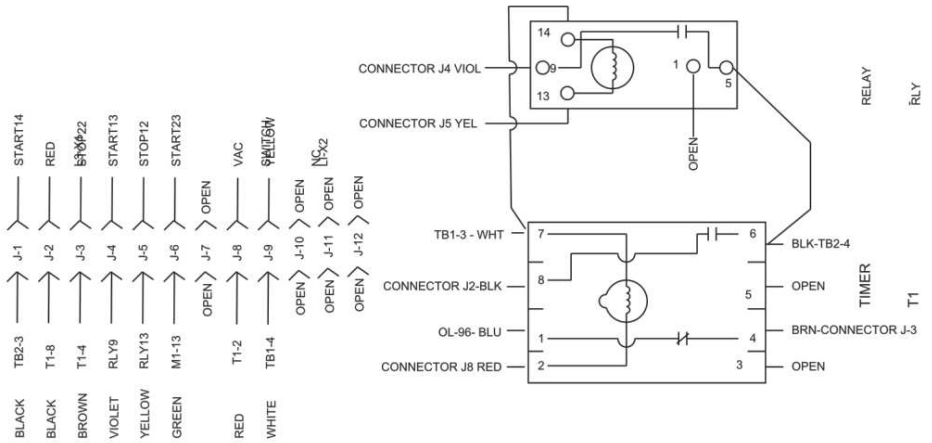
DWG TITLE CHC **Skid Electrical** **7.5 HP Pump**	EcoWater CHC 5807 Business Park San Antonio, TX 78218
ALL DATA CONTAINED ON THIS DRAWING IS EXCLUSIVE PROPERTY OF VRTX TECHNOLOGY. DUPLICATION OR DISCLOSURE WITHOUT WRITTEN CONSENT IS STRICTLY PROHIBITED.	DWN BY: CAS · DATE: 12/05/06 · CHK BY: · DATE:
DO NOT SCALE THIS DRAWING	SHT SZE: B · DWG NO. · REV: C

