ECOWATER SYSTEMS®
PROFESSIONAL PRODUCTS

CHC

CHC Treatment Systems

A TECHNICAL OVERVIEW
BY CARL STEFFEN

Understanding the Application

In general terms, the CHC technology can be applied to most Cooling Tower Markets. However the markets that contain Cooling Towers are actually quite numerous and different.

Definition: A cooling tower is any tower that uses water to cool a heat load. That heat load can be contained inside of the tower, as in an Evaporative Condenser or Fluid Cooler, or it can be external to the tower, as in applications of a tower within a HVAC or Process cooling environment. Normally the tower is constructed in such a manner so that it takes full affect of evaporation to cool the water contained within. This cooler water is then used to remove the heat from the heat load.

As evaporation occurs the solids in the water are left behind in the tower water, similar to the solids that are left behind in a boiling pot of water on the stove. As the level of solids increase in the cooling water, the likely hood of the solids plating out (creating scale) on a heat transfer surface increase. Since the majority of the water is lost in evaporation, all cooling towers incorporate a Makeup water source to replenish the water that has been evaporated. A form of Blow Down is also used to minimize the solids concentration in the cooling water. As the highly concentrated water is removed from the system, it is replaced by Makeup water with a lower solids content.

Traditional Treatment Methods

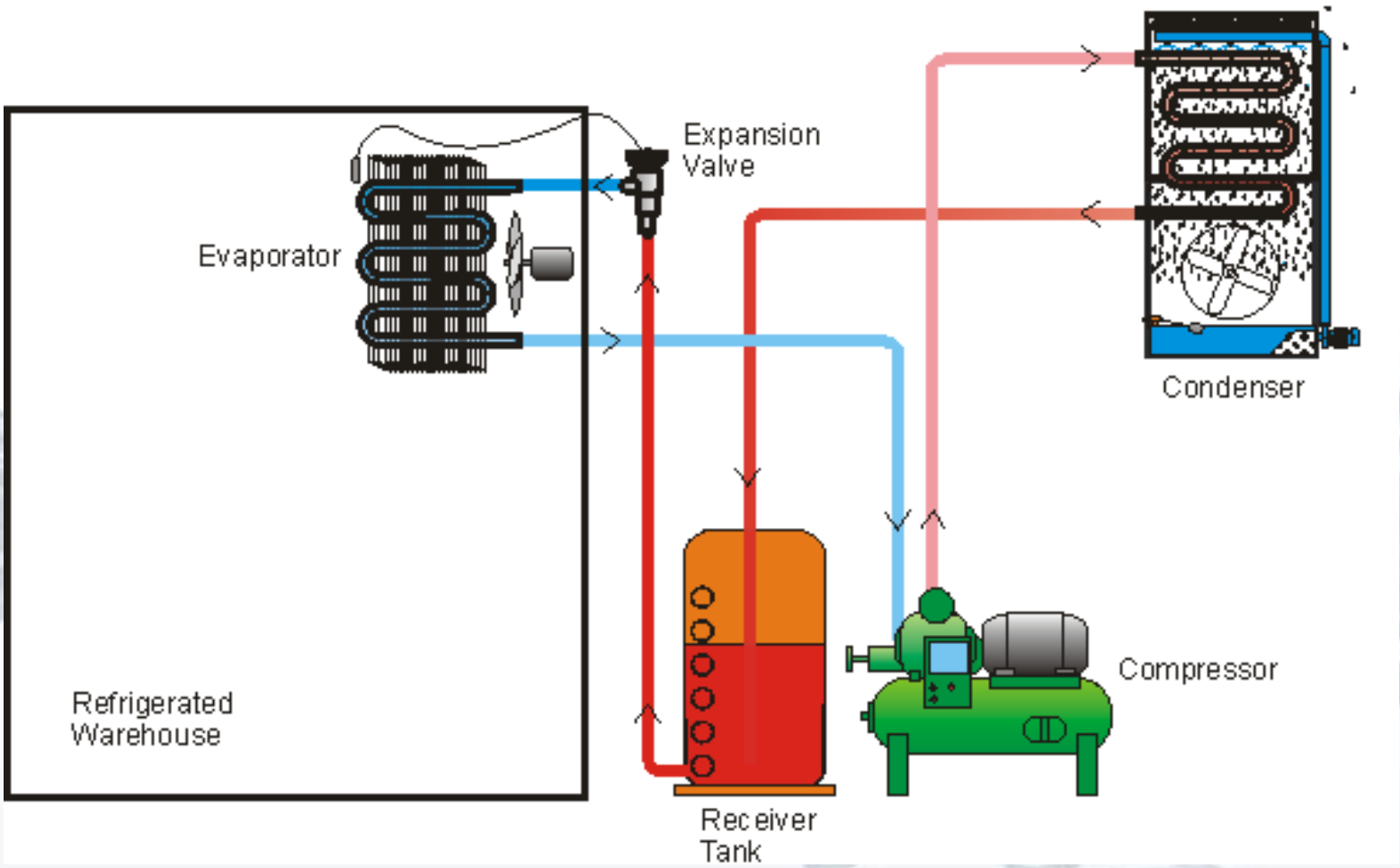
- Traditionally, Chemical Water Treatment has been used to make sure the water's chemistry is within Tower manufacturer specifications. Chemical Water Treatment normally consists of some form of scale inhibitor as well as some form of Biological control.
  - This level of control requires:
    - Oversight by a proficient Chemical Treatment Professional
    - Monitoring of the level of solids concentration by a Conductivity Monitor. This monitor is also used to control the blow down of the tower water to keep concentrations within tolerance.
    - Application of a Corrosion Inhibitor to control the corrosivity of the cooling tower water.
    - Application of a Scale Inhibitor to control the Scaling tendencies of the water.
    - Routine changes in Biological Controls, so that biologics do not become accustomed to control method.
    - Possible use of Acids and other chemicals that requires special personnel protection.
    - In most cases the tower blow down water is laden with Chemicals, and must be monitored to meet strict and ever changing municipal water treatment requirements.

The CHC Treatment Chamber

- EcoWater's Patented technology is a controlled method of harnessing the power of Hydrodynamic Cavitation without it being destructive to the system.
- The CHC chamber is a mechanical water softener
- The CHC chamber creates aragonite crystals of calcium reducing the waters tendency to scale.
- The CHC chamber tears apart biologics in the water stream from the heat created by the collapse of the Cavitation bubbles as well as the shear pressures created within the chamber. This method of control, the biologics cannot become accustomed to.
- The CHC chamber strips CO2 from the water, raising pH and reducing corrosivity.
- All CHC systems incorporate a measurement of Conductivity and blow down control.
- All CHC systems incorporate a filtration system to remove the created crystals and other collected tower debris.
- You cannot over treat the tower with CHC Treatment.
- Normally, no personal protection equipment is required.
- Blow Down water can be used for alternate water uses.
- All CHC systems incorporate a Remote Monitoring system to help ensure appropriate operation.
- No oversight required by Chemical Treatment Professionals

Refrigeration

Basic Refrigeration require some type of refrigerant (Freon or Ammonia) to cool a refrigerated area. The basic flow starts in a high pressure Receiver Tank and then up to an Expansion Valve were the liquid refrigerant is turned into a gas. As the gas passes through the Evaporator, it extracts the heat from the refrigerated area. That heated, low pressure gas then returns to the Compressor and is pressurized and sent up to the heat exchanger inside of a Condenser. As the gas is cooled down is starts to become a liquid and is returned to the Receiver, where it starts again.



Evaporative Condensers

Critical Items:

Heat Exchanger- should be clean and not scaled.

Deep Rust- If rust is too bad, the life of the tower and or heat exchanger may be shortened.

