

# Technical Information for Cooling Towers Using Recycled Water



*San Diego County  
Water Authority*



# Technical Information for Cooling Towers Using Recycled Water

## INTRODUCTION

### WHY USE RECYCLED WATER?

In today's highly competitive markets, businesses and institutions must make wise use of available resources. Increasingly the most forward-thinking companies are partnering with local utilities to reduce their demands for energy and water, both to save costs and improve the long-term sustainability of their business.

Using highly treated recycled water for non-potable purposes is an effective way to reduce the demand for precious fresh-water resources. It is also a recognized green building practice. Recycled water has been used in industrial settings throughout California and the arid west for nearly 100 years.

Locally, Biogen Idec, a company specializing in the development of therapeutic products for the medical field, worked with the County and City of San Diego in 2006 to convert their cooling towers to recycled water. The cooling towers at Biogen Idec are the largest users of water in the facility. Conversion to recycled water has allowed Biogen Idec to realize significant cost savings through discounted rates and has provided Biogen Idec with a drought-proof source of water.

Elsewhere in Southern California, Orange County's Irvine Ranch Water District provides recycled water for cooling tower and toilet-flushing use in over 40 high-rise office buildings. Los Angeles County's West Basin Municipal Water District delivers service to the cooling towers at Cal State Dominguez Hills and the American Honda Campus.

In Riverside County, Inland Empire Utilities Agency's headquarters building secured 52 LEED® points to achieve Platinum Certification from the U.S. Green Building Council. Among these points was credit in the "Innovation and Design Process" category because of indoor recycled water use.

There is approximately 13,000 acre-feet of recycled water reused annually within the San Diego County Water Authority (SDCWA) service area. Roughly 70% of the recycled water is used for agriculture, landscape irrigation, and other municipal and industrial uses. The annual beneficial reuse of recycled water in San Diego County is projected to increase to over 53,000 acre-feet by the year 2020.

By converting to recycled water, cooling tower customers can secure a drought-proof water supply that can protect future growth potential even when water supply shortages loom. Converting to recycled water enhances overall water use efficiency and helps customers comply with their green building goals.

### PURPOSE OF THIS GUIDE

The purpose of this guide is to provide information tailored specifically for customers planning to use recycled water in evaporative cooling tower applications.

Evaporative cooling systems, which don't need potable water, are a good use of recycled water. By focusing on water quality and optimizing system control, customers can reduce their demand for potable water without compromising the performance of their systems. SDCWA has published this document to assist customers, who are considering converting to recycled water by providing detailed information on water quality and system management together with cost saving potential.

For additional information or questions concerning water recycling, contact the SDCWA's recycled water information line at (858) 514-1720

## OPERATIONAL ROAD MAP TO CONVERTING COOLING TOWERS

The steps for establishing an operational regime for a cooling tower are outlined below. These steps can be performed by the system owner or, as is often the practice, by its maintenance contractor.

**Step 1:** Determine the materials used in the cooling system and the temperature, flow rates and hours of operation. By understanding these factors, system owners can narrow the list of water quality constituents that cause concern. For example, if a system contains 304 SS, chloride levels are an important concern. However if the system is constructed of fiberglass, this water quality parameter is less of a problem.

**Step 2:** Evaluate the source water quality in order to understand if treatment is necessary to make the water compatible with your system materials.

**Step 3:** Select a treatment system if source quality is problematic.

**Step 4:** Establish the desired cycles of concentration to minimize water and chemical use, without compromising system performance. While pretreatment can condition water to acceptable standards, each cycle of concentration will increase the TDS, Conductivity and Chlorine concentration in the water and at some point, these constituents will affect system performance. This point limits the cycles of concentration and establishes when blowdown should occur and make-up water added. The system manufacturer's recommendations for conductivity and system performance with respect to TDS will likely be the limiting factors on cycles of concentration

**Step 5:** Potable water back-up is necessary. This will provide increased reliability and assist with blending during conversion.

**Step 6:** Monitor Makeup and Blowdown water quality to confirm that the system is behaving as anticipated.

**Step 7:** Reset chemical dosing and/or cycles of concentration as necessary to achieve desired performance.

# 1

## COOLING SYSTEM BASICS

These guidelines focus specifically on evaporative cooling units. Due to the nature of evaporative cooling units, water lost from evaporation and blowdown has to be replenished. In regions where potable supply is plentiful, cooling towers use potable water for making up the water losses in the cooling tower. However, as California's water supplies are increasingly constrained, businesses and institutions can consider converting to recycled water to supply the makeup water.