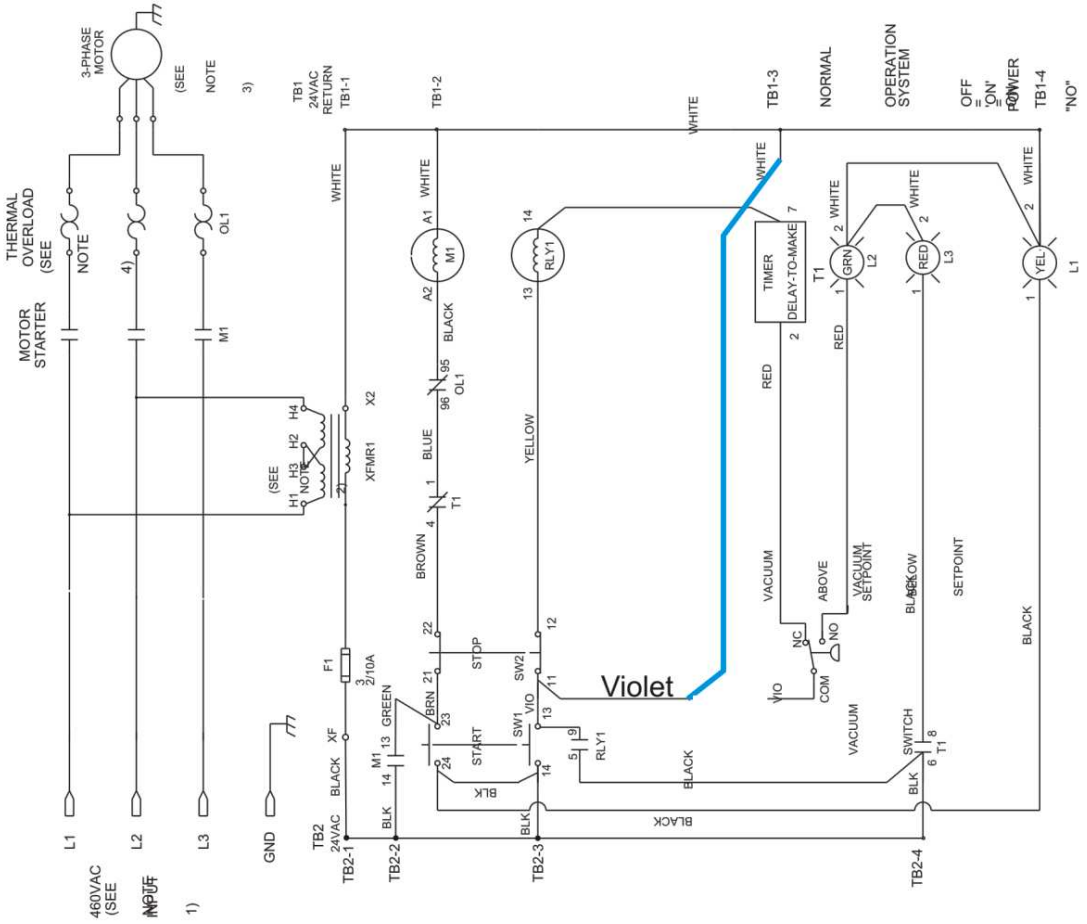

Filtomat Pressure Control and Counter Schematic (4 Seasons)
Violet Common
Blue N.O
Black N.C
Pressure Switch
PSW-190
Pressure Regulating Actuator
Breaker
1 A
Transformer
120V
460V
XFMR 100VA
Primary Fuses
.4
.4 A (x 2)
Relay
120V SPST or Equivelent
Black
Brown
Counter
1234
E40 or Equivelent
460 V, 3 Phase 60Hz
L1
L2
L3
N
DWG TITLE
Filtomat Counter and Back Pressure Control
EcoWater CHC
5807 Business Park
San Antonio, TX 78218
ALL DATA CONTAINED ON THIS DRAWING IS EXCLUSIVE PROPERTY OF VERTX TECHNOLOGY. DUPLICATION OR DISCLOSURE WITHOUT WRITTEN CONSENT IS STRICTLY PROHIBITED.
DWN BY: CAS
DATE: 12/05/06
CHK BY:
DATE:
SHT SIZE: B
DWG NO.
REV: C
DO NOT SCALE THIS DRAWING


Phoenix Pneumatic Controls (Generic) Wiring Schematic
EcoWater CHC
Controller
POWER LAMP
COMMON FAULT LAMP
BACKWASH LAMP
COUNTER
Counter
FILTER IN BACKWASH
SUPPLY
COMMON FAULT
CUSTOMER MAX VOLTAGE 110 Vac
MAX CURRENT 5A
PROXIMITY SWITCH
DP SWITCH
RESET BUTTON
NORMAL DP SWITCH (N/C CONTACTS)
HIGH DP SWITCH (N/C CONTACTS)
KEY
BULKHEAD CONNECTOR
BROWN
BLUE
BLACK
ORANGE
RED
WHITE
GREEN
MANUAL B/W SWITCH
PROXIMITY SWITCH
BACKWASH VALVE
INDEXER
+24Vdc
0 Vdc
LOGO! POWER
MCB
CUSTOMER 110/230 Vac SINGLE PHASE CONNECTIONS
L
N
E
INDEX RETURN
* INDEX FORWARD
BACKWASH VALVE OPEN
* BACKWASH VALVE CLOSE
COMMON EXHAUST AIR SUPPLY
PNEUMATIC CONNECTIONS
* DENOTES NORMALLY OPEN
TERMINAL NUMBER
CABLE NUMBER
PIN NUMBER
CABLE COLOUR
DO NOT SCALE THIS DRAWING
ALL DATA CONTAINED ON THIS DRAWING IS EXCLUSIVE PROPERTY OF VRTX TECHNOLOGIES,LLC DUPLICATION OR DISCLOSURE WITHOUT WRITTEN CONSENT IS STRICTLY PROHIBITED.