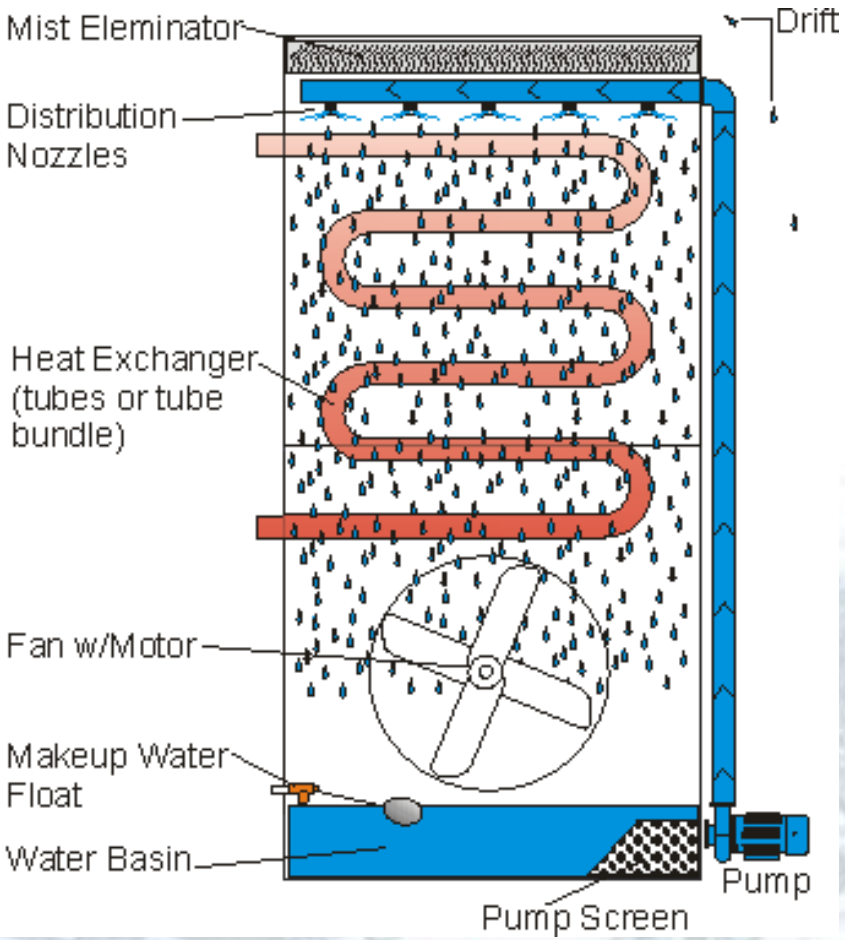
Pump- Needs to move water without vibration or defective bearings.

Distribution Nozzles- The nozzles must be free flowing and pass water to all areas of the tubes.

Pump Screen- Should be cleaned as needed to allow adequate flow to the pump.

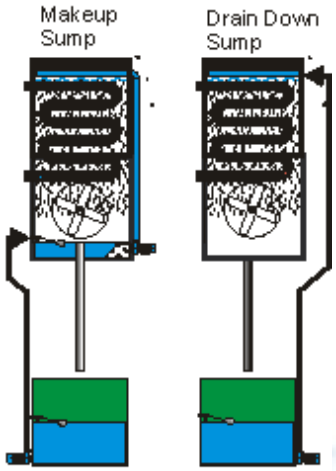
Makeup Water Controls- Should be monitored and adjusted as needed. If the valve does not allow adequate water flow, the system may fail. If it leaks then too much water can enter the basin and then pass to the overflow, lowering cycles.

Cycles Must Be Controlled- If cycles of concentration increase too high the water within the system can become scale forming and or corrosive.



There are several other items you need to understand when working with Condensers:

Sumps- Some customers have chosen to use a sump with their condenser. There are two types of sumps. And it is very important that you identify which type the customer has.



Makeup Sump- The construction of this type of sump, uses the water in the sump as make up water for the condenser. An overflow pipe is installed in the condenser so that an excess water in the basin flows back to the sump. The recirculating pump is present on this type of application. If power to the sump pump is turned OFF, water will remain in the condenser basin. In this type of application the EcoWater CHC device will normally treat the condenser water.

Drain Down Sump- The construction of this type of sump replaces the makeup and pumps on the condenser with those on the sump. The pump on the sump passes water directly to the distribution nozzles at the top of the tower. If power to the pump is turned OFF, the water in the condenser will drain down to the sump. In this type of application the EcoWater CHC device will normally treat the sump water.

Load and Sizing- A single sump can be used on a single tower or on multiple towers. The sizing of the EcoWater CHC unit must account for all of the water in the system (including the sump and piping to and from the condensers). Normally the load is calculated by the size of the condensers being used.

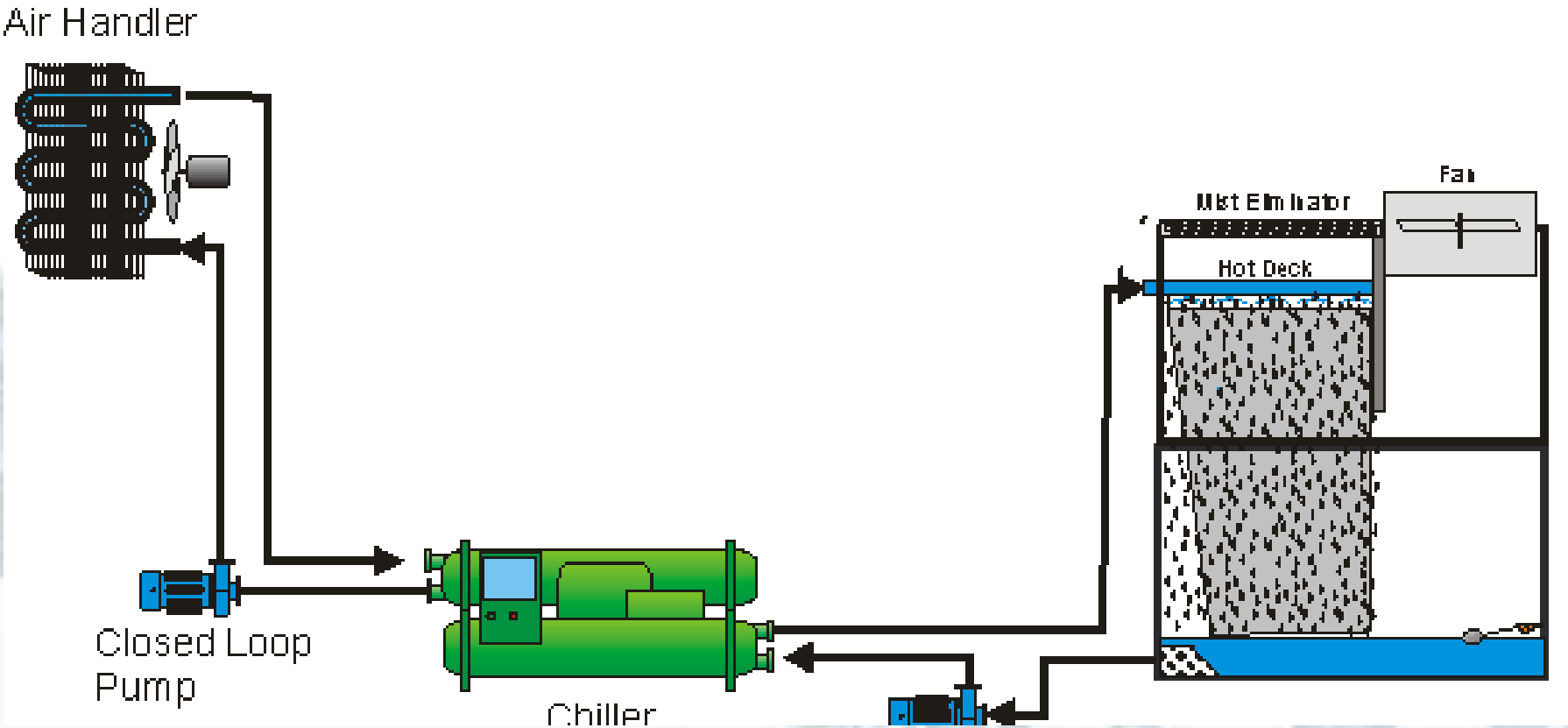
Condenser Usage- Whenever there is water in the condenser it is important to treat it with the EcoWater CHC device. Some customers may only use the system on weekdays and not on the weekends. In these applications, Special modes of operation can be used to cycle the treatment system OFF and ON to conserve energy. However in colder climates, the customer may drain the condensers and sumps, and in that environment, the treatment system will be turned off and drained as well.

Multiple Condensers and or Sumps- When a customer has multiple condensers, a single treatment system may be applicable for the treatment of the water in all towers as long as there are close proximity, and the water heights are the same. Some applications may require multiple treatment systems. If you have multiple sumps, you will need multiple treatment systems.

Head Pressures- The customer may reference their Head pressure as a term that identifies the operational health of their refrigeration system. Too low of a head pressure (normally below 100 PSI) and they are cooling the refrigerant too much and too high of a head pressure (usually above 250 PSI) and there is a problem with the condenser heat exchanger not removing enough heat (scaled tubes or plugged distribution nozzles), or the load is too high or the Condenser is too small.

HVAC Applications

fall of water in the cooling tower, by slowing down the water, evaporation is improved and cooler water is achieved in the tower system.