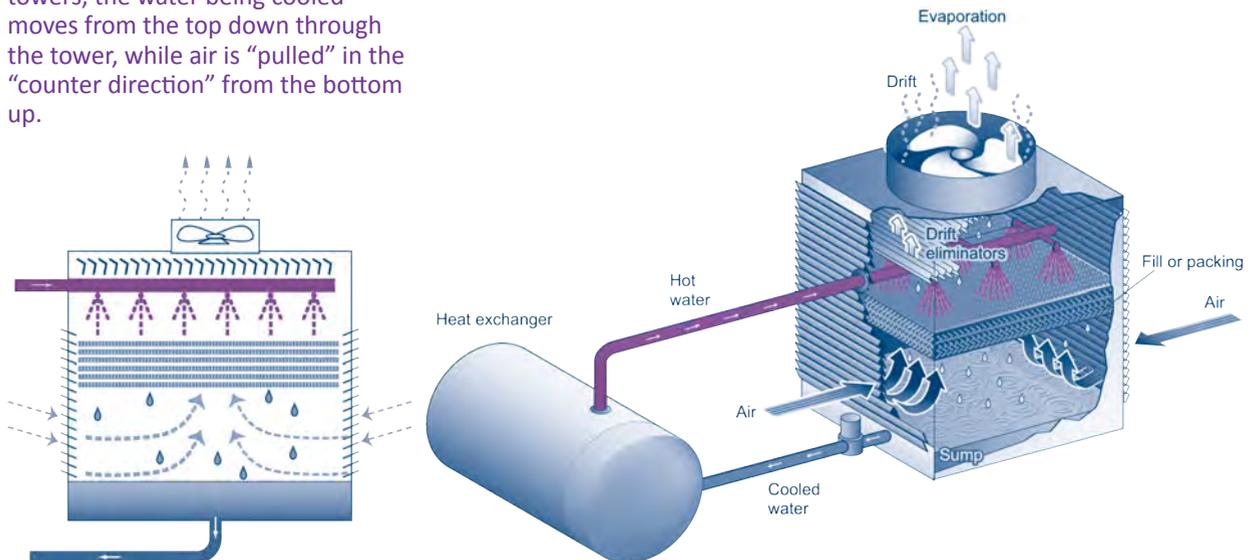
### EVAPORATIVE COOLING SYSTEM OVERVIEW

Evaporative cooling systems are composed of two components: a heat exchanger (chiller) and a cooling unit (cooling tower). The heat exchanger or chiller allows cooling water to transfer heat from production source (facility equipment or fluids) without direct contact, creating heated water. The main purpose of the cooling tower is to expel the heat from the heated water efficiently. Heat is removed by transferring it to air through evaporation. Cooling tower packing material or fill optimizes the contact of air and water, improving the heat transfer and efficiency of the tower. Splash and film fill types are the two types of packing materials inside the cooling towers.

The figures below illustrate evaporative cooler configurations.

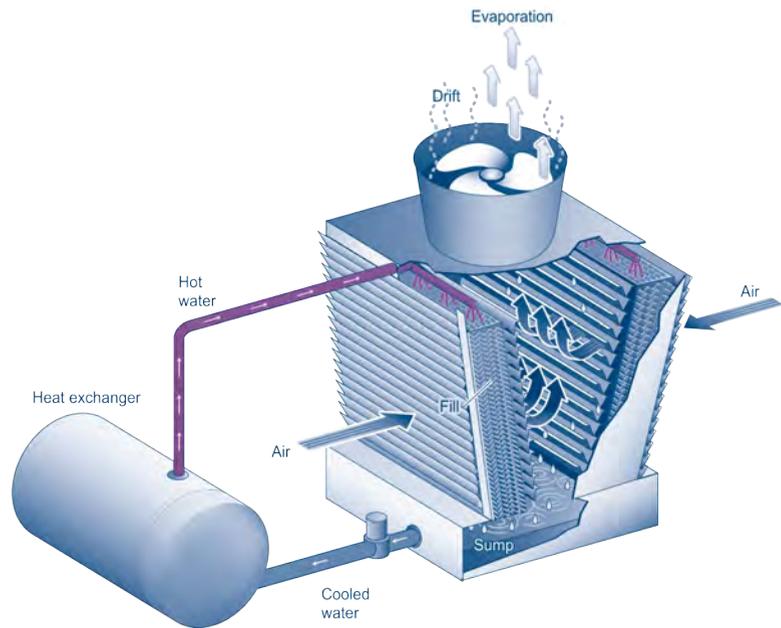
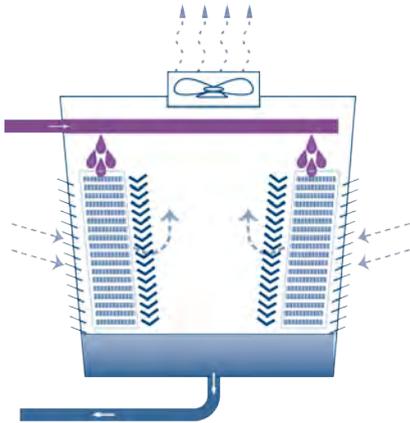
### COUNTER FLOW INDUCED DRAFT COOLING TOWER

In counter flow induced draft cooling towers, the water being cooled moves from the top down through the tower, while air is "pulled" in the "counter direction" from the bottom up.



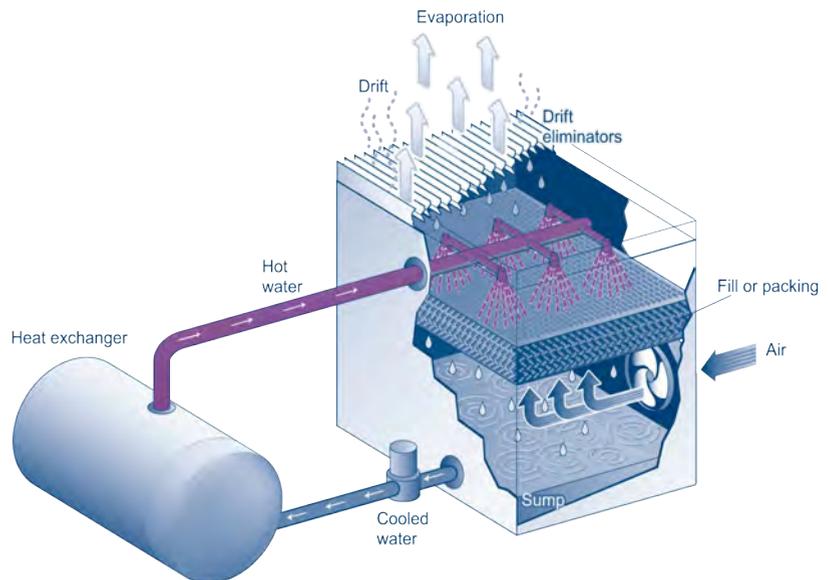
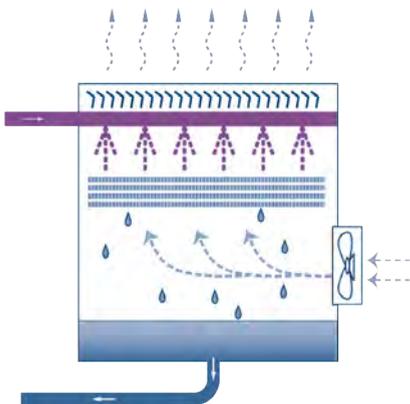
## CROSS FLOW INDUCED DRAFT COOLING TOWER