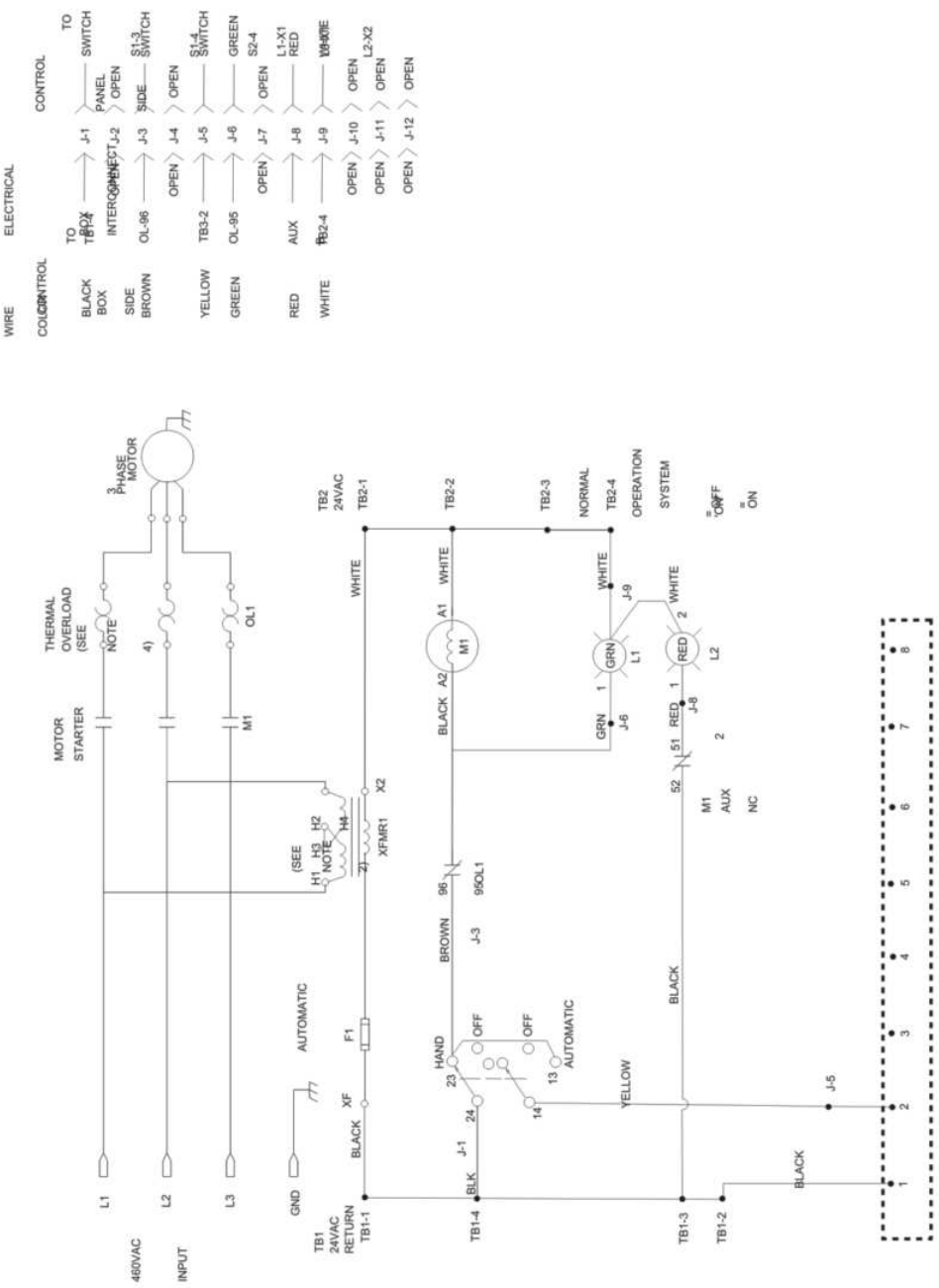

Filtomat Pressure Control and Counter Schematic (Skid with Control Box)
460 V, 3 Phase 60Hz
L1
L2
L3
Primary Fuses
.4
.4
.4 A (x 2)
460V
Transformer
120V
XFMR 100VA
Breaker
1A
Manual BW Switch
BW Inprogress Alarm LED
Filter 1 DP Switch
Filter 1 BW Solenoid
Pressure Regulating Actuator (Optional)
Controller
L N I1 I2 I3 I4 I5 I6
Q1 Q2 Q3 Q4
N 3 4
1 3 4
DWG TITLE
Filtomat TECO Controler
EcoWater C HC
5807 Business Park
San Antonio, TX 78218
ALL DATA CONTAINED ON THIS DRAWING IS EXCLUSIVE PROPERTY OF FBTA TECHNOLOGY. DUPLICATION OR DISCLOSURE WITHOUT WRITTEN CONSENT IS STRICTLY PROHIBITED.
DRN BY: CAS
DATE: 11/08
CHK BY:
DATE:
SHT SIZE: B
DWG NO.
REV C
DO NOT SCALE THIS DRAWING

Cabinet Style CHC (Push ON/OFF) With Modification

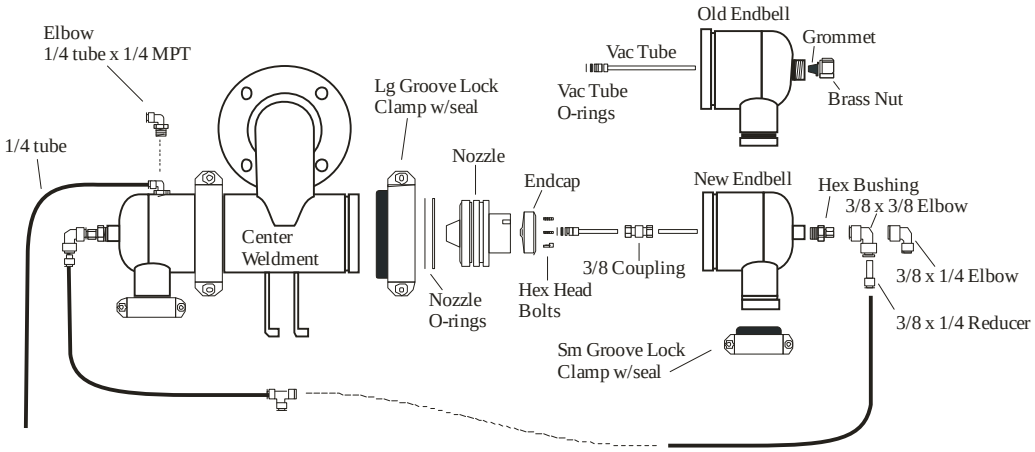




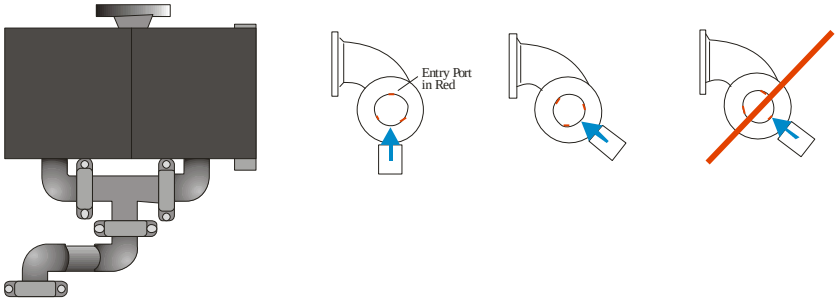
Cabinet Style CHC (HOA Switch)



CHC Chamber Parts and Information



Discharge



Other Reference Materials in file

CHC equipment views with callouts, old and new

CHC operation manual (example)

Corrosion Coupon Analysis

Walchem Conductivity meter (s) operation manuals

ZGF Manuals (all)

Filtomat Manuals (all)

Turbo Disk (looking for)
Forsta Manual

Spears Manual

MSDS sheets for Rydlyme, D5, and Micronice

Spray nozzle worksheet

Power schematics

DP switch procedure