- The parts of a HVAC Cooling tower are very similar to the parts of an Evaporative Condenser.
- The concerns are basically the same.
- When the application incorporates the uses of a Chiller or other heat exchanger, the Approach temperature is very important. The approach temperature is an indicator used to judge the performance of the heat exchanger. If the approach temperature is low (below 5 degrees), the heat exchanger is doing its job at imparting the heat into the Open Loop water. If the approach temperature increases above 8 degrees, this is normally an indication that scaling or fouling has occurred within the exchanger and should be addressed.
- The owners of both types of towers are required to conduct standard maintenance on both to maintain efficiency.

Other Types of Towers

Fluid Coolers- Used in process cooling of water that is used in some other process. This type of tower incorporates a heat exchanger directly into the tower, similar to that of an Evaporative Condenser.

(Smaller HVAC systems, Process cooling for Manufacturing….)

Process Cooling- Similar to a standard Cooling tower, this type of application cools water that is passed to an external heat exchanger.

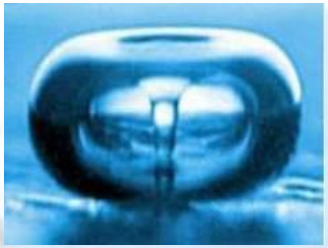
(Metal Fabrication, Plastics, Other Process Cooling for Manufacturing…)

Cavitation

- Cavitation

cav.i.ta.tion \ kav' i ta' shun \ n [1. the rapid formation and collapse of vapor pockets in a flowing liquid in regions of very low pressure.

Metal Destruction from Uncontrolled Cavitation

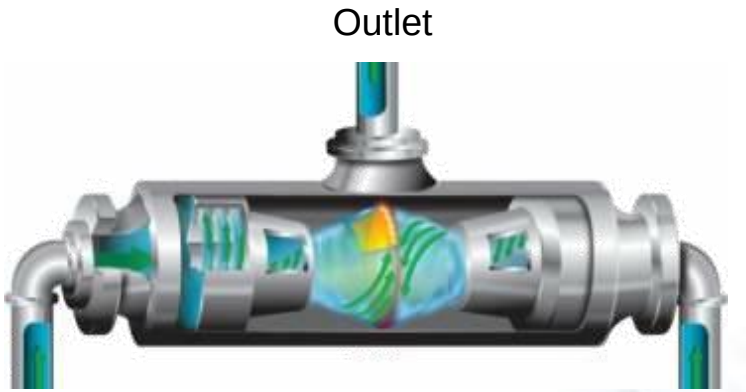


Microjet

CAVITATION BUBBLE COLLAPSE

CHC Chamber Design

CHC nozzle design & geometry controls the flow of liquid to achieve desired results without damage to nozzles or chamber housing.



The Chamber in Action

CHC Scale Control

Cavitation Zone Chemistry

Notes:

1.Chemical treatment tries to keep hardness in solution. CHC removes hardness from the water.

2.Chemicals maintain delicate balance between scale control and corrosion

Implications

Note:

1.With CHC, you cannot over treat.

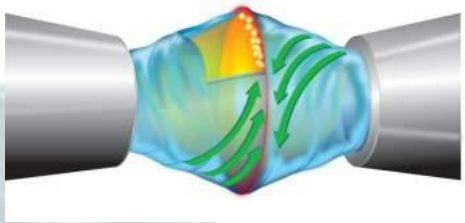
CO_2 Stripping: High-vacuum exceeds partial-pressure of CO_2; CO_2 is vented

Hardness Removed: As CO_2 vents, reaction shifts right, soft, powdery $CaCO_3$ precipitates and is filtered :

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$$

Dissolved — Precipitate 2 — Gas (vented)

CHC Corrosion Control



Water Molecules Disassociate from cavitation events oxidants formed

$$H_2O \rightarrow 2H^* + OH^*$$

$$OH^* + OH^* \rightarrow 2H_2O_2$$

Prevents microbiologically induced corrosion

Slightly Elevated pH creates a corrosion-inhibited solution

$$H_2CO_3 \longrightarrow H_2O + CO_2$$

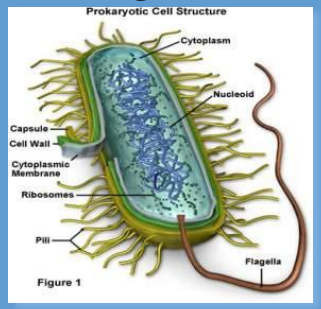
Carbonic Acid — Gas vented

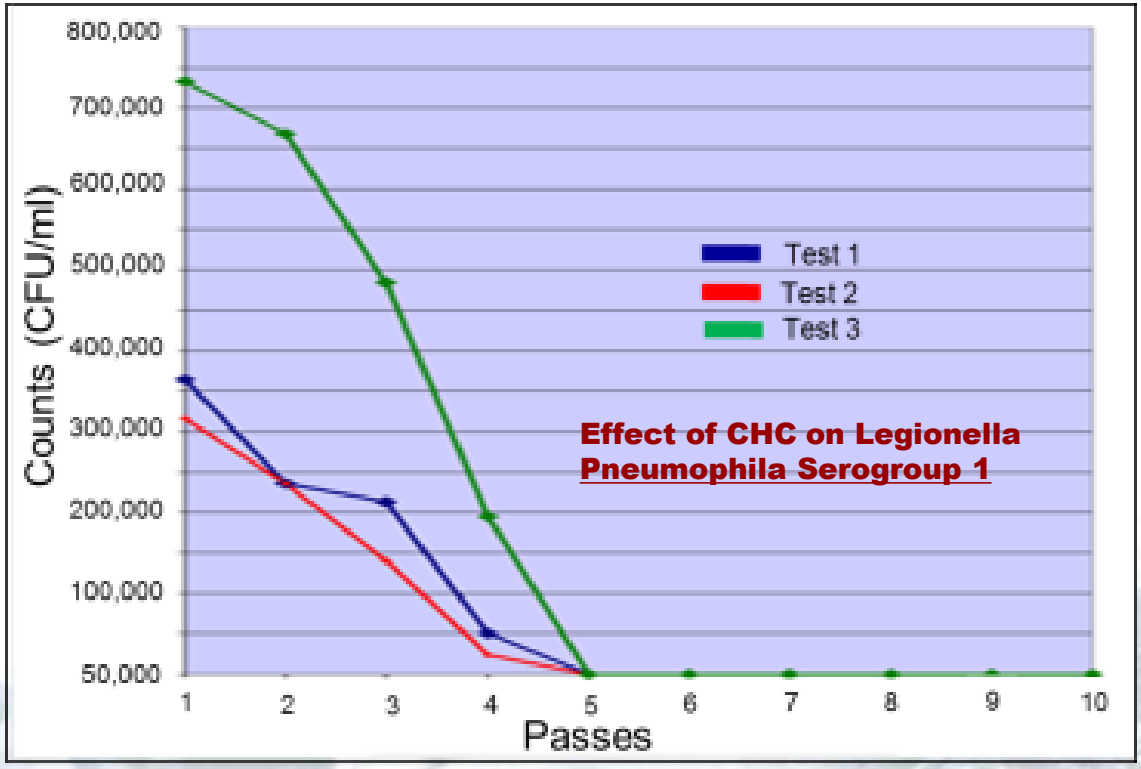
Biological Control Using CHC

Kinetic Energy Generated by Bubble Collapse

1. Microjet Collapse
2. Dramatic Pressure Changes
3. Mechanical Sheer Stress
4. Localized High Temps
5. Pressure Waves

Kinetic Energy Destruction of Biologics



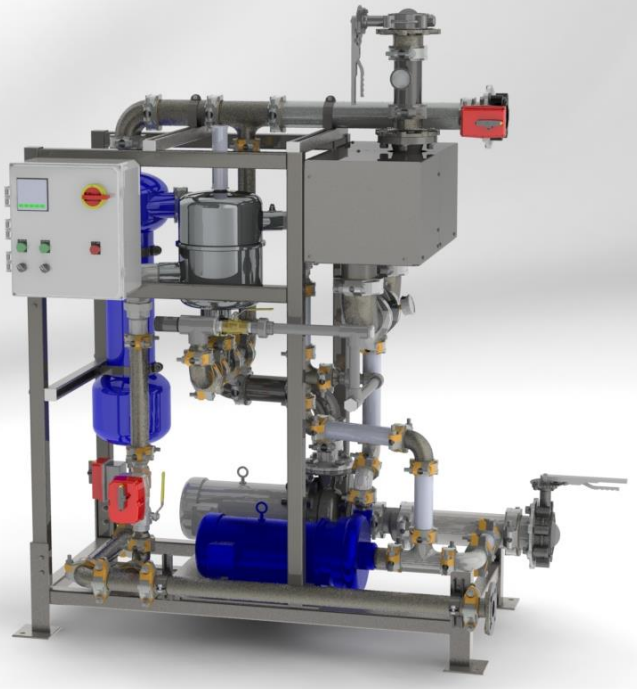


Data from Merican Sciences, J Usher and G. Hatchhroft and Principle Consultant Alan Edwards C.Chem MRSC from Alan Edwards and Partners, UK