In cross flow induced draft cooling towers, the water being cooled moves from the top down through the tower, while air moves “across” the water flow and then out the exhaust. Air is moved by fans, blowers or natural draft.



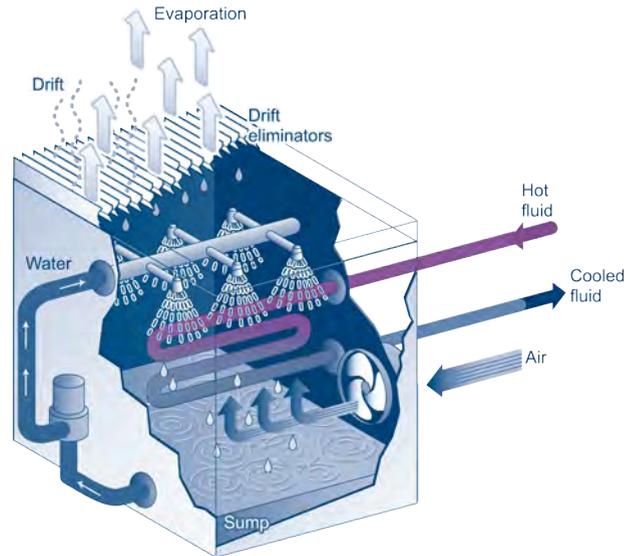
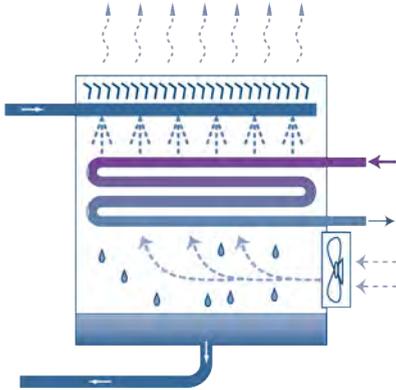
## FORCED DRAFT COOLING TOWER

In forced draft cooling towers, air is “pushed” through the tower from an inlet to an exhaust. Downward direction for movement of the water being cooled is shown here.



## EVAPORATIVE CONDENSER COOLING TOWER

In evaporative condenser cooling units, the fluid that removes heat from the process is kept isolated from the water used for evaporative cooling. The cooling water is never circulated to the process it cools. Some systems use condensable fluids as refrigerants for transferring heat.



Because the cooling system relies on evaporation, the total dissolved solids in the cooling tower water are concentrated. In a well-designed and operated cooling tower, even with a good water quality control system, a portion of this water in the cooling tower is constantly flushed to make sure that solids buildup does not damage the equipment. This “blowdown” water is replaced with new “makeup water” that has lower dissolved solids concentration.

The combination of evaporation, blowdown and makeup creates the cooling tower water demand and it is this demand that can be served by recycled water.

## WATER USE IN COOLING TOWERS

### EVAPORATION

The purpose of a cooling tower is to expel heat from water to the air by evaporation. As a general rule of thumb, for each 10° F that the water needs to be cooled, one percent of the cooling water is evaporated.

Depending on the cooling needs, the evaporative water demand can be substantial.

The table on the right provides an example of the water used to achieve 10° F, 20° F, and 30° F changes in temperature.



**Cooling Tower Evaporation at 10° Intervals**  
At 1,000 GPM Circulating Rate\*

Temperature Reduction	Water Evaporated		
	Per Minute	Per Day	Per Year
10°F	10 gal	14,400 gal	5,256,000 gal
20°F	20 gal	28,800 gal	10,512,000 gal
30°F	30 gal	43,200 gal	15,768,000 gal

\*System operates 24 hours/day, 365 days/year

## **MAKEUP WATER AND BLOWDOWN**

All water has some concentration of dissolved or suspended solids. When water evaporates, as it does in a cooling system, the dissolved solids are left behind increasing the concentration in the remaining water.

Concentrated solids can build up in the form of scale and cause blockages or corrosion to the cooling system materials. Also the growth of algae and other biological matter can lead to corrosion, plugging of film fill, and eventually collapse of film fill. Water treatment can reduce the impact of the solids and biological matter, however, after a certain point impurities become too concentrated and solids and biological matter must be removed from the system to avoid serious damage.

To stay below this maximum acceptable concentration and to maintain the tower's water balance, fresh makeup water is added and concentrated blowdown water is discharged. The maximum acceptable levels for solids and biological matter are site specific and depend on both local water quality and cooling tower construction.

## **CYCLES OF CONCENTRATION**

A cycle of concentration occurs when the water balance of evaporation, makeup water and other losses concentrates solids by multiples of the makeup water. For example, when the solids concentration in the cooling tower water has doubled that of the makeup water, it is described as two cycles of concentration. When the solids concentration in the cooling tower water is triple that of the makeup water, it is described as three cycles of concentration.

Increasing the cycles of concentration is a very common water conservation measure for cooling towers. It can also reduce treatment chemical costs, because when less water is used, fewer pounds of treatment chemicals are required. Determining the optimum number of cycles of concentration is a balancing act between savings in water, sewer and chemical costs and the increased risk of scale, plugging and film fill failure that can occur with water that has higher dissolved solids.

Usually, cooling towers using makeup water with low dissolved solids can be operated at the higher cycles of concentration. Because recycled water typically is higher in dissolved solids than potable water, converting to recycled water for makeup water may require operational changes, including reducing cycles of concentration to manage the different quality of recycled water.

# 2

## WATER QUALITY CONSIDERATIONS

Matching the cooling system materials, design, and operation with water quality allows users to develop the water treatment program and operation cycles that meet their needs. It is not the water source, but the effect the water source's constituents have on the cooling system that matters. Protecting the cooling system is the first priority.

Optimizing the performance of the cooling system requires:

- ◆ Evaluating the cooling system to determine the materials that can be affected by water quality
- ◆ Evaluating the water quality constituents
- ◆ Evaluating the water treatment options
- ◆ Establishing the treatment and operational cycle regime for the system

### EVALUATING THE COOLING SYSTEM

Matching the cooling system materials, design, and operation with the water treatment program and water quality is essential for protecting the cooling water contacted equipment. Thus, the water quality within the cooling system will determine what water treatment program should be used.

This table below describes materials commonly found in cooling towers, the affect of water quality on the material, and recommended management considerations.

Cooling System Component Considerations		
Material	Water Quality Effects	Management Considerations
Wood	N/A	Protect from decay or chemical attack.
Mild Steel	Susceptible to corrosion from high total dissolved solids, suspended solids, biomass, scale and heavy metals.	Chemical water treatment minimizes this potential. Increased flow rates and periodic flushing of heat exchangers minimizes this potential.
Galvanized Iron (Cu and Zn coating)	Susceptible to corrosion from high dissolved solids and pH levels below 6.5 or above 8.5.	Reduce cycles of concentration. Adjust pH with chemical treatment.
Stainless Steel 304-SS	Susceptible to corrosion from chlorides when deposit-forming conditions exist.  Biomass deposits can cause rapid pitting.  Corrodes at chloride levels of 200 mg/l when deposit-forming conditions exist.  Tolerates chlorides levels of 1,000 mg/l on clean surfaces.	Chemical water treatment minimizes this potential.  Maintaining a positive oxidant level will benefit the integrity of the protective oxide film on stainless steels and will reduce biomass accumulation.  Nitrates, which occur in higher levels in recycled water, are known to reduce stainless steel corrosion.

Cooling System Component Considerations		
Stainless Steel 316-SS	Similar to 304-SS with higher chloride tolerances.  Tolerates chloride levels of 5,000 mg/l when deposit-forming conditions exist.  Tolerates chloride levels up to 30,000 mg/l on clean surfaces.	Similar to 304-SS.
Copper alloys	Susceptible to corrosion from ammonia and high dissolved solids.  Ammonia above 0.5 mg/l as NH <sub>3</sub> can cause cracking and corrosion and contributes to biomass that can cause corrosion to copper alloy under deposits.  Coppernickel alloys (90/10 and 70/30) are resistant to cracking.	Water treatment can minimize this potential.  Copper corrosion inhibitors such as TTA (Tolytriazole or BZT (Benzotriazole) and BBT (Butylbenzotriazole) reduce but do not totally eliminate cracking. BBT is most effective.  Coppernickel alloys (90/10 and 70/30) are resistant to cracking.
Plastics		Keep clean and free of deposits to prevent clogging. Keep plastic film free of biomass buildup.

## EVALUATING THE WATER QUALITY CONSTITUENTS

All water, regardless of its source contains various constituents at different concentrations. Some constituents can be very beneficial, while others need to be handled by specific water conditioning or chemical treatment. Knowledge and understanding are needed to assure successful water conservation and use. The chemistry of any given source of water will impact the structures and operation of all types of cooling towers. Operations at higher cycles of concentrations increase the potential for equipment scaling, corrosion, and fouling unless some type of treatment is implemented. The table below describes common water quality parameters and their effects on cooling systems.

Impact of Water Quality Parameters on Cooling Systems	
Water Quality Parameter	Impact on Cooling Water System
Hardness (Measure of combined calcium and magnesium concentrations)	Contribute to scale.  Calcium salts exhibit inverse solubility which increases precipitation with water temperature.  Magnesium is troublesome when silica levels are also high and can result in magnesium silicate scale in the heat exchangers.
Alkalinity (Measure of water's ability to neutralize acids.)	Alkalinity is an important means of predicting calcium carbonate scale potential.