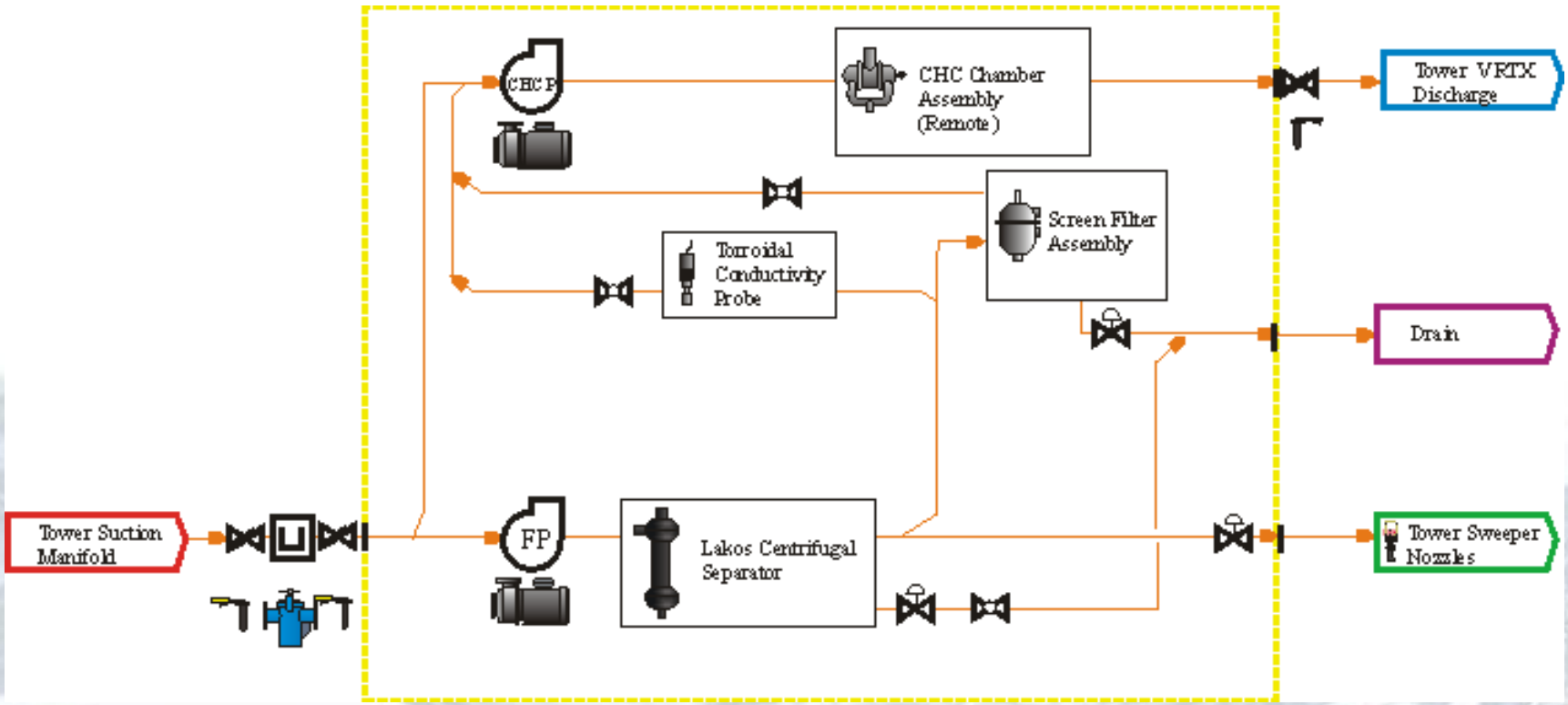
****Biological Cells Do Not Build Tolerance to CHC****

CHC Systems Breakdown

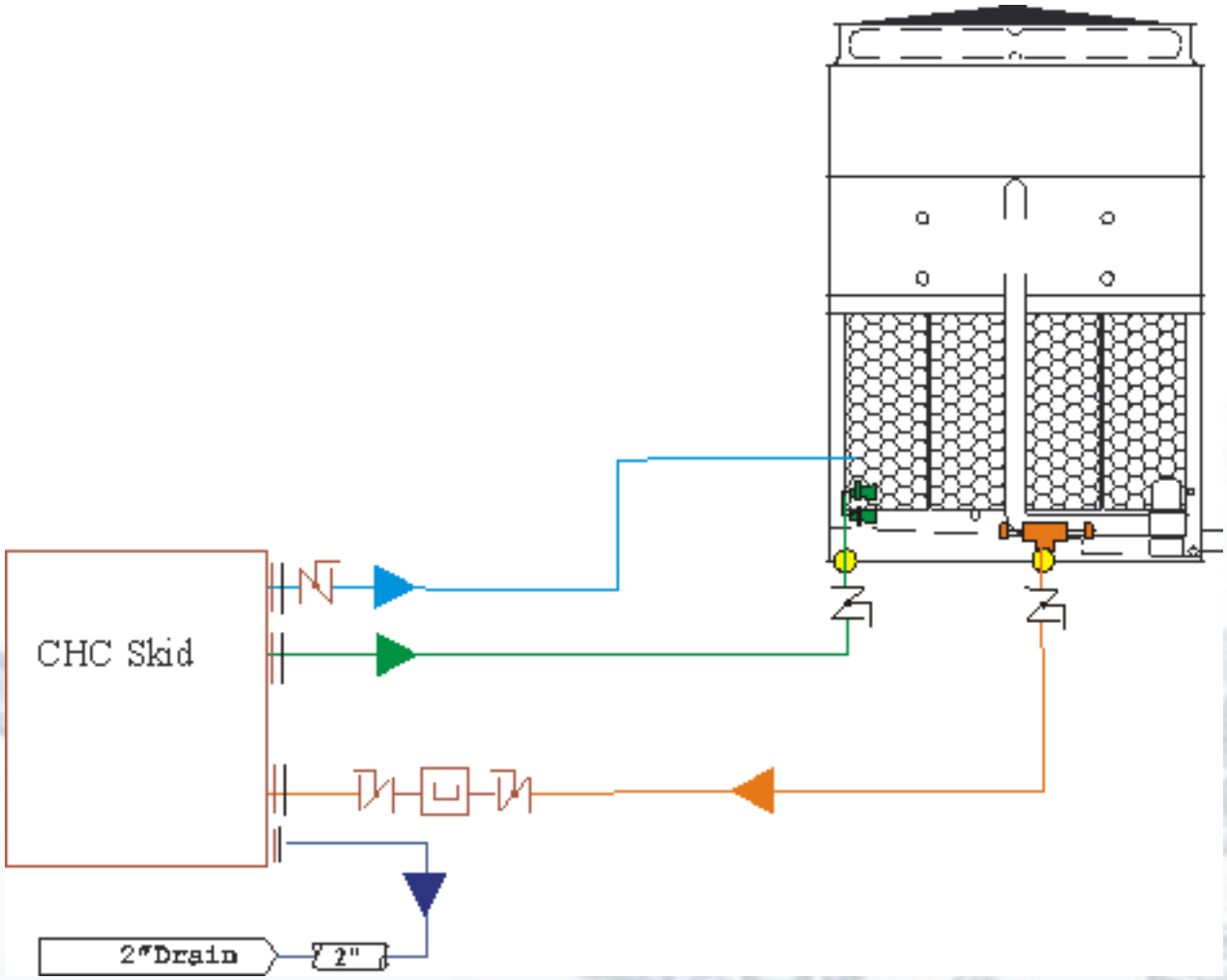
- CHC Treatment
- Filtration
- User Interface
- Conductivity Control
- Tower Interface (Sweepers, Suction Manifolds)
- Alarm Monitoring
- CHC Insight (Remote Monitoring)
- Options to meet customer Needs



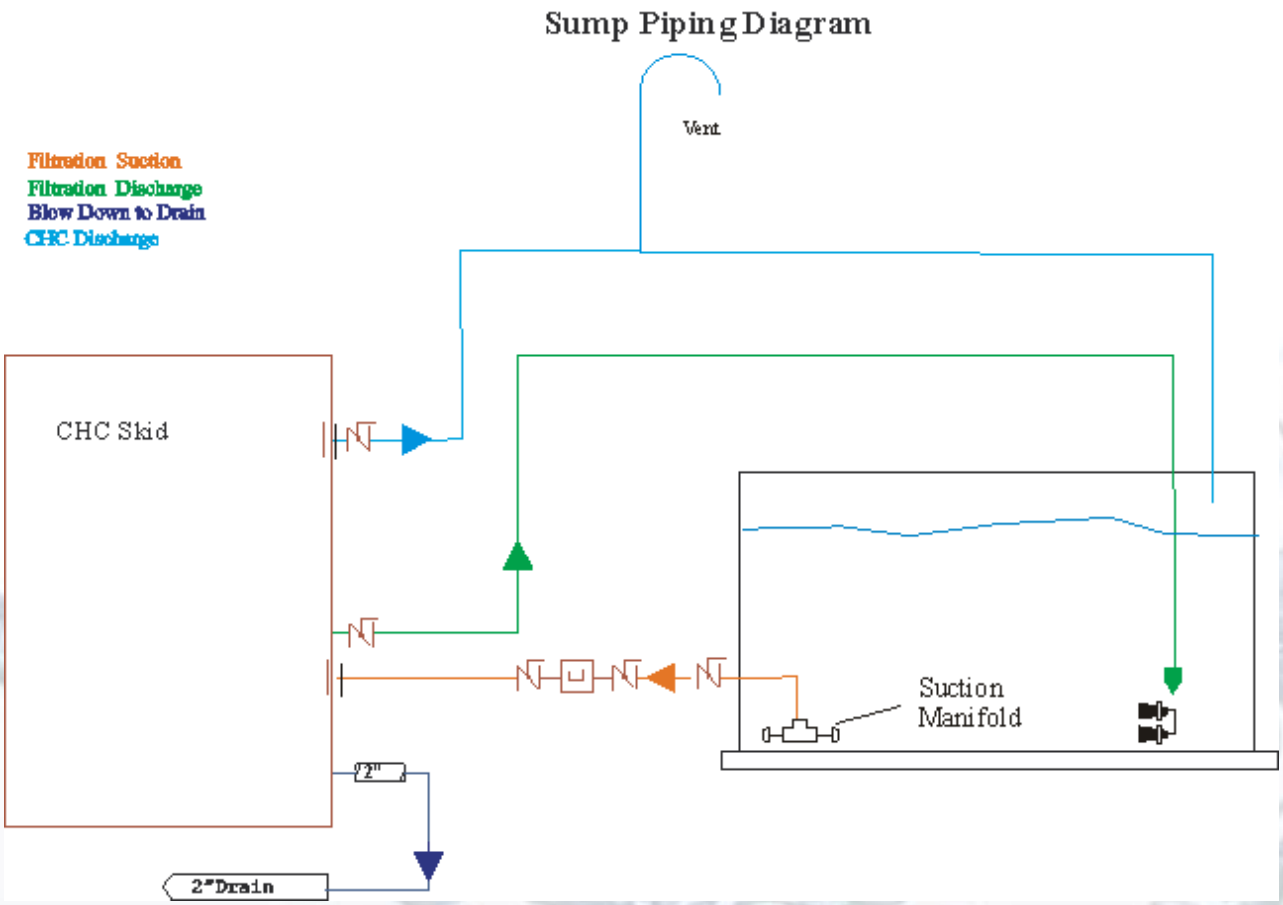
Skid Flow Diagram



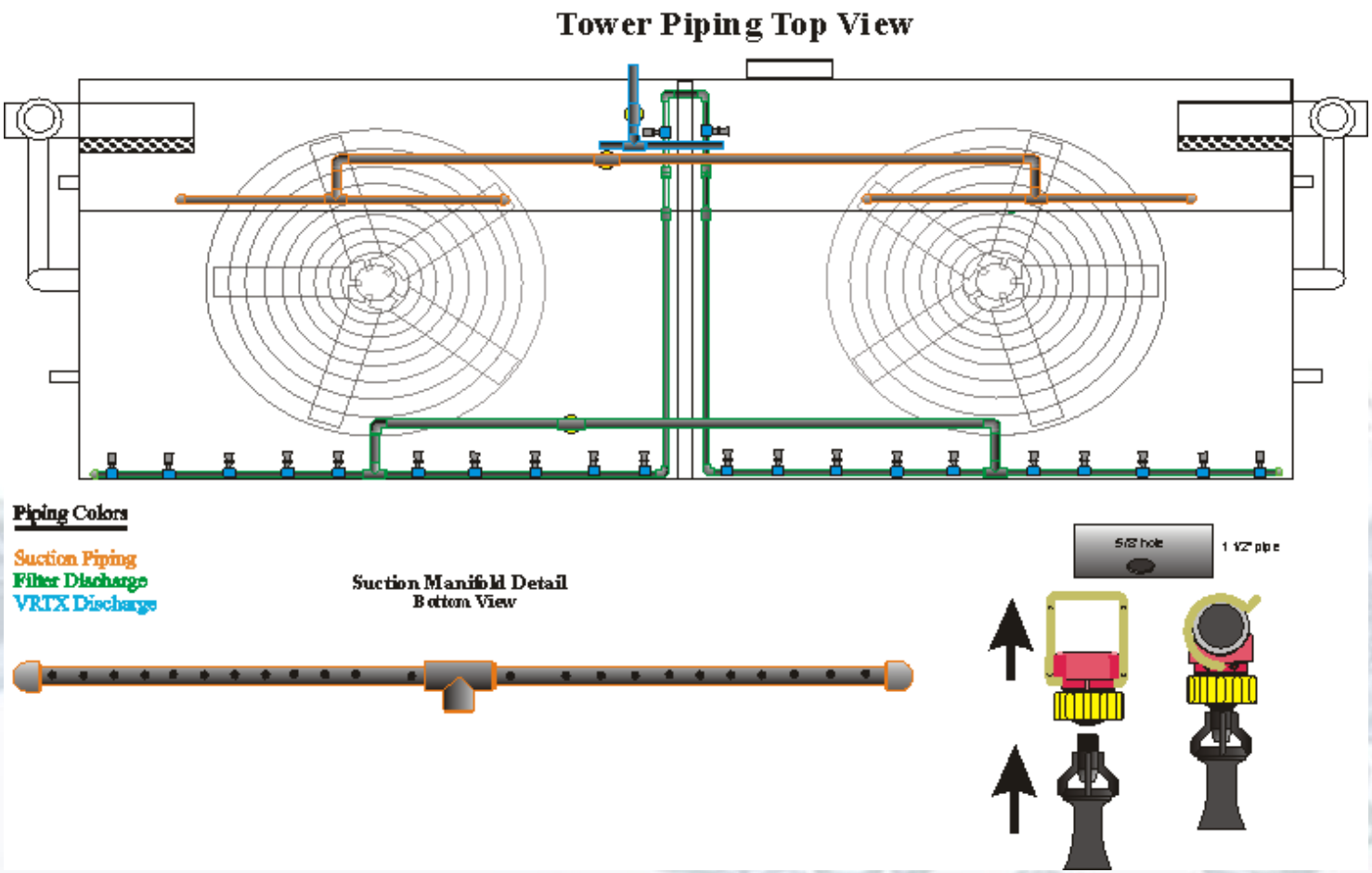
Typical Tower Application



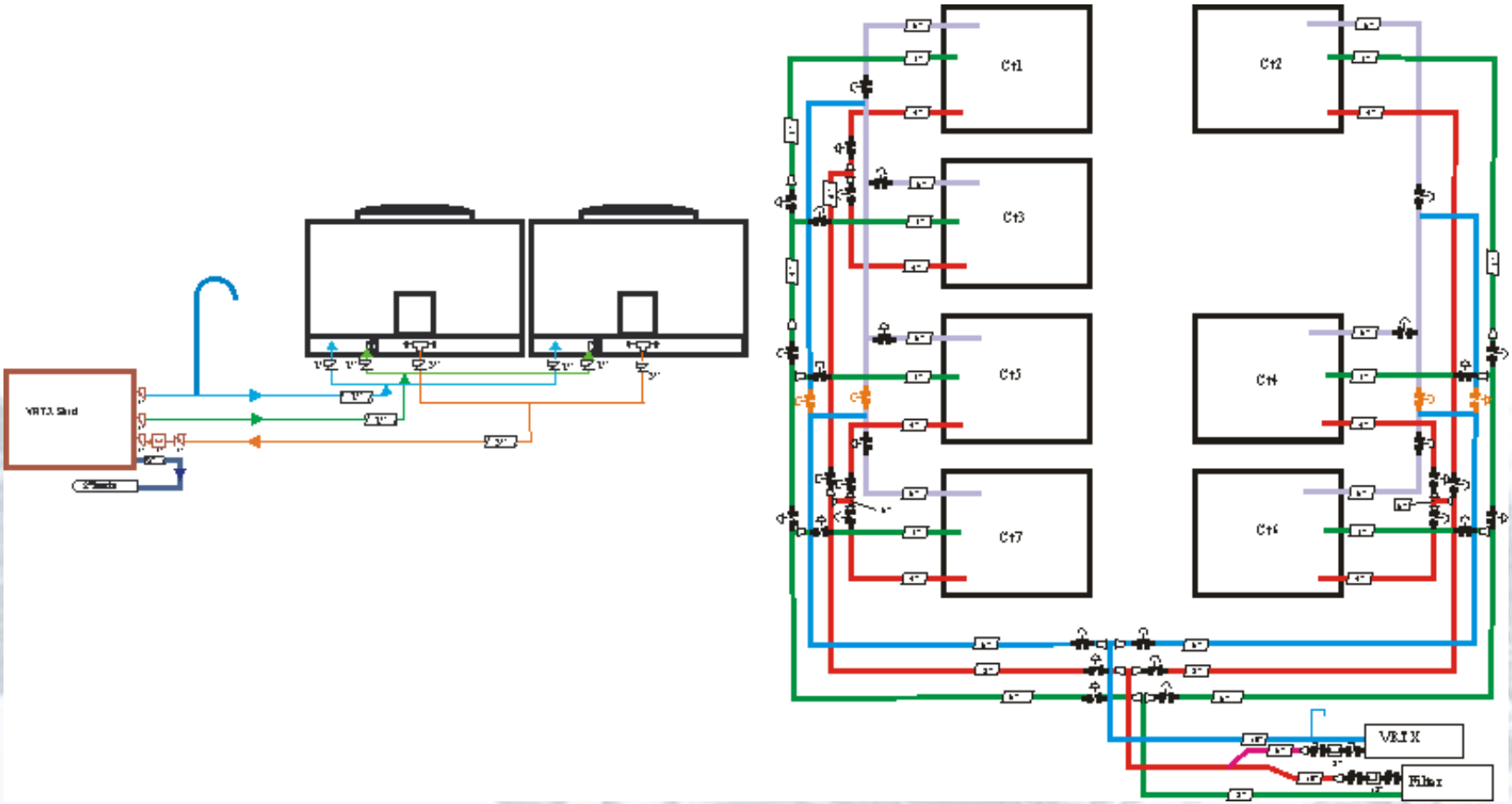
Typical Sump Application



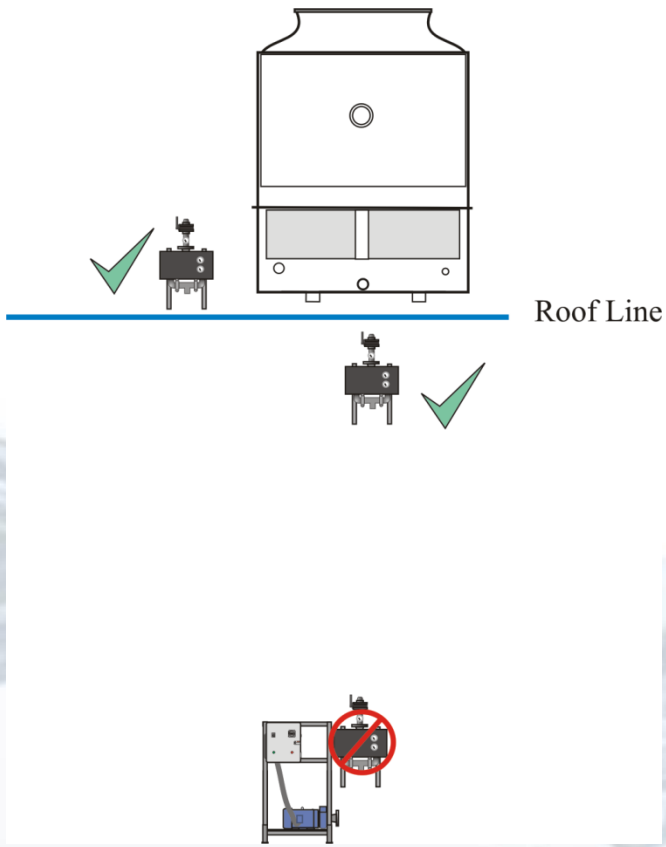
Tower Piping

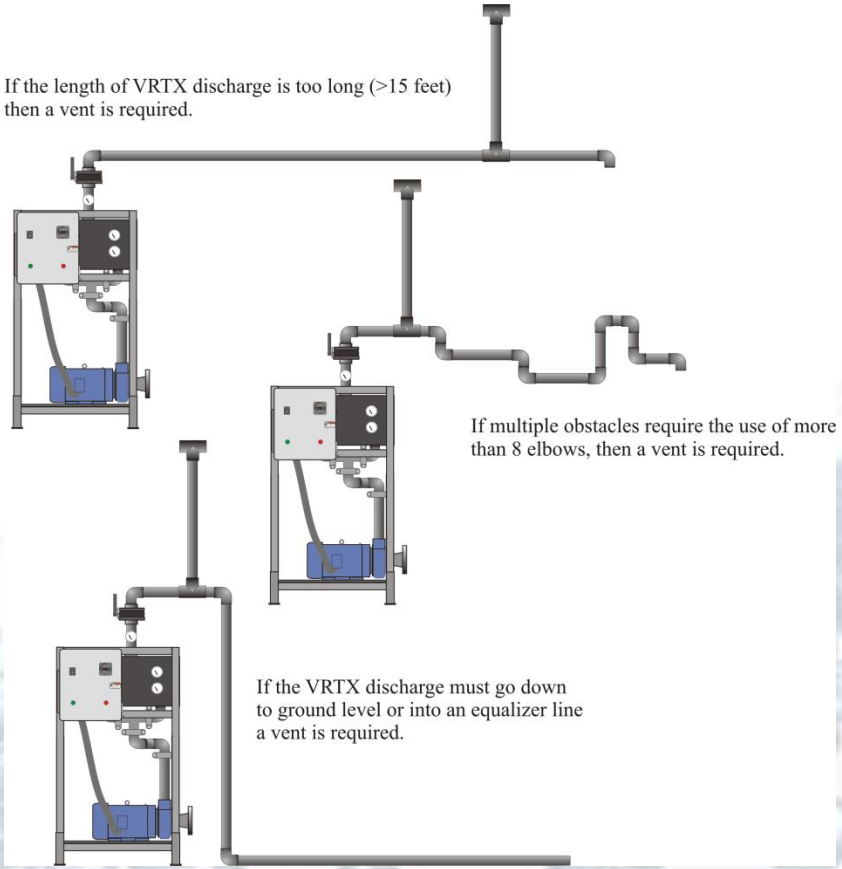


Multiple Tower Installations



Installation Notes





Filtration

Ever since CHC was first installed on HVAC and Refrigeration systems, we have realized the importance of filtration.

Since the CHC system creates solids, and since Towers and Evaporative Condensers are great at scrubbing debris from the air, debris control has been very important to us.

Debris in a cooling system can reduce the efficiency of the system, cause failures in system operation, require periodic service to keep the tower(s) clean, creates health concerns with regards to the control of bioligics as well as just looks bad.

Filtration – Lessons Learned

- Cooling tower debris consists of Heavier and Lighter than water particles.
- You can't just filter water, you have to be able to remove debris.
- Automated filtration is essential to the success of a system. Instead of replacing a Bag or Cartridge, replace the filter.
- Not all Centrifugal Separators are Created Equal.
- Not all Automatic Screen Filters are Created Equal.
- Sand Filters waste water and are problematic.
- You must control Conductivity and ensure its calibration.
- You must monitor the filter back wash and alert to problems.
- Many systems are generic filters and not designed for the cooling tower application.