## Impact of Water Quality Parameters on Cooling Systems

Water Quality Parameter	Impact on Cooling Water System
Silica	<p>Can produce difficult-to-remove scale deposits.</p> <p>Pretreatment or sidestream filtration is often required if the silica levels are above 150 ppm (as SiO<sub>2</sub>).</p>
Stainless Steel 304-SS	<p>Susceptible to corrosion from chlorides when deposit-forming conditions exist.</p> <p>Biomass deposits can cause rapid pitting.</p> <p>Corrodes at chloride levels of 200 mg/l when deposit-forming conditions exist.</p> <p>Tolerates chlorides levels of 1,000 mg/l on clean surfaces.</p>
Total Suspended Solids (TSS) (Consists of undissolved material such as silt, sand, fine clay, and vegetation.)	<p>Can enter the system with makeup water and can be generated in the system from corrosion and scale byproducts or from air/water contact.</p> <p>Suspended solids can adhere to biofilms and cause under-deposit corrosion.</p> <p>TSS can be controlled through pretreatment, sidestream filtration or through use of deposit control agents.</p>
Ammonia	<p>Promotes biofilm development in the heat exchangers and cooling tower fill.</p> <p>Corrosive to copper alloys at concentrations as low as 2.0 ppm.</p> <p>Combines with chloride to form chloramines which can negate the disinfecting effect of chlorine and some non-oxidizing biocides such as glutaraldehyde.</p> <p>Bromine is a more cost-effective biocide if ammonia is present.</p>
Phosphate	<p>At concentrations of 4.0 mg/l or less and pH is controlled between 7.0 and 7.5, phosphate may provide corrosion protection because it is an anionic inhibitor.</p> <p>At concentrations greater than 20 mg/l, combined with calcium greater than 1,000 mg/l, there is a potential for calcium phosphate scaling.</p> <p>Acts as a nutrient for biofilms.</p>
Chloride	<p>Corrosive to most metals.</p> <p>Limit concentrations to 300 ppm for stainless steel: up to 1,000 ppm for other metals.</p>
Iron	<p>Can combine with phosphate to form foulants.</p> <p>May deactivate specialized polymers used to inhibit calcium phosphate scaling.</p> <p>Recycled water has concentrations over 0.1 mg/l of iron and specialized treatment for iron may be required.</p>

## Impact of Water Quality Parameters on Cooling Systems

Water Quality Parameter	Impact on Cooling Water System
Biological Oxygen Demand (BOD)	Reflects the organic content and associated demand for oxidizing biocide.
Nitrates and Nitrites	Can provide additional mild steel corrosion control at levels above 300 mg/l.  Can contribute to reductions in stainless steel cracking and pitting erosion.  Nitrates do not attack copper alloys or protect them from corrosion.
Zinc	Can assist phosphates and nitrates in reducing mild steel corrosion rates and pitting tendencies.  Levels in cooling water above 0.5 mg/l are beneficial, but levels above 3.0 mg/l can contribute to deposits.
Organics	Acts as fertilizer for microorganisms.  Water-soluble cationic polymers can react with some anionic treatment biocides, as well as some scale and corrosion inhibitors.
Fluoride	At 10 ppm or more can combine with calcium to cause scale formation.
Heavy Metals (e.g. Cu, Ni, and Pb)	Copper and nickel can plate out on steel, causing localized galvanic corrosion that can rapidly penetrate thin steel heat exchanger tubes.

## EVALUATING WATER TREATMENT OPTIONS

Cooling tower water treatment can be both chemical and physical. New physical treatment systems based on electromagnetic energy are presenting opportunities to manage cooling tower water quality without dependence on chemical systems. Because of CDPH's requirements for biocide addition to recycled water used in cooling towers, combined systems that use physical treatment for corrosion and depositional control and chemical treatment for microbiological control can provide an effective "hybrid" system.

### CHEMICAL TREATMENT

It is most common for chemical treatment programs to be used for controlling corrosion, deposition, and microbiological growths. Prior to installing a chemical treatment system, or introducing a new chemical treatment agent, contact your local fire department's hazardous materials unit for regulatory, reporting, and permitting requirements.

#### *Corrosion Control (Inhibitors)*

Corrosion is an electrochemical process in which metals are oxidized by transferring electrons from an anodic site to a cathodic site. Cathodic inhibitors reduce the amount of cathodic surface available and anodic inhibitors reduce the amount of anodic surface available. Sometimes both types of inhibitors are needed to prevent corrosion. Phosphates, zinc salts, molybdates, and polysilicates are typical mild steel corrosion inhibitors, while organic nitrogen-based compounds (azoles) are copper alloy corrosion inhibitors.

## Deposition Control

Several different types of deposits can form in cooling water systems, necessitating different approaches for control:

- ◆ Depositional Inhibitor Control focuses on either solubilizing agents to prevent scale from precipitating or crystal modifiers to alter the nature of precipitate to prevent adhesion to surfaces.
- ◆ Dispersants and Surfactants are charged molecules that adsorb suspended solids and cause a mutual repulsion, which keeps solids as smaller particles.
- ◆ Acid, Phosphonates and Water-Soluble Polymers are typical mineral scale inhibitors. Deposition control is particularly critical in systems with high levels of calcium hardness.

## Microbiological Growth Controls

The hydroxyl radicals, hydrogen peroxide and hypochlorite (bleach), and chlorine gas are oxidizers that kill microbiological growths. CDPH requires the use of microbiological growth controls when recycled water is used for cooling tower applications

The table below illustrates common conditioning chemicals, their use and their recommended maximum concentrations.