- Use pressure transmitters, not DP switches, less hassle, more accuracy, and they allow for better system monitoring and control.

What Does a CHC Filter Look Like and Why

- Our filter systems utilize two filtration elements, a centrifugal separator for the removal of heavier than water particles, and an automated screen filter for the removal of lighter than water particles.
- Our filter systems utilize PLC controls to improve performance and monitoring capabilities.
- Our filter systems integrate conductivity and blow down control (with selectable Duty Cycles) to unify our offering. Continued Water Analysis enables us to pick settings to maximize Cycles of Concentration throughout each year.
- We chose to utilize Toroidal conductivity sensors to maximize accuracy and reduce customer service requirements.
- We chose to utilize Hayward strainers to protect the pump and minimize customer service requirements.
- We chose to use the best pan sweepers available and then pioneered sweeper systems that maximize debris removal.
- We invented a suction manifold that removes debris while allowing low operating water levels. We pioneered it usage to protect the tower screen from debris clogging.
- We invented zoned filtration “CHC Wave Technology” that enables us to maximize debris removal, while minimizing the energy needed to do so.
- We have standardized on Remote Monitoring (CHC Insight) to give us insight into the health of our treatment systems.
- We design installations with the possible customer’s usage of their cooling system, in mind.
- Our filtration systems are skid based to reduce installation costs and complexity.

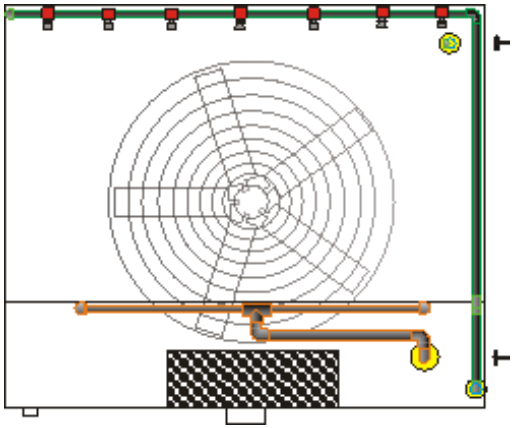
Filter Application Notes

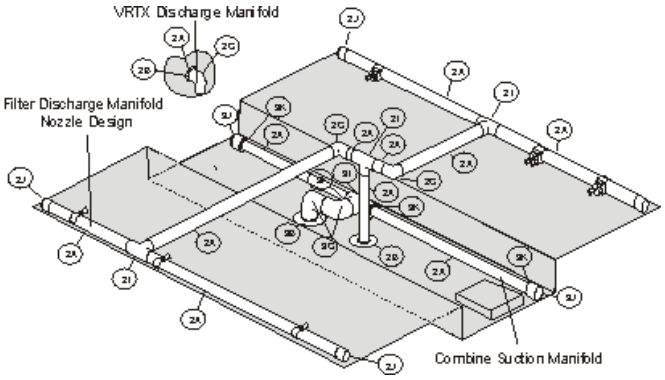
- Sweeper Nozzles
- Suction Manifold Technology
- Patent Pending CHC Wave Technology
- Single tower applications
- Multiple tower applications
- The Do's and Don'ts of installation design
- The Commissioning process
- CHC's Aids and Promise to your successful design

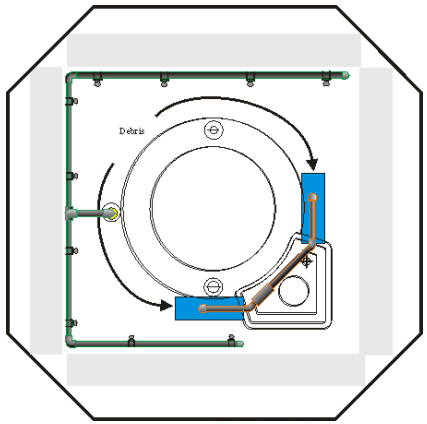
Sweeper Nozzles and Suction Manifolds

- EcoWater CHC utilizes eductor nozzles. These nozzles range from 3 GPM to over 50 GPM per nozzle and increase the actual sweeping flow by using a venturi effect.
- Sweeper piping is designed to enhance normal water flow in towers.
- You must understand where in the tower the debris loading originates from, to be able to design appropriate nozzle array designs.
- Sweeper jets are chosen to match overall basin square footage and distance debris must be moved.
- Adjustable clips are available for 1 ½" and 2" PVC piping and the smaller sweepers (smallest three sweepers can utilize clips).
- Larger nozzles will thread directly into pipe or fittings.
- Sweeper array designs must move debris towards the suction manifold.
- Sweeper array zones (CHC Wave Technology) can enhance the debris movement process.
- Suction Manifolds are always designed to protect the tower screen.
- Suction Manifolds are sized depending upon the flow rate of the CHC treatment system
- The holes of the Suction Manifold always face the basin floor.
- The Suction Manifold should be constructed to be self supporting and allow for servicing.
- The Suction Manifold must be placed in the tower between the Tower Inlet Screen and the debris load.

Examples of Sweeper Arrays and Suction Manifolds

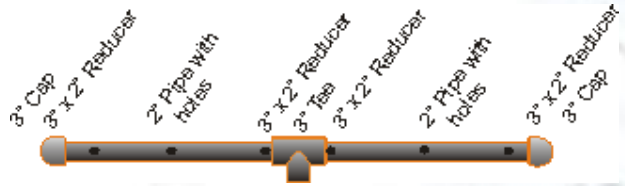


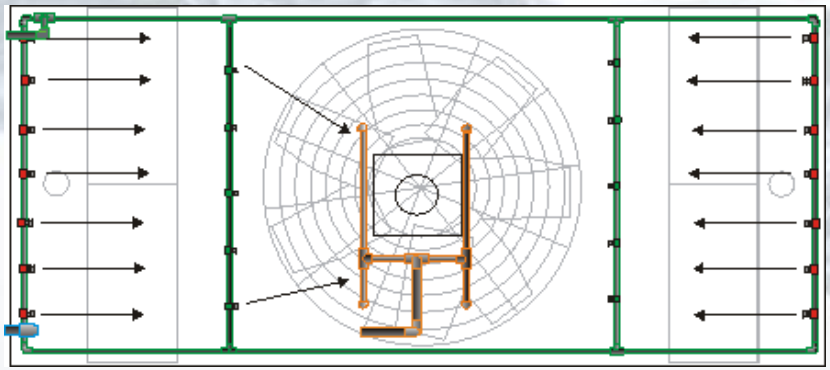


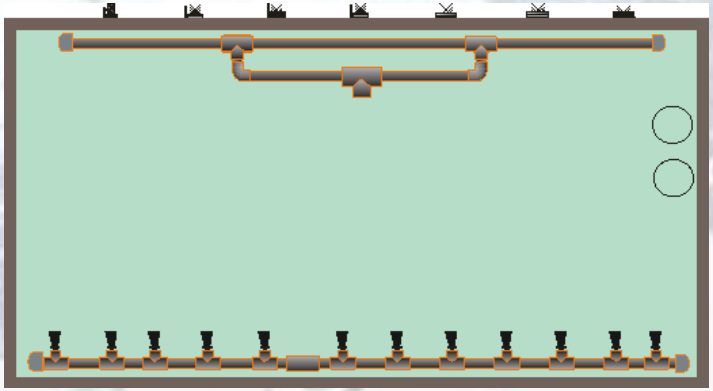


Clips for 1 ½" or 2" piping. Clips available for three smalles sizes.

Eductors utilize MPT threaded inlets.







Treatment System Piping

- EcoWater CHC has designed single as well as multi tower installations.
- Sump installations are very similar to tower installations.
- The installation must take into account the yearly usage of the system by the customer. CHC recommends the use of balanced piping runs to help ensure equal treatment to multiple towers.
- We recommend that the suction penetrations be under water level, however, check valves can be used when needed. Other connections can be below or above water level as needed.
- CHC recommends that suction piping flow rates be within 5-10 feet/second whenever possible to help keep debris moving.
- Equalization pipes should be utilized in your system design whenever possible.
- Each tower or sump connection should include isolation valves.
- Consider the work flow around the towers when designing your plumbing or positioning the treatment system.
- Use vents for the CHC discharge as needed.
- Remember you have to consider mounting options for the skids.
- CHC likes multiple towers at the same height, but may be installed on towers of differing heights when needed.
- With multiple tower installations, the CHC discharges must be kept at the same height to allow for equal flow.
- With roof top tower installations, see if the equipment can be placed in a mechanical room downstairs, if possible visibility of the treatment system by customer personnel is improved.
- Freeze protection must be considered.
- Serviceability of equipment must be considered.

The Do's and Don't

The Design of the installation is very important, if the designer, designs a system on bad information, then the installation will not succeed.

CHC offers installation examples as well as custom installation designs for your application.

The CHC system offers many options and benefits that are very beneficial to the customer and may help close the deal.

EcoWater wants our partners to be successful and we have made this information as well as oversight by our engineering group available to help ensure your success.

Effectiveness of the CHC Treatment system requires the buy in of the customer to do their required maintenance.

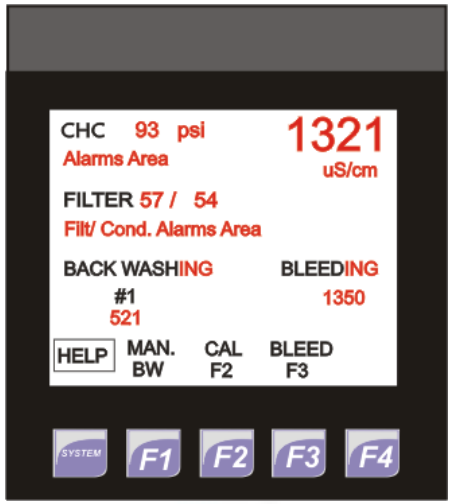
Commissioning and Supporting Materials

- Each CHC installation (Conducted by CHC personnel or 3rd party Mechanical Contractors) is inspected against our Commissioning Process. This process helps guarantee that the installation was conducted against the original design as well as verifies the quality of construction.
- CHC offers Supporting Material (OP Manuals, Videos, Daily Check Sheets, ….) to our customers upon the completion of their system training and commissioning. These tools are made available to our partners as references for their use as well.
- CHC reserves the right to make changes to these resources as they become available.
- CHC tries to train all shifts of personnel at the customer site during commissioning, this helps ensure that appropriate system awareness is reached.