Conditioning Chemical Additives		
Conditioning Chemical	Use	Recommended Maximum Concentration**
Organophosphates (phosphates)*	Control scaling for steel	20 mg/l as PO <sub>4</sub>
Orthophosphates, Polyphosphates	Inhibit corrosion and control scaling	20 mg/l as PO <sub>4</sub>
Sodium silicate	Inhibit corrosion	100 mg/l as SiO <sub>2</sub>
Aromatic triazoles	Inhibit corrosion	2-4 mg/l
Molybdates***	Inhibit corrosion	40 mg/l as molybdenum
Non-Oxidizing Biocides such as: Isothiazolin**** Dibromotripropionamide Quaternary amines	Inhibit biological growth	See notes.
Oxidizing Biocides Chlorine Bromine	Inhibit biological growth	0.5 mg/l
<p>* Requires close monitoring of blowdown and dispersant to prevent calcium phosphate scale.            ** If corrosion protection of the cooling system require high chemical dosing rates that result in concentrations of inhibitors that exceed these recommended maximum levels, the system should be thoroughly investigated to determine the cause.            *** Molybdates discharged to treatment plants may be prohibited in certain service areas.            **** Copper is often used as a stabilizer in isothiazolin biocides. Because the presence of copper is not typically noted on the Material Safety Data Sheet (MSDS), chemical analysis data should be obtained before use. Such data may be obtained from the vendor or other industrial dischargers. Copper containing additives must not be used.</p>		

## PHYSICAL TREATMENT (ELECTROMAGNETIC SYSTEMS)

The operating principles of these devices are based on four essential methods of action: electromagnetic signal; interaction of the induced electric field with colloidal particles; control of microbial populations; and corrosion control. Pulsed-power systems work by changing how calcium carbonate and other dissolved minerals precipitate from solution. Pulsed-power fields activate colloidal nucleation sites in the bulk solution. These activated sites become the preferential nucleation sites for precipitation. The amorphous precipitate, generated by a pulsed-power system, does not adhere to the pipe wall but remains with the bulk solution and is removed via blowdown and/or side-stream filtration. The systems use colloidal science instead of inorganic chemistry to control scaling.

Pulsed power systems are a bacteriostatic product rather than a true bactericide. Although the bacteria are not killed, they are controlled through two mechanisms. The first relates to the well-established effect in water treatment that coagulation and calcium carbonate precipitation will result in a microbial reduction. The second mechanism involves sub-lethal injury that controls bacteria even when there is no precipitation occurring. This mechanism is based on the interaction of the low frequency radiation generated by the pulsing with the bacteria. In California, CDPH requires that biocides be used in cooling towers with recycled water feedwater regardless.

Corrosion inhibition is accomplished indirectly by maintaining sufficient cycles of concentration to force the system into the alkaline mode at the saturation point of calcium carbonate, which is a cathodic corrosion inhibitor. In this type of water system, the expected corrosion rate on mild steel is 2 to 5 mils per year (mpy). The Cooling Technology Institute Guideline WTP-130 lists corrosion rates in cooling towers on mild steel of 2 to 5 mpy as “good” and 0 to 2 mpy as “excellent”. In many municipal water systems, phosphates or silicates are used as corrosion inhibitors to meet EPA’s copper/lead requirements. Where these systems are cycled up, the corrosion rate on mild steel is typically less than 2.0 mpy.

# 3

## GREEN BUILDING CONSIDERATIONS AND LEED® CERTIFICATION

LEED is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.

Utilizing recycled water in your building can assist you in achieving certification. The Inland Empire Utilities Agency (IEUA) received 2 LEED Credits in the Innovation and Design Process Category for its indoor use of recycled water.

The first credit was for water use efficiency, recycled water combined with conservation efforts reduced the building's water use by 73%. The second credit was for its Green Building Education program. IEUA included signage in its building and provides tours and education publications about the sustainable nature of its building.



# 4

## REGULATORY CONSIDERATIONS

Converting to recycled water use means complying with requirements set forth by the California Department of Public Health and San Diego County Department of Environmental Health as well as complying with guidance established in the Uniform Plumbing Code. This section provides an overview of the various requirements.

### RECYCLED WATER REGULATORS

#### CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

The CDPH is responsible for protecting public health and safety by regulating both the potable and recycled water supplies. CDPH's authority around water quality and treatment is outlined Title 22 of the California Code of Regulations. CDPH's authority around backflow prevention is outlined in Title 17 of the California Code of Regulations. For each recycled water use, CDPH must review and approve both an Engineering Report and the project design documents.

#### SAN DIEGO COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH

The San Diego County Department of Environmental Health (DEH) regulates the use of recycled water through a delegation agreement with CDPH. Land and Water Quality Division staff review recycled water use plans, and conduct site inspections to ensure drinking water supplies are not contaminated with recycled water. Staff also monitor spray irrigation sites to ensure the recycled water irrigation does not present a risk to the public. Recycled water sites must also pass an initial cross-connection control shut down test and retesting every four years thereafter. This test should be coordinated with the agency supplying the recycled water.

#### LOCAL BUILDING OFFICIALS

Whether you are constructing a new facility or re-plumbing your facility to change the source water for your cooling system, contact your local building official for permits or requirements. In some instances there may be special requirements for reusing process water in cooling systems.

### COMPLYING WITH THE CDPH REQUIREMENTS

As noted above, CDPH through Title 17 and Title 22 of the California Code of Regulations sets forth a number of specific requirements for users employing the recycled water supply. Most of these requirements can be satisfied with a thoughtful design process. Several of the requirements are specific to operations and reflect practices that are common to any facility where a potable and a nonpotable water supply are employed.

#### THE ENGINEERING REPORT

The Engineering Report is a very important tool for explaining the project to both your water district and CDPH. The Report should provide the detail and explanation necessary to allow regulatory agencies to understand your project and your strategy for complying with regulatory requirements.

The Engineering Report should be submitted as early as possible in the design process in order to allow for comment and revision before detailed site plans, mechanical plans and plumbing plans are complete.

The Engineering Report should include a description of the proposed projects and recycled water use area and enough detail and graphics to allow the project to be reviewed. Typical components of the Engineering Report include:

- ◆ Description/location of recycled water use areas
- ◆ Site piping diagram illustrating compliance with all separation requirements
- ◆ Description of the pipe/valve labeling scheme
- ◆ Description and location of backflow prevention
- ◆ Description and location of signage
- ◆ Description (manufacturer's cut sheet and specifications) for the drift eliminator(s)
- ◆ Description of proposed bacteriological control system including schematic flow diagrams if appropriate
- ◆ Description and plan of back-up water supply
- ◆ Location of connection(s) to the sanitary sewer system

## PIPE SEPARATION AND LABELING

CDPH requires that recycled water pipelines be separated from potable water pipelines. CDPH also requires that recycled water pipelines, valves and other devices be clearly labeled and identified.

The Engineering Report should include enough detail on the Site Plan to illustrate the separation requirements can be met. The Engineering Report should describe the pipe/valve identification system that will be used.

If recycled water is used inside your building for uses beyond cooling (i.e. non-potable domestic uses such as toilet flushing), your building is considered dual-plumbed. The plumbing system design requirements for dual-plumbed buildings are outlined in Chapter 16 of the International Association of Plumbing & Mechanical Officials (IAPMO) Uniform Plumbing Code. This Chapter has not been officially adopted in California, although its provisions are followed by recycled water utilities throughout the state.

For sites that intend to use recycled water only for industrial or irrigation purposes, it is recommended that dedicated lines be located outside the building (or in an approved, dedicated pipe-chase) in order to avoid the need for project-specific dual-plumbing review; this design concept is illustrated on the next page.

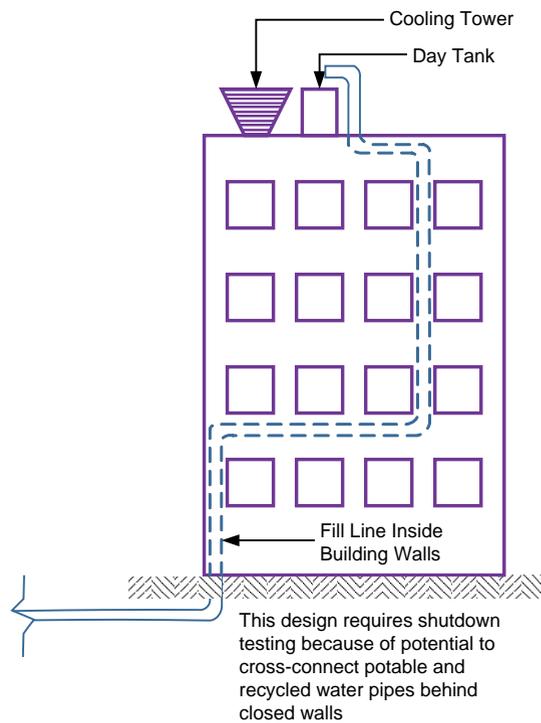
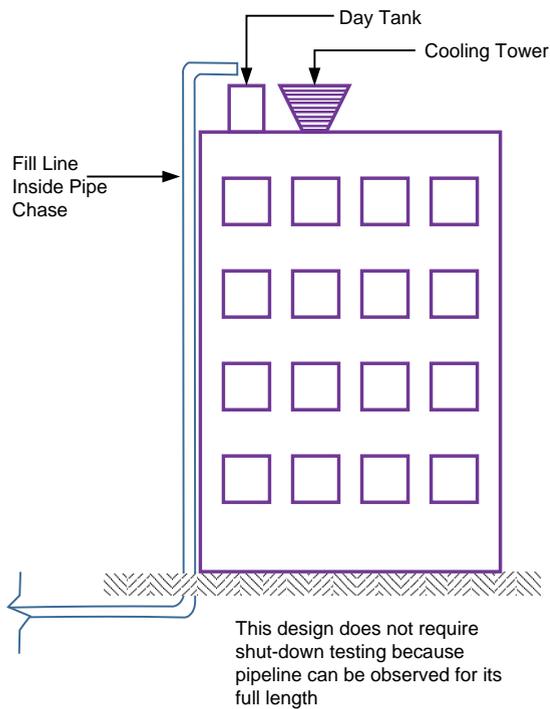
## SIGNAGE

Title 22 requires the use of advisory signs to inform workers and the general public of recycled water use, when there is a probability of coming into contact with the water. The figure below illustrates common signage for industrial use.

For many industrial applications, the actual signage requirements may be quite minimal since industrial and cooling facilities are typically not accessible to the public. The Site Plan included in the Engineering Report should illustrate the location of proposed signage. The Engineering Report should provide a brief description of the rationale for location of signage.



Locating Recycled Water Lines  
Outside of Building Minimizes  
Cross-Connection Testing

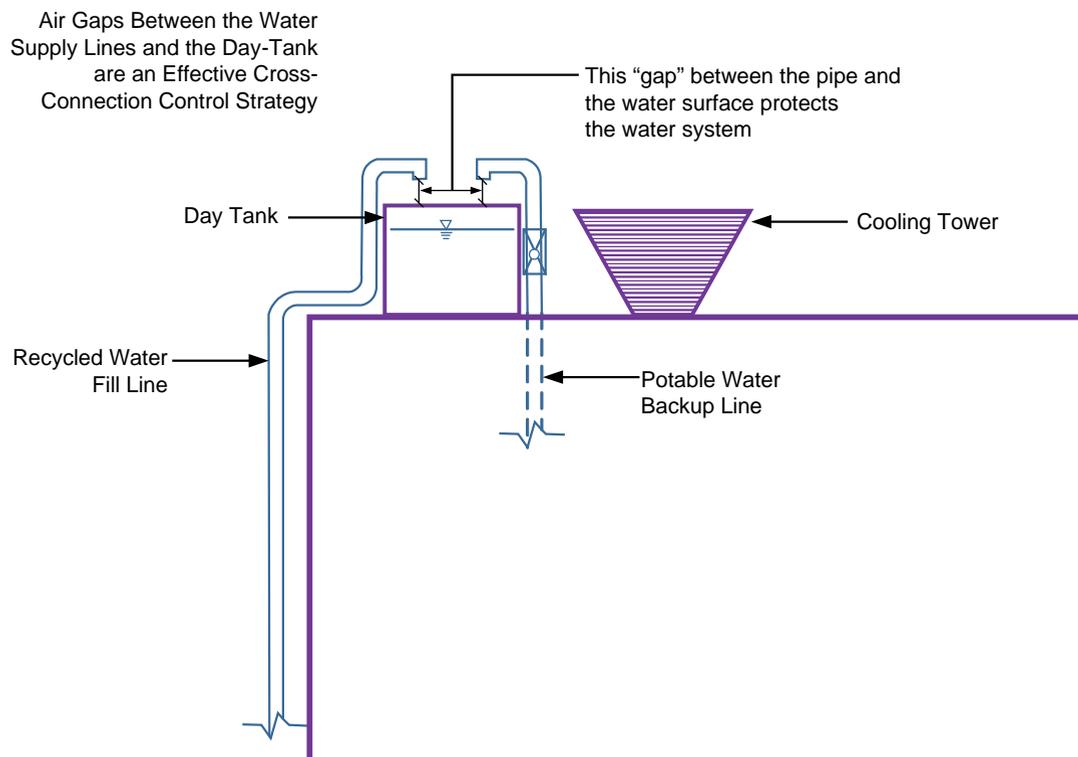


## CROSS-CONNECTION CONTROL

Title 17 requires that the public water system be protected at all times from cross-connection. Typical enforcement of Title 17 includes:

- ◆ Requiring a backflow prevention device on potable water connections to sites where recycled water is in use. Typically this includes a reduced pressure backflow prevention device (RP);
- ◆ Requiring cross-connection prevention between the recycled water supply line and the cooling water system. Typically this is achieved by an “air gap” between the recycled water supply lines; any back-up potable supply lines and the basin of the cooling tower (see illustration below).
- ◆ Requiring a cross-connection control test at system startup.
- ◆ Requiring annual visual inspection and subsequent cross-connection control testing if the situation warrants.

The Engineering Report should illustrate the location and type of all backflow prevention devices.



At system start-up all recycled water systems must be subject to a cross-connection control test performed by an American Water Works Association (AWWA) certified cross-connection control specialist, to assure that there are no connections between the potable and non-potable water systems. Subsequent cross-connection control tests may be required if the user installs new equipment or significantly modifies its recycled water use patterns.

A visual inspection through cross-connection review of the recycled water system should be conducted by the Site Supervisor annually and the results should be included in the annual self-monitoring report.

All on-site backflow preventers should be tested annually by an AWWA certified backflow tester. The results of these tests should be included in the annual self-monitoring report.

Dual-plumbed buildings (those that cannot provide a dedicated pipe chase or supply line), must have a cross connection control test performed every four years to verify that there are no cross-connections between the potable and non-potable water systems. The test must be performed by an AWWA certified cross-connection control specialist and the report must be filed with the appropriate agencies.

## **DRIFT CONTROL**

Title 22 allows the use of tertiary treated recycled water in cooling towers but the regulations seek to limit the contact that employees or members of the public have with mist generated from the system.

All new or retrofitted cooling towers must include a high efficiency drift eliminator that serves to collect and condense fine mist. The Engineering Report shall include a description (manufacturer's cut-sheet and specifications) for the drift eliminator. The sketches provided in Section 1 Cooling System Basics illustrate the use of drift eliminators.

## **BACTERIOLOGICAL CONTROL AND BIOCIDES**

Title 22 requires that when recycled water is used in a cooling tower, the system must be designed so that the cooling system recirculating water is treated with chlorine or another biocide to minimize the growth of Legionella and other micro-organisms.

CPDH currently does not permit electromagnetic water treatment devices (such as Clearwater's Dolphin System) to be used in lieu of biocides. CDPH has permitted specific installations of electromagnetic water treatment devices, without mandatory biocide treatment, if the system design allows for emergency biocide dosing and the biocides are stored on site.

The Engineering Report shall include a clear description of the proposed bacteriological control system including, where appropriate, schematic flow diagrams.

## **BACK-UP WATER SUPPLIES**

When recycled water is used for cooling system it is necessary to have a back-up potable water supply to the site. The potable water supply is used during the required cross connection tests and can also provide an important element of reliability for the industrial customer.

Many industrial users employ a day-tank on both their potable and recycled water supplies to further enhance overall system reliability.

The Engineering Report shall include a clear description of the proposed back-up water supply and the Site Plan should illustrate the major features of the system.



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## RESOURCES

### CONTACT INFORMATION

San Diego County Water Authority  
4677 Overland Avenue  
San Diego, CA 92123  
(858) 522-6600  
(858) 514-1720 Recycled water Information line  
[www.sdcwa.org/watermanagement](http://www.sdcwa.org/watermanagement)

### RESOURCES

[www.watereuse.org](http://www.watereuse.org)  
[www.awca.com](http://www.awca.com)  
[www.swrcb.ca.gov](http://www.swrcb.ca.gov)  
[www.ca.gov](http://www.ca.gov)  
[www.sdcounty.ca.gov/deh](http://www.sdcounty.ca.gov/deh)

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**San Diego County  
Water Authority**