Other CHC Offerings

- CHC Control Station
- Communication Options
- Remote Monitoring
- Power Saver Mode
- Water Reuse Options- Irrigation options
- Optional Parameter Monitoring
- Optional Meter Integration

CHC Control Station (CCS)



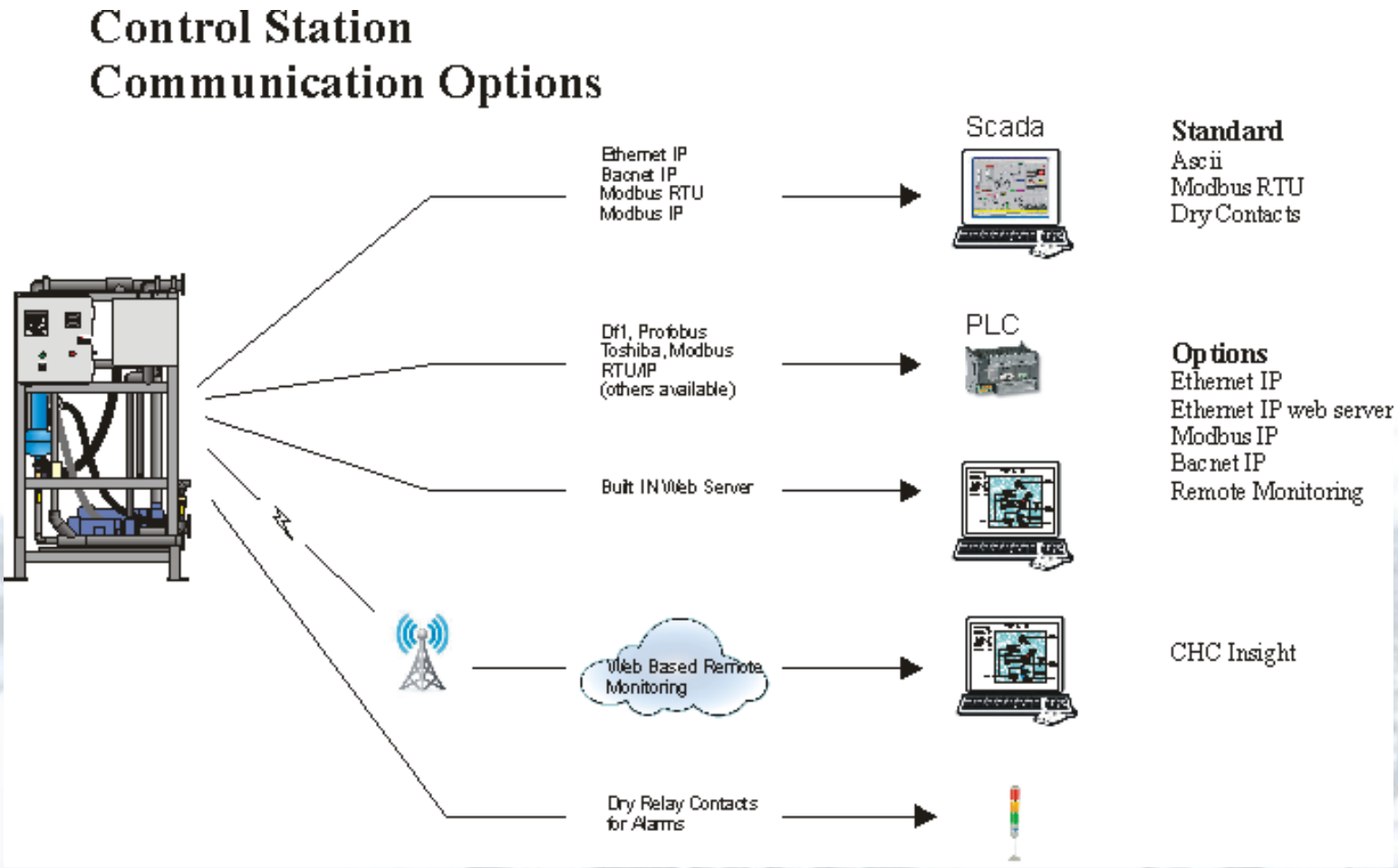
EcoWater realized early on that Filter Controllers and Conductivity Controllers are not created equally. Many filter controllers did not include provisions to monitor or control backwash efficiency. Most Conductivity Controllers were created for chemical treatment and thereby were not easy to use. So CHC created our own control system, the CCS. This system integrates SYSTEM monitoring and control into one platform with the customer in mind.

Its all-in-one design, simplifies troubleshooting, creates a simple uniform user interface across many languages as well as units of measure. It was created with a Cooling System in mind....

It is supported with a single unified code that was constructed to meet the needs of several different types of filter systems, measurement parameters and control algorithms. With a build in micro SD card, software upgrades are simple, alarms/measurement logs are easily retained.

The CCS has also been constructed with the OEM in mind. The initial Company logos and help numbers can easily be changed to meet your companies needs. To learn more about the CCS, refer to the CHC Control Station Technical Manual.

Communication Options



CHC Insight -Remote Monitoring

- Web based Remote Monitoring Solution
- Based on GSM cell modem technology.
- Interfaces directly with a CHC Specialist, via Email alarm notifications 24/7/365.
- Multiply tear construction allows Customers as well as their management to see sites assigned to them.
- Simple visual system constructions allow users to quickly determine system operational condition as well as historical trending. Its user interface allows for standard as well as optional parameter monitoring without a confusing display.
- It allows modification to CHC PLC from Corporate.
- It allows for historical trending and information download as seen fit.
- It is made to grow……

Required Service

- Customer Responsibilities:
  - Maintain Routine Tower Maintenance
  - Verify Operation of CHC Equipment
  - Clean Basket Strainers as needed

- EcoWater CHC Responsibilities:
  - Monitor System Operation via CHC INSIGHT
  - Check System Operation and Calibration (On-Sight)
  - Grease Pumps (minimum 2 x per year)
  - Verify Motor Amperage (minimum 2 x per year)
  - Verify System Operation through Water Samples
  - Monitor Biological Growth with Dip Strips
  - Verify Customer doing their part.

Perfect Service

- When conducting service at a site, it is important to have an interaction with the customer before arriving.
  - Call ahead and schedule the visit. Request time with the appropriate personnel to discuss their CHC treatment.
  - Understand any concerns they may have.
  - Verify if there are any new customer maintenance personnel that require training.
  - Verify they have been receiving the Reports and Water Analysis from the last visit.

- Once you arrive, you will be verifying the following:
  - Is the customer conducting their required service (Cleaning of the Basket Strainer)
  - Overall condition of the skid and piping (look for leaks, loose bolts, broken piping)
  - CHC System Condition upon arrival (System ON? Any Alarms? Current Conductivity?)
  - Presence of CHC Sound?
  - Gauge operation (Turn the pumps OFF and ON and verify the pressures change).
  - Pressure Sensor operation (Turn the pumps OFF and ON and verify the pressures change).
  - Verify Calibration of the Conductivity Meter using Hand held meter.
  - Verify the operation of the Blow Down Valve with water flow to Drain.
  - Verify the operation of the Auto Screen Filter Back Wash, Actuators function with water to Drain.
  - Take makeup water samples and tower water samples for shipment to EcoWater.
  - Complete your check sheet, identify the type of verification that was made (Repair, Maintenance Verification, or Mechanical)
  - Send your samples to EcoWater CHC and fax or email your report to: Email to steffenc@ecowater.com, Fax to 210-910-6528

  - At least 2 x per year the pumps will require grease.
  - At least 2 x per year the Amperage draw on the three legs of each pump will require readings.

  - When you find a failure you will troubleshoot and repair problems as specified by EcoWater CHC Service Personnel.

Troubleshooting

- Troubleshooting problems depend upon the problem.
- The first troubleshooting tool, is contact with your EcoWater CHC Service Personnel for guidance.
- A Troubleshooting Guide and other documentation has been provided on the CD for your reference.
- Some problems will require immediate attention, while others can be repaired on your next scheduled visit.
- EcoWater CHC will provide parts for those accounts having a maintenance agreement.
- Compensation will be determined upon the agreed schedule amounts.

Notes: