COOLING TOWER WATER MANAGEMENT

PROGRAM AND PLAN

Canandaigua VA Medical Center

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Prepared by: Bishop Fargo

Certification Date:

(NOTE: plans require annual update and certification. Plans should be certified by (at a minimum) the Chief Engineer and Water Safety Committee chairperson)

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1. Purpose and Scope

Purpose: This document establishes mandatory design requirements and operational standards for the management of cooling towers water systems associated with VHA owned and/or operated facilities/buildings. The plan is based on the requirements of VHA Directive 1061 "PREVENTION OF HEALTH CARE-ASSOCIATED LEGIONELLA DISEASE AND SCALD INJURY FROM WATER SYSTEMS" and VHA Engineering Standard ES-2019-001 "Cooling Tower Water Systems". The requirements of these standards are incorporated into this plan by reference.

Scope: The Scope of this document includes VHA operated facilities located at:

Background

Cooling tower systems are critical to the support and continued operation of VA medical facilities and must be maintained and operated properly to ensure optimalperformance and resilient supply. This includes water treatment, cleaning, and maintenance to ensure heat transfer surfaces are not fouled and are performing as designed, and that equipment and piping are not corroding and failing prematurely.

Evaporative cooling water systems can present an environment for growth of *Legionella* and other pathogens and subsequent transmission to people since water is emitted from the systems in the form of aerosols that can be inhaled. Conditions such as humidity, wind velocity and other factors can influence the travel distance of the contaminated aerosols. Inhalation of *Legionella* contaminated aerosols has the potential to cause Legionnaires' disease (LD), and outbreaks of LD have been linked to cooling towers. Many of these outbreaks resulted in numerous cases being identified over a short period of time. Since the aerosols generated by cooling towers can travel some distance, some LD cases have been reported to occur several miles away from the source. *Legionella* and other biological growth in cooling towers can be controlled through prevention and mitigation methods. These practices are critical to reduce and mitigate exposure of people to *Legionella* contaminated aerosols.

Definitions

A. ***Biocide*** – For this Engineering standard, a biocide is a chemical agent or substance which can deter, inactivate, or kill microorganisms.

B. ***Biocide residual*** – The amount of biocide present in the water system after biocide demand has been satisfied. Required biocide residuals in a cooling tower water system are in-part determined by water quality, water system conditions (piping system corrosion, water flow/turnover, etc.), and type andquantity of microorganisms requiring inactivation.

C. ***Biofouling*** **–** The development of a film or layer of material on the inside of pipes and underwater surfaces by organisms such as barnacles and algae. Also known as fouling.

D. ***Blowdown*** **–** The process of removing (discharging to the sewer) water with high concentrations of contaminants as a result of evaporation. Blowdown isdone based on concentration and/or at regular intervals (e.g. on a timer) to maintain water quality.

E. ***Bromine*** **–** An EPA listed biocide chemical used as a disinfectant which can be used as an alternative for chlorine. Bromine is used to mitigate the formation and growth of algae, bacteria and odors in water systems.

F. ***Chlorine*** **–** An EPA listed biocide chemical approved for use in treatment of potable water to control/inactivate waterborne bacteria, viruses, and protozoa. In high concentrations, used for disinfection of water systems and their components.

G. ***Control measure*** **–** Any action or activity that can be used to prevent or eliminate a hazard or reduce the hazard to an acceptable level. [WHO, 2007]

H. ***Cooling Tower*** **–** Heat-transfer device in which warm water is cooled by evaporation in atmospheric air. Cooling towers usually incorporate a fan for forced air movement, a circulating water pump, a water spray system and a cooling coil.

H. ***Corrective action*** **–** Corrective action is any action to be taken when the resultsof monitoring indicate that a primary or supplemental control is not within the established control limits.

I. ***Disinfection*** **–** Disinfection is the irreversible inactivation of microorganisms on a surface or in a system and reduction to non-hazardous levels. Chemical disinfection of cooling tower water systems can be accomplished using EPA listed biocides. Disinfection of evaporative cooling water systems is conducted in accordance with recognized entities such as the Cooling Technology Institute (CTI).

J. ***Drift*** **–** Water lost from a cooling tower system due to splashing and airflow.

K. ***Engineering Control limit*** **–** A minimum and/or maximum value at which an engineering parameter must be maintained in order to prevent or eliminate a hazard or reduce the hazard to achieve a desired outcome.

L. ***Equipment offline*** **–** Equipment that has been shut down, locked out and drained or disconnected that cannot be readily used for the intended application.

M. ***Equipment shutdown*** **–** The process of taking a piece of equipment out of service. The shutdown may be the first step in taking a piece of equipment offline or may be implemented to rotate the equipment from operational to standby.

N. ***Evaporative Condenser*** **–** A combination of a water-cooled condenser and an air-cooled condenser, utilizing the principle of heat rejection by the evaporation

of water into an air stream traveling across the condensing coil.

O. ***Halogen*** **–** Any of the elements fluorine, chlorine, bromine, iodine, or astatine, occupying group VIIA (17) of the periodic table. They are reactive nonmetallic elements that bond with hydrogen to form strongly acidic compounds that can be used as biocides in water treatment.

P. ***Hyperhalogenation*** **–** Introduction of high levels of a halogen to the cooling tower for remediation purposes.

Q. ***Legionella*** **–** *Legionella* is a genus of Gram-negative bacterium that is naturally found in the environment, including soil and water, and has been associated with building water distribution systems and cooling towers. Over 50 species and 70 serogroups have been identified.

R. ***Legionella*** **disease (LD) –** LD is the term used in this Engineering standard for the disease traditionally known as "Legionnaires' disease;" a type of pneumonia caused by pathogenic species of the bacterium, *Legionella*. Most, but not all, cases of disease in the U.S. are caused by the species *Legionella pneumophila* serogroup 1.

S. ***Legionellosis*** **–** Legionellosis refers to diseases (Legionnaires' disease, Pontiac Fever) caused by pathogenic species of *Legionella* bacteria. Legionnaires' disease is defined above (see "Legionella disease"). Pontiac feveris a milder respiratory infection without pneumonia and symptoms resolve without treatment.

T. ***Legionnaires' disease*** **–** See "*Legionella* disease."

U. ***Makeup water*** **–** Non-potable water used to replace water lost from the system as part of the processes of evaporation, drift, and blowdown.

V. ***Mitigation*** **–** Actions taken to reduce the volume of pathogens, such as

Legionella, in a water distribution system (also called "remediation").

W. ***Monitoring*** **–** The process of routinely checking water chemistry, physicalcharacteristics and biological levels.

X. ***Primary control measures*** **–** Main or routine methods used to suppress pathogen growth in a cooling tower water system. Primary control measures typically used in cooling tower water distribution systems include treatment withbiocide and corrosion inhibitors.

Y. ***Process flow diagram*** **–** A systematic representation of the sequence of stepsor operations used in the production or manufacture of a particular item [WHO, 2007].

AA. ***Process water*** **–** Non-potable water used as part of a building infrastructure process such as cooling (cooling towers)

BB. ***Remediation*** **–** The process of implementing actions to reduce the volume of pathogens such as *Legionella* in a water system (also called "mitigation").

CC. ***Validation*** **–** The process of obtaining evidence of a plan's effectiveness. In this

Engineering standard, validation specifically refers to verifying that the primary and any supplemental engineering controls are effective at inhibiting the growth of *Legionella*.

2. Water Management Plan Team

Include a listing of VA personnel plus water treatment vendor personnel and their roles in the cooling tower management program.

NAME	TITLE/REPRESENTING	ROLE
Jake Jablonski	Canandaigua VA	USRO (Utility Systems Repairer Operator)
Scott Serrett	Canandaigua VA	USRO (Utility Systems Repairer Operator)
Bryan Laity	Canandaigua VA	Plumbing/HVAC Supervisor
Mark Tompkins	Nalco Water	Contractor

NOTE: plans require annual updates, ensure that the team members listed are kept current

3. Inventory of Cooling Towers and Equipment

Below is an inventory of the facility cooling towers and related equipment.

COOLING TOWER EQUIPMENT INVENTORY

System Name				
	Tower 1	**Tower 2**	**Tower 3**	**Tower 4**
TOWERS				
Manufacturer	MARLEY SPX	MARLEY SPX	MARLEY SPX	MARLEY SPX
Make and Model	NC8405RCN4CGF	NC8405RCN4CGF	NC8405RCN4CGF	NC8405RCN4CGF
Serial number	10155125-A1	10155125-A2	10155125-A3	10155125-A4
System served	1	2	3	4
Rated and operating capacity (Tons)	2189 PER CELL	2189 PER CELL	2189 PER CELL	2189 PER CELL
Rated and operating pressure	50 PSI	50 PSI	50 PSI	50 PSI
Rated and operating flow	30326567 GPM	30326567 GPM	30326567 GPM	30326567 GPM
CHILLERS	**Chiller 1**	**Chiller 2**	**Chiller 3**	**Chiller 4**
Manufacturer	World Energy	Carrier	Carrier	Carrier
Make and Model	SWHH500	19XRV-2	19XRV-3	19XRV-4
Serial number	WE1903023	1719Q27387	1719Q27388	1719Q27389
System served	1	2	3	4
Rated and operating capacity (Tons)	500	400	400	400
Rated and operating pressure	50 PSI	50 PSI	50 PSI	50 PSI
Rated and operating flow	1000 GPM	720 GPM	720 GPM	720 GPM
PUMPS				
Manufacturer	TACO	TACO	TACO	TACO
Make and Model	FI4009C	FI4009C	FI4009C	FI4009C
Serial number	N/A	N/A	N/A	N/A
System served	1	2	3	4

Rated and operating capacity (GPM)	52 GPM	52 GPM	52 GPM	52 GPM
Rated and operating pressure	300 PSI	300 PSI	300 PSI	300 PSI
OTHER				
Location	OUTSIDE CHILLER PLANT	OUTSIDE CHILLER PLANT	OUTSIDE CHILLER PLANT	OUTSIDE CHILLER PLANT

Number of Cells	2	2	2	2
Basin Size (ft(	22X29X2	22X29X2	22X29X2	22X29X2
Drift eliminators used	YES	YES	YES	YES
Dead Legs	NO	NO	NO	NO
SideStream Filter	YES	YES	YES	YES
Operation scheduled	SEASONAL	SEASONAL	SEASONAL	SEASONAL
Oxidizing Biocide Used	YES	YES	YES	YES
Non-oxidizing Biocide Used	NO	NO	NO	NO
Corrosion/deposit inhibitor used	YES	YES	YES	YES
Automated	YES	YES	YES	YES

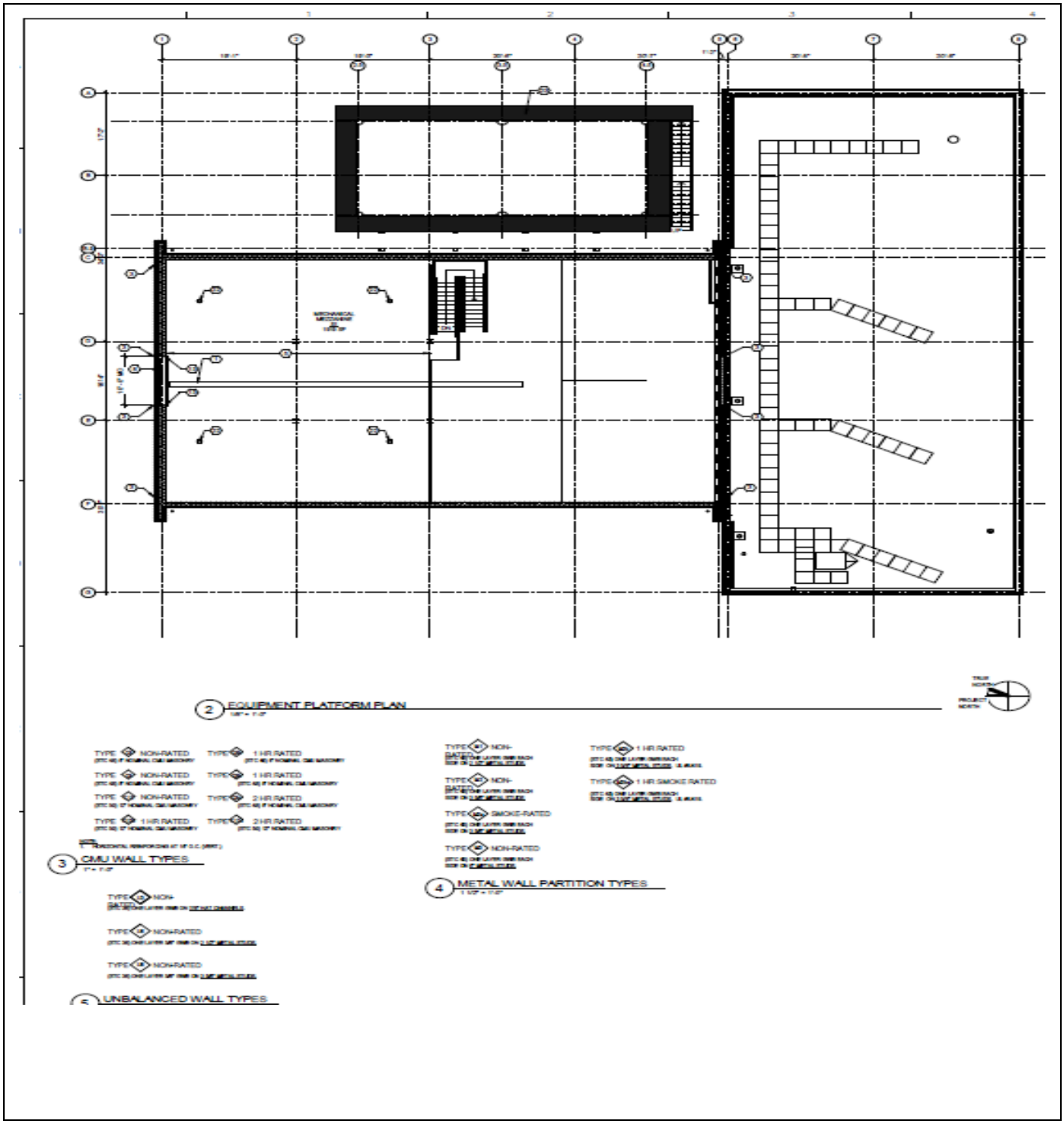
Cooling Tower Photographs:

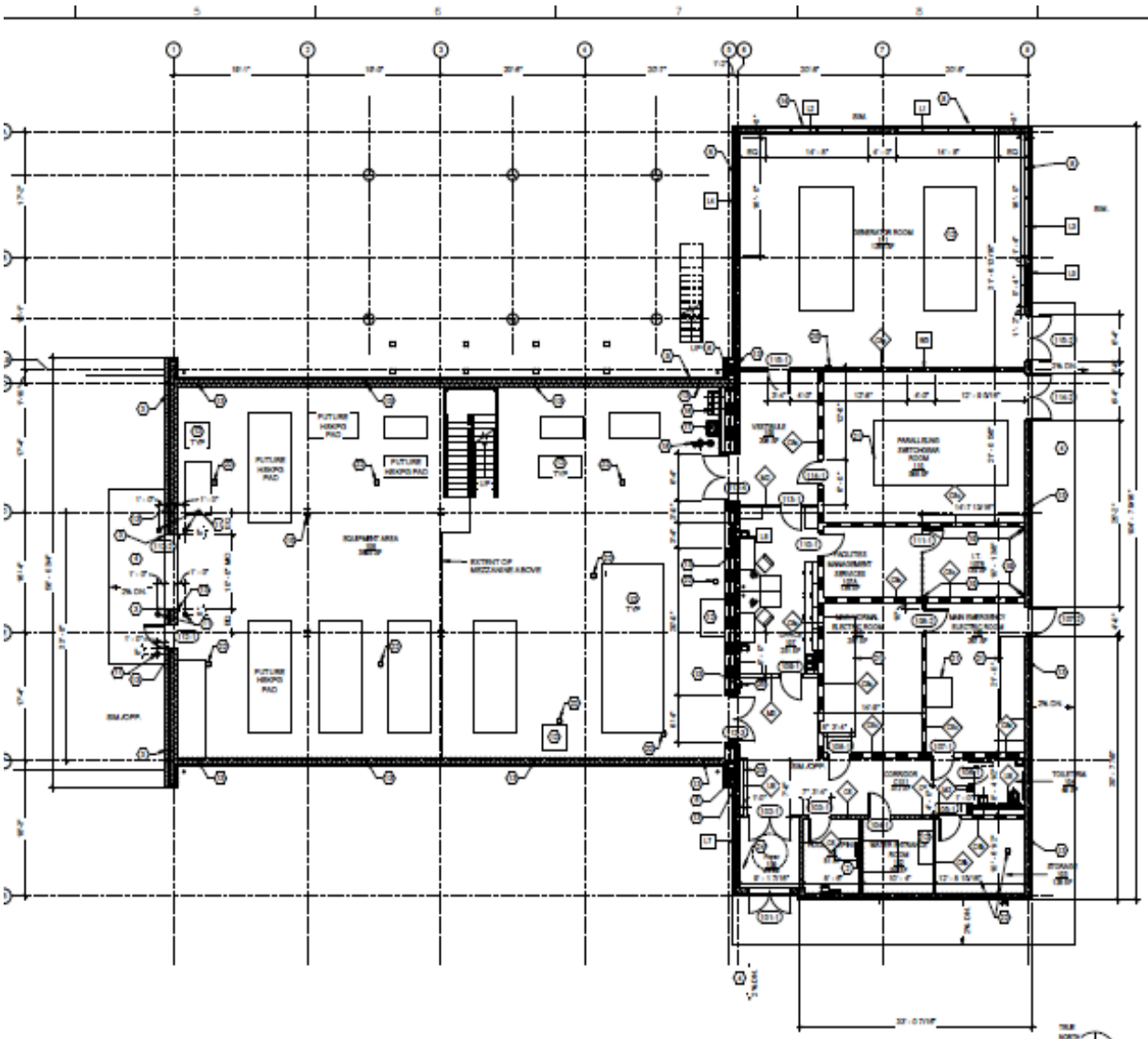
NOTE: Towers 1 thru 4, located outside chiller plant, Marley SPX, NC8405RCN4CGF, Serial numbers 10155125-A1, 10155125-A2, 10155125-A3, 10155125-A4

Cooling Tower Schematics:

ADD System schematics with all equipment and instrumentation uniquely labeled (e.g., tag number), including chemical treatment systems and components. All equipment, valves and instruments must be physically labeled to match the schematic.

SCHEMATICS CANANDAIGUA VAMC





1 GROUND FLOOR PLAN
1/8" = 1'-0"

PLAN KEY NOTES	NOTED AS	ON PLAN
1	CRANE RAIL	
2	METAL LADDER	
3	VERTICAL BRICK EXPANSION JOINT	
4	CONCRETE ENTRY PAD	
5	CONCRETE DECK (EQUIPMENT PLATFORM)	
6	EXPANSION JOINT	
8	LOUVER	
9	MECHANICAL PIPING TO COOLING TOWER	
11	STEEL BOLLARDS WITH PVC COVER	
12	CONCRETE HOUSEKEEPING PAD	
13	CMU CONTROL JOINT	
14	LOUVER WITH 2" INSULATED BLANK-OFF PANEL	
15	WALL MOUNTED PORTABLE FIRE EXTINGUISHER	

PLAN KEY NOTES	NOTED AS	ON PLAN
16	HI-LOW COMBO WATER COOLER	
17	WASH SINK	
18	EMERGENCY SHOWER & EYEWASH WASH	
19	3/4" THK. AC GRADE, WALL MOUNTED PLYWOOD UP TO 6'-0" AFF	
20	FIRE ALARM CONTROL PANEL	
21	CONCRETE PAD	
22	FLOOR DRAIN	
23	COOLING TOWER PLATFORM	
24	CABINET UNIT HEATER	
25	SEMI RECESSED FIRE RATED FIRE EXTINGUISHER CABINET	

RATED PARTITIONS ARE INDICATED AS FOLLOWS:

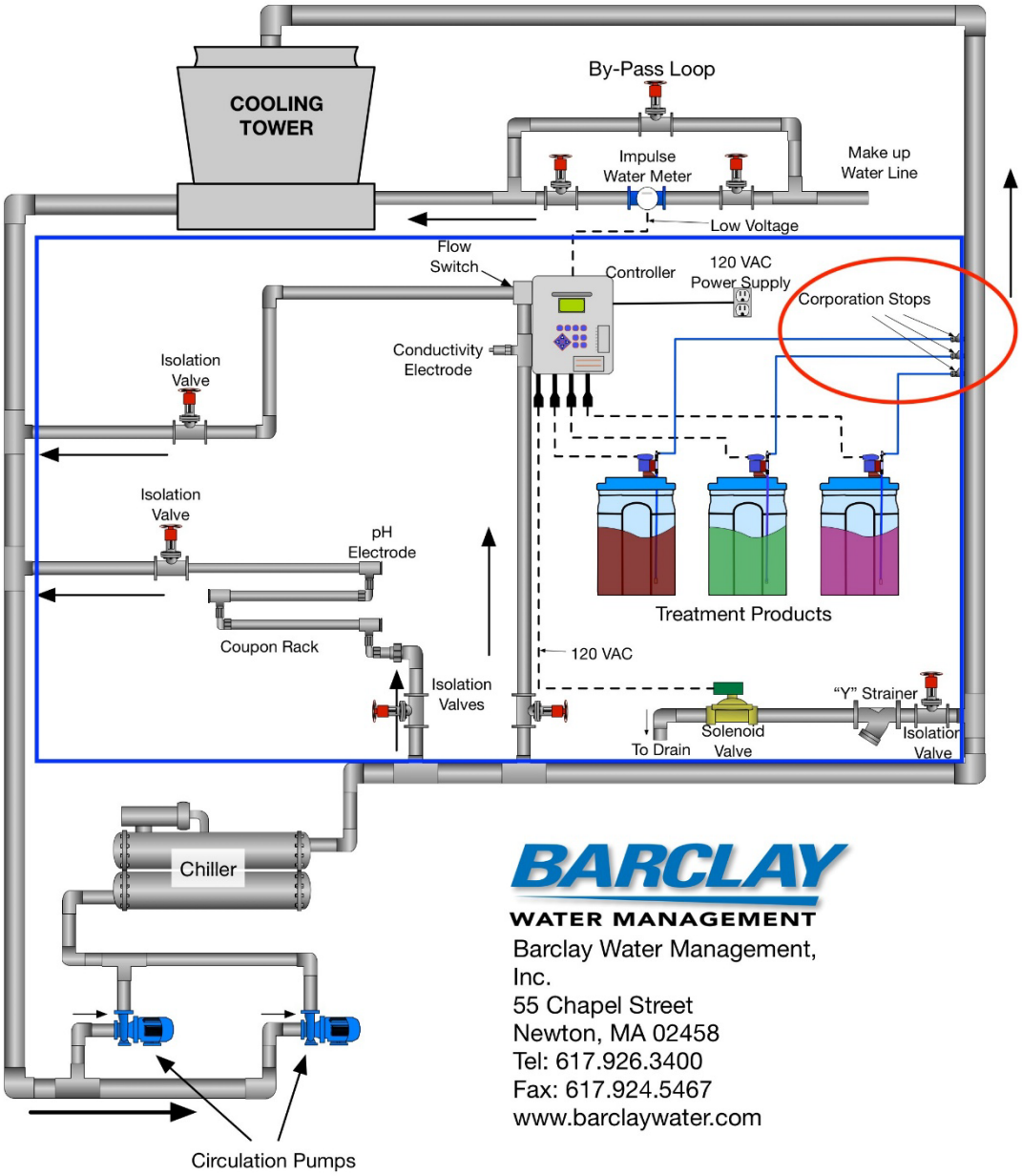
- SMOKE PARTITION
- 1 HR RATED FIRE BARRIER
- 2 HR RATED FIRE BARRIER
- 1 HR SMOKE BARRIER
- 2 HR HORIZONTAL EXIT/SMOKE BARRIER

REFERENCE SYMBOLS ARE INDICATED AS FOLLOWS:

- 101 — DOOR REFERENCE
- X — VIEW WINDOW TAG
- X — PARTITION TYPE REFERENCE SYMBOL SEE SHEET AST10

LAYOUT SCHEMATIC
Tower Water Treatment Chemical Treatment System

This drawing illustrates general installation of the chemical feed system components.



BARCLAY WATER MANAGEMENT

Barclay Water Management, Inc.
55 Chapel Street
Newton, MA 02458
Tel: 617.926.3400
Fax: 617.924.5467
www.barclaywater.com

4. MAINTENANCE PLAN:

Each cooling tower must be cleaned, maintained and inspected to ensure proper operations. All actions must be documented, with records retained for three years.

This includes the following:

1. Safety and preparation

- Lockout/tagout electrical supply before any work. Verify zero energy.
- Wear appropriate PPE: gloves, eye protection, hearing protection, insulated tools.
- Work with a second person for heavy lifts and refrigerant handling.
- Use manufacturer-approved replacement parts and refrigerant; follow environmental regulations for refrigerant handling and disposal.
- Keep a PM log with date, technician, observations, and corrective actions.

1. PM frequency summary

- Daily / Visual: basic operation checks
- Weekly/Biweekly: simple functional checks
- Monthly: instrumentation and cleanliness33212
- Quarterly (3 months): lubrication, belts, motors
- Semiannual (6 months): filters, coils, electrical connections
- Annual: full system inspection, controls calibration, oil/refrigerant analysis, major cleaning, performance test

1. Daily / Start-of-shift checks

- Verify unit runs and completes normal start/stop cycles.
- Check operating pressures/temperatures vs. expected ranges.
- Listen for abnormal noises or vibration.
- Check condensate drain for flow/blockage and overflow alarms.
- Look for visible refrigerant/oil leaks, water leaks, or corrosion.

1. Weekly / Biweekly

- Check and record suction/discharge pressures and temperatures.
- Verify control panel indicators and alarms; clear and log any active alarms.
- Inspect condenser/cooling coil fins for heavy debris; blow off loose debris.
- Check fan operation and blades for damage.

1. Monthly

- Inspect electrical wiring, terminations, and conduit for signs of overheating or looseness.
- Check motor mounts and base bolts; tighten per torque specs from manufacturer.
- Inspect belts for wear, cracking, and tension; adjust or replace as needed.
- Clean/replace air intake filters and screens.
- Check and clean condensate pan and float switches; test overflow alarm.
- Inspect shaft seals and mechanical seals for leaks.

1. Every 3 months

- Lubricate fans, bearings, and motor components per manufacturer lubricant type and intervals.
- Check coupling alignment and condition, correct misalignment.
- Inspect drive belts/pulleys and measure belt tension; replace belts showing >10–15% stretch or visible damage.
- Inspect heat exchanger and coil fins; straighten fins and clean with manufacturer-approved cleaners.
- Test safety devices: low-pressure cutouts, high-pressure cutouts, and emergency stop.

1. Every 6 months

- Inspect and clean condenser coils thoroughly (chemical or pressured wash as appropriate).

- Inspect refrigerant lines for insulation, integrity and corrosion; replace damaged insulation.
- Check motor amperage underload and compare to nameplate values.
- Verify expansion device operation and superheat/subcooling; adjust per design.
- Change or clean oil separator (if applicable) and filters/dry-cards in liquid lines.

1. Annual

- Perform a full system performance test: compare capacity, power draw, and operating points to design values.

5. Operations and Monitoring Plan

1. Purpose & Scope

- Establish safe and efficient operation of cooling towers within VA facilities.
- Ensure compliance with VHA Directive 1061 and ES-2019-001 for Legionella and water safety.
- Responsibilities
- Facility Director approves station cooling tower SOP.
- Engineering staff maintain water treatment, testing, and system operation.
- Water Safety & Infection Prevention Committees review annual reports.
  - Pre-Operation Checks
- Verify cold water basin water level and float valve operation.
- Ensure valves are open and spray nozzles unobstructed.
- Confirm power availability and correct fan/pump rotation.

2. Normal Operation & Monitoring

- Maintain biocide residuals within VA-approved ranges.
- Conduct daily inspection of noise, vibration, and water levels.
- Record monthly chemical readings: biocide, pH, conductivity.
- Perform quarterly microbial testing (HPC).

3. Water Treatment & Blowdown

- Maintain chemical treatment as specified by facility guidelines.
- Perform scheduled blowdown to control TDS and remove contaminants.
- Dispose of blowdown water per environmental regulations.
    - Biological Control & Legionella Prevention
- Follow VHA Directive 1061 testing frequency.
- Implement hyper halogenation if test results exceed limits.
- Report findings to VISN contacts within required timelines.
    - Shutdown Procedures
- Follow lockout/tagout procedures before service.
- Drain and clean basins; flush lines before returning to service.
- Inspect and clean drift eliminators.
    - Record-Keeping & Reporting
- Maintain daily, weekly, and monthly logs for water chemistry.
- Retain equipment inspection and maintenance records.
- Submit annual operational summary to required VA committees.
    - Training Requirements
- Staff must be trained on sampling, biocide handling, and PPE use.
- Contractors must adhere to VA policies and SOP requirements.
    - Monitoring Tasks
- Conduct daily visual inspections for drift, leaks, abnormal noise, and vibration.
- Verify proper water level in cold water basin and float valve operation.
- Record daily chemical readings including biocide residual, pH, and conductivity.
- Log makeup water usage and compare to historical baselines.
- Inspect strainers, filters, and sump screens weekly and clean if necessary.
- Perform monthly verification of blowdown control settings and TDS levels.
- Record monthly corrosion coupon and inhibitor performance readings.
- Perform quarterly HPC microbial testing.
- Monitor Legionella testing results according to VHA Directive 1061.
- Trend and review historical readings to detect early issues.

6. Water Testing Requirements

Summary: VHA Directive 1061, Appendix D, paragraph 4b requires heterotrophic plate count (HPC) testing to provide information on whether engineering controls are preventing bacterial growth in cooling tower water systems. The use of routine HPC testing, performed by an accredited laboratory, is one biological indicator method for assessing system controls. Another acceptable indicator method is the routine use of commercially available dip slides to measure total aerobic bacteria (sometimes also called microbiological activity). Whichever method is chosen, it is important to continue using the same method as much as possible for comparison of results over time.

Total Aerobic Bacteria by Heterotrophic Plate Count (HPC) Validation Testing
Method: Commercially available dip slides, or accredited lab analysis for HPC

Notes:

1) It is a local decision as to whether HPC testing by an accredited lab or dip slides will be used to determine the bacteria level. Regardless of method chosen, the frequency of testing defined below is to be followed.

2) Biological indicator testing is time sensitive. For HPC testing by an accredited lab, the sample must be processed by the lab as soon as possible after it is collected, and temperature control during transport is critical. Samples held for longer than 24 hours are to be considered invalid. Lab accreditation is determined by a recognized regional, national or international accrediting body (e.g., NELAP, AALA).

3) Acceptable dip slides are ones that test for total aerobic bacteria (or similar description for testing microbial activity) and are marketed for testing cooling tower water systems. Water sampling and dip slide processing must be in strict adherence to manufacturer's protocols.

Frequency: At a minimum every two weeks while system is in operation unless there is a control issue or risk analysis dictates more frequent testing.

Sample volume: For HPC testing by an accredited lab, samples are to be 100 ml (consult with the lab to determine if they require a different volume). For dip slide testing, follow manufacturer's instructions for sample volume.

Sample Locations: Water sampling locations for bacterial testing shall be taken at a minimum in the following locations:

- Blowdown (on mezzanine, SE Corner)
- Cooling tower sump
- South end of chiller at chemical injection port

Note: exact sampling locations should be specified for each facility in the plan

HPC testing results should be interpreted in accordance with the table below. Document all actions undertaken with respect to elevated results and report them to the facility Water Safety Committee.

Corrective Actions Required (based on HPC results)	Heterotrophic Plate Count or Dip Slide	Process Triggered by Test Results
1	<10,000 CFU/ml	• Maintain water chemistry and biocide levels per the Cooling Tower Management Plan.
2	≥ 10,000 CFU/ml to <100,000 CFU/ml	• Within 8 hours, increase the biocide concentration and/or chemical treatment to mitigate the issue. Magnitude of increase in level and duration must be documented with basis of review and decision. • Review treatment program and facility plan and revise as required; retest water within 3-7 days. • Continue retesting and interpret in accordance with this Table until level 1 is reached.
3	≥ 100,000 CFU/ml	• Within 8 hours, increase the biocide concentration and/or chemical treatment to mitigate the issue. Magnitude of increase in level and duration must be documented with basis of review and decision. • Within one week, perform remediation of the cooling tower by removing cooling tower from service, hyperhalogenating[3], cleaning, and flushing. • Review treatment program and facility plan and revise as required; retest water within 3-7 days. • Continue retesting and interpret in accordance with this Table until level 1 is reached.

Legionella Validation Testing: Sampling of each cooling tower for Legionella by culture methodology must be performed within 7 days of startup and every 90 days

during periods when the cooling tower is operational or operational-ready (i.e., cleaned, disinfected, full of water and ready for operation).

NOTE: specify actual facility requirements based on the following language from the standard*: The number of water samples is dependent on the size and configuration of the cooling tower. At a minimum, samples must be collected from each basin/sump, and the supply to and return from the chiller(s).* ***Canandaigua chillers are on a common header, only one sample is required****. NOTE: Depending on the time of the year and VA medical facility location, a VA medical facility may have some cooling towers that are operational and some that are not. These testing requirements only apply to those cooling towers that are operational or operational-ready.*

Additional Sample Information: At the time that cooling tower water samples are collected for Legionella detection, also collect the following information for each sample: pH, biocide level and temperature.

Laboratory Requirements. Once collected, samples are to be processed for Legionella detection by a testing laboratory with proficiency in microbial testing of cooling tower water.

Testing Modality: All cooling tower water samples must be analyzed using a Legionella culture method.

Interpretation of Legionella Culture Results from Water Testing and Mitigation Actions	
Sample is <10 colony forming units per milliliter (CFU/ml)	No action required. Maintain water chemistry and biocide levels per the Cooling Tower Management Plan
Sample is ≥10 CFU/ml to <1,000 CFU/ml	1. Review system operations including chemical treatment system. Perform immediate **Remediation** for cooling towers (see note below) 2. Retest the cooling tower 3-7 days after completion of Remediation. If retest is ≥10 CFU/ml and <1000 CFU/ml, repeat Remediation for cooling tower (at increased concentrations) and retest at same interval until <10 CFU/mlis attained. 3. If retest is ≥1,000 CFU/ml see paragraph 4.a.(5)(c). 4. Review Cooling Tower Management Plan and update as necessary (e.g., using information from assessment of system operations, *Legionella* positivity results and response efforts).
Sample is ≥1,000 CFU/ml	1. Review system operations including chemical treatment system. Perform immediate **Disinfection** for cooling tower (see note below). 2. Retest the cooling tower 3-7 days after Disinfection. If

	retest is ≥10 CFU/ml and <1000 CFU/ml, conduct remediation for cooling tower and retest at same interval until <10 CFU/ml is attained 3. If retest is ≥1000 CFU/ml: Immediately perform Disinfection for cooling tower at an increased concentration/duration and retest and repeat actions until <10 CFU/ml is attained. 4. Review Cooling Tower Management Plan and update as necessary (e.g., using information from assessment of system operations, *Legionella* positivity results and response efforts)

Remediation for cooling towers: Treat the cooling tower water system with either a different biocide or a similar biocide at an increased concentration than what is currently used. Treatment must be maintained for a minimum of 2 hours, or longer if required to ensure the chemical is circulated throughout the system fully.

Disinfection for cooling towers: Dose cooling tower water system with a minimum of 10 mg/L of free residual halogen and dispersant for at least eight hours. Then the system is drained and flushed with clean water and the wetted surfaces are cleaned (cooling tower sump, fill, drift eliminators, etc.). Following this, the system is refilled, dosed to 1 to 5 mg/L of free residual halogen and circulated for 30 minutes, then drained. Finally, the system is refilled, routine treatment is re-established, and retesting is done for verification of treatment. Please refer to the following pH ranges for the selected halogen. For chlorine treatment, the pH should be 7.0 – 7.6; and for bromine treatment, the pH should be 7.0 – 8.7. For higher pH values treatment times may need to be extended. 4. Stabilized halogen products should not be used for remediation or disinfection.

7. COOLING TOWER SYSTEM RISK ANALYSIS

Note: this is a requirement of VHA ES-2019-001 (see Appendix A). The assessments should be facility-specific

	Risk Management Assessment			
Critical Risks and Hazards	Tower 1	Tower 2	Tower 3	Tower 4
Dead Legs	No	No	No	No
Operating configurations and conditions that may occur after inactivity lasting more than 3 days including idling or low circulation while not fully drained	Program to circulate tower water through piping and equipment every three days is being developed	Program to circulate tower water through piping and equipment every three days is being developed	Program to circulate tower water through piping and equipment every three days is being developed	Program to circulate tower water through piping and equipment every three days is being developed
System parts that require continual operation throughout the year making periodic offline cleaning and disinfection difficult	No	No	No	No
Any components that may add additional risk factors such as strainers and out of use filters	No	No	No	No
Sources of elevated organic contamination including but not limited to windblown debris, bird waste and plant material	No	No	No	No
Design Configuration that present a risk of direct exposure of basin deck or fill	System is automatically cycled to prevent stagnant water	System is automatically cycled to prevent stagnant water	System is automatically cycled to prevent stagnant water	System is automatically cycled to prevent stagnant water
Ventilation intakes or other routes for human exposure to cooling tower aerosols	Tower located 100 ft from road near chiller plant on isolated side of building	Tower located 100 ft from road near chiller plant on isolated side of building	Tower located 100 ft from road near chiller plant on isolated side of building	Tower located 100 ft from road near chiller plant on isolated side of building
System components adversely affecting water quality management procedures	No	No	No	No
Other risk or limiting factors or constraints in the cooling tower system's design and functioning	No	No	No	No

APPENDIX A – COOLING TOWER STANDARD OPERATING PROCEDURES

A. Shock Dose

Shock treatment of cooling tower water can be performed either with a different biocide or with the biocide currently used at a higher dosage. Shock Treatment is a term used to describe the addition of a large quantity of a biocide into a water system all at once to achieve a high concentration for a short period. The biocide will then be consumed over time either by reaction with organic or inorganic material, microorganisms, system blow down, volatility or any combination thereof.

This procedure is based on the general start-up and shutdown procedures described by ASHRAE Guideline 12 as a general approach to shock treat a system with either an oxidizing biocide or non-oxidizingbiocide.

1.Turn off scale and corrosion inhibitor feed equipment plus any other chemistry or monitoring device that may be affected by a high oxidant levels.
2. Make sure all parts of the system are open to flow.
3. Maintain operation of condenser water pumps and ensure all other system pumps are active and running. Also, confirm that all side stream devices, secondary loops, balancing lines and cross-connections are open to allow flow during the disinfection process. No part of the system should be out-of-service during the disinfection process.
4. Add an oxidizing biocide to the cooling tower sump or basin per one of the following:
If system pH is less than 8.0, add oxidizing biocide to achieve at least 5 ppm as free chlorine.
If system pH is greater than 8.0, add oxidizing biocide to achieve at least 10 ppm as free chlorine.
5. Return all equipment to normal operation after the 24-hour blowdown period.

Notes: The existing oxidizing biocide used for water treatment may be used and must be applied in a manner consistent with label use directions. When using chlorine where the system pH is greater than 8.0, it may be necessary to open the blow-down valve to reduce the system pH below 8.0 before chlorine is added. If the system is being treated with a stabilized oxidizing biocide, precautions must be made to prevent over stabilization. Stabilized oxidizing biocide should not be used for shock treatments.
If a non-oxidizing biocide is used for "Shock Treatment," it must be applied consistently per label use directions. DBNPA is the recommended non-oxidizing biocide for this purpose.

6. Allow the system to mix for 15 minutes and measure free chlorine using high range free chlorine indicator strips orequivalent to verify system dosage. Only one of these collected samples is needed to meet or exceed the target dosage.
7. Add additional biocide if required to achieve the target dosage as available chlorine. The target dosage needs only to be achieved, not maintained.
8. Turn on system blowdown for 24 hours to allow system release of biofilms and other solids that may remain suspended in the system.
9. Record action taken, amount of chemical added for future reference, and free chlorine level achieved.

On-line Disinfection a.k.a.,"Hyperhalogenation"

This procedure is adapted from the Cooling Technology Institute Legionellosis Guidelines

Procedural notes. In compliance with local Health and Safety requirements, all personnel involved with the protocol must use personal protective equipment (PPE) as may be required or needed.

1. Turn off all water treatment dosage and control equipment that may be affected by the high oxidant concentration.
2. Close building air intakes within 100 feet of the cooling tower during the disinfection process. Turn off cooling tower fans, or if possible, reduce cooling tower fan speeds to reduce drift loss from the system.
3. Switch off system blow-down, but keep makeup water valves open.
4. Maintain operation of condenser water pumps and ensure all other system pumps are active and running. Also, confirm that all side stream devices, secondary loops, balancing lines and cross-connections are open to allow flow during the disinfection process. No part of the system should be out-of-service during the disinfection process.
5. Begin the disinfection procedure by adding an oxidizing biocide (chlorine- or bromine-based) to the cooling tower sump or basin per one of the following:
If system pH is less than 8.0, add oxidizing biocide to achieve at least 10 ppm and maintain 5 ppm as free chlorine for 6-hours.
6. If system pH is greater than 8.0, add oxidizing biocide to achieve at least 25 ppm and maintain 15 ppm as free chlorine for 6-hour
7. If a 6-hour disinfection cannot be performed, add oxidizing biocide to achieve at least 50 ppm and maintain 25 ppm as free chlorine for 1-hour.

Note: If the system pH is greater than 8.0, it may be necessary to open the blow-down valve to reduce the system pH below 8.0 before adding an oxidizing biocide. In addition, high doses of oxidizing biocides applied as a disinfection measure may attack the materials of construction and cause corrosion. Appropriate precautions such as applying a corrosion inhibitor should be taken when possible.

8. At the same time, or within 15 minutes of adding oxidizing biocide, add a dispersant and antifoam per label use directions. Apply antifoam as needed. Allow the system to mix for 15 minutes and measure free chlorine using high range free chlorine indicator strips or equivalent to verify system dosage. Confirm the level of oxidizing biocide during the disinfection period initially and then every 15 minutes if performing a 1-hour disinfection or every 30-minutes if performing a 6-hour disinfection. Add additional oxidizing biocide to maintain the minimum target dose during the disinfection period.
9. Record action taken, amount of chemical added for future reference, and free chlorine levels achieved and maintained.
10. Drain the tower after the disinfection period. High concentrations of chlorine may not be allowed to enter the sewer system or controlled waters and should be neutralized before discharged. The customer must confirm requirements with the local governing authority.
11. Refill the system with fresh water and return the system to normal operation.
12. Turn on system blow-down for 24 hours post remediation to allow system release of biofilms and other solids that may remain suspended in the system.
13. Return all equipment and water treatment program to normal operation after the 24-hour blow-down period.

Off-line Cleaning and Disinfection Procedure

This procedure was adapted from the Cooling Technology Institute Legionellosis Guidelines.
Procedural Notes: All personnel involved with the protocol must use personal protective equipment (PPE) as may be required or needed. The working area should be cordoned off with barrier tape, and warning notices erected. Site personnel should not enter the vicinity of the working area unless there are suitable precautions to safeguard health.

Should the system be known to be, or is suspected of being heavily scaled and corroded, a full site survey should be conducted to determine the extent of the problem and the necessary remedial action. Step 2 of this procedure will only remove loose debris from the cooling tower and the disinfection is only effective on exposed surfaces.

A supplementary cleaning process before final disinfection should include at least one or a combination of the following actions when the cooling tower and system contain deposits such as scale, corrosion products, grease, or silt:
Chemical de-scaling of cooling tower fill, pipes, and heat exchangers.
Removal and cleaning or replacement of cooling tower fill packing.
Removal of sediment and sludge.
Cleaning may uncover previously unknown conditions such as:
Small leaks in the tower basin caused by under-deposit corrosion. When the procedure removes the deposit, such leaks may be exposed.
Damaged fill. The physical processes included in the protocol may disturb the fill and can cause some minor damage.
Damaged tower components may be discovered such as missing or damaged distributor nozzles, sump strainers, or sump heaters. Replace or repair damaged components as necessary.

Step 1. Pre-Cleaning Disinfection (Sterilization)

1. Turn off all water treatment feed and control equipment that may be affected by the high oxidant concentration.
2. Close building air intakes within 100 feet of the cooling tower during the disinfection process.
Turn off cooling tower fans, or if possible, reduce cooling tower fan speeds to reduce drift loss from the system.
3. Switch off system blow-down, but keep makeup water valves open.
4. Maintain operation of condenser water pumps and ensure all other system pumps are active and running. Also, confirm that all side stream devices, secondary loops, balancing lines and cross-connections are open to allow flow during the disinfection process. No part of the system should be out-of-service during the disinfection process.
5. Begin the disinfection procedure by adding an oxidizing biocide (chlorine- or bromine-based) to the cooling towersump or basin per one of the following:
If system pH is less than 8.0, add oxidizing biocide to achieve at least 10 ppm and maintain 5 ppm free chlorine for 6-hours.
If system pH is greater than 8.0, add oxidizing biocide to achieve at least 25 mg/L and maintain 15 ppm as free chlorine for 6-hours.
If a 6-hour disinfection is not possible, add oxidizing biocide to achieve at least 50 ppm and maintain 25ppm as free chlorine for 1-hour.
Note: *If the system pH is greater than 8.0, it may be necessary to open the blow-down valve to reduce the system pH below 8.0 before adding an oxidizing biocide. Also, high doses of oxidizing biocides may attack the materials of construction and cause corrosion. Apply a corrosion inhibitor when possible.*
6. At the same time, or within 15 minutes of adding oxidizing biocide, add a dispersant and antifoam per directions on label. Apply antifoam as needed.

7. Allow the system to mix for 15 minutes and measure free chlorine using high range free chlorine indicator strips or equivalent to verify system dosage. Confirm the level of oxidizing biocide during the disinfection period initially and then every 15 minutes if performing a 1-hour disinfection or every 30-minutes if performing a 6-hour disinfection. Add additional oxidizing biocide to maintain the minimum target dose during the disinfection period. Record action taken. amount of chemical added for future reference, and free chlorine levels achieved and maintained.
8. Drain the tower after the disinfection period. High concentrations of chlorine may not be allowed to enter the sewer system or controlled waters and should be neutralized before discharged. The customer must confirm requirements with the local AHJ.
10. Lock out the condenser water pumps and prepare the system for step 2, Manual Cleaning of Cooling Tower.

Step 2 Manual Cleaning of Cooling Tower

1. Cover the outlets from the towers so that no debris from the cleaning will enter the system.
In the event that the system contains large amount of mineral scale and deposit, it is recommended that a sample of the deposit be analyzed to determine if additional cleaning chemical is required. A sample can be taken and given to your water treatment supplier for analysis and recommendations.
2.Starting at the very top use pressure washers to completely clean the distribution deck, fill, and sump. The fill will be spread apart to rid it of microbiological contaminants.
3. Fill-Kleen (or similar product) will be applied to assist in the cleaning process. The cleaning procedure is designed to remove any loose dirt, debris, or dead bacteria without risk of damaging equipment, and have it collect in the tower basin.
4. Vacuum each individual sump to completely remove all dirt and debris. Deposits, including the sump, are removed for disposal. The debris removed from the cooling tower is made of mineral deposit and/or micro-bio and it may be disposed of in a dumpster or other approved disposal device
After the cleaning is finished, the towers can be left dry for the winter or returned to service after post-cleaning disinfection.

Post Cleaning Disinfection
1. Repeat the disinfection process outlined in Step 1 once the system is filled with water.
2. Refill the system with fresh water and return the system to normal operation.
3. Turn on system blow-down for 24 hours post remediation to allow system release of biofilms and other solids that may remain suspended in the system.
4. Return all equipment to normal operation after the 24-hour blow-down period.

Emergency Cleaning and Disinfection Procedures (for very high Bacteria or Legionella levels)

This procedure was adapted from the Cooling Technology Institute Legionellosis Guidelines and the Occupational Safety and Health Administration Technical Manual entitled "Legionnaires' Disease. The approach may be modified to accommodate the availability of resources and to implement a protocol that willprovide the best possible outcome given local system operations and conditions.

Procedural Notes: All personnel involved with the protocol must use personal protective equipment (PPE) as may be required or needed. The working area should be cordoned off with barrier tape, and warning notices erected. Site personnel should not enter the vicinity of the working area unless there are suitable precautions to safeguard health.

Should the system be known to be, or is suspected of being heavily scaled and corroded, a full site survey should be conducted to determine the extent of the problem and the necessary remedial action.

Step 2 of this procedure will only remove loose debris from the cooling tower and the disinfection is only effective on exposed surfaces. A supplementary cleaning process before final disinfection should include at least one or a combination of the following actions when the cooling tower and system contain deposits such as scale, corrosion products, grease, or silt:

Chemical de-scaling of cooling tower fill, pipes, and heat exchangers.

Removal and cleaning or replacement of cooling tower fill packing.

Removal of sediment and sludge.

Cleaning may uncover previously unknown conditions such as:

Small leaks in the tower basin caused by under-deposit corrosion. When the procedure removes the deposit, such leaks may be exposed.

Damaged fill. The physical processes included in the protocol may disturb the fill and can cause some minor damage.

Damaged tower components may be discovered such as missing or damaged distributor nozzles, sump strainers, or sump heaters. Replace or repair damaged components as necessary.

Step 1. Pre-Cleaning Disinfection

1. Turn off all water treatment feed and control equipment that may be affected by the high oxidant concentration.
2. Close building air intakes within 100 feet of the cooling tower during the disinfection process.
3. Turn off cooling tower fans, or if possible, reduce cooling tower fan speeds to reduce drift loss from the system.
4. Switch off system blow-down, but keep makeup water valves open.
5. Maintain operation of condenser water pumps and ensure all other system pumps are active and running. Also, confirm that all side stream devices, secondary loops, balancing lines and cross-connections are open to allow flow during the disinfection process. No part of the system should be out-of-service during the disinfection process.
6. Begin the disinfection procedure by adding an oxidizing biocide (chlorine- or bromine-based) to the cooling towersump or basin per one of the following:

If system pH is less than 8.0, add oxidizing biocide to achieve at least 10 ppm and maintain 5 ppm free chlorine for 6-hours.

If system pH is greater than 8.0, add oxidizing biocide to achieve at least 25 mg/L and maintain 15 ppm as free chlorine for 6-hours.

If a 6-hour disinfection is not possible, add oxidizing biocide to achieve at least 50 ppm and maintain 25 ppm as free chlorine for 1-hour.

Note: *If the system pH is greater than 8.0, it may be necessary to open the blow-down valve to reduce the system pH below 8.0 before adding an oxidizing biocide. Also, high doses of oxidizing biocides may attack the materials of construction and cause corrosion. Apply a corrosion inhibitor when possible.*

7. At the same time, or within 15 minutes of adding oxidizing biocide add a dispersant and antifoam per label directions. Apply antifoam as needed.

8. Allow the system to mix for 15 minutes and measure free chlorine using high range free chlorine indicator strips or equivalent to verify system dosage. Confirm the level of oxidizing biocide during the disinfection period initially and then every 15 minutes if performing a 1-hour disinfection or every 30-minutes if performing a 6-hour disinfection.

9. Add additional oxidizing biocide to maintain the minimum target dose during the disinfection period.

10. Record action may not be allowed to enter the sewer system or controlled waters and should be neutralized before discharged. The customer must confirm requirements with the local AHJ.
11. Lock out the condenser water pumps and prepare the system for step 2, Manual Cleaning of Cooling Tower.

Manual Cleaning Of Cooling Tower

1. Cover the outlets from the towers so that no debris from the cleaning will enter the system.

2. In the event that the system contains large amount of mineral scale and deposit, it is recommended that a sample of the deposit be analyzed to determine if additional cleaning chemical is required.

3. A sample can be taken and given to you water treatment supplier for analysis and recommendations.

4. Starting at the very top use pressure washers to completely clean the distribution deck, fill, and sump.
5. The fill will be spread apart to rid it of microbiological contaminants.
6. Fill-Kleen (or similar product) will be applied to assist in the cleaning process.
7. The cleaning procedure is designed to remove any loose dirt, debris, or dead bacteria without risk of damaging equipment, and have it collect in the tower basin.
8. Vacuum each individual sump to completely remove all dirt and debris. Deposits, including the sump, are removed for disposal. The debris removed from the cooling tower is made of mineral deposit and/or micro-bio and it may be disposed of in a dumpster or other approved disposal device.
9. After the cleaning is finished, the towers can be returned to service after post-cleaning disinfection

Post Cleaning Disinfection

1. Repeat the disinfection process outlined in Step 1 once the system is filled with water.
2. Refill the system with fresh water and return the system to normal operation.
3. Turn on system blow-down for 24 hours post remediation to allow system release of biofilms and other solids that may remain suspended in the system. 4. Return all equipment to normal operation after the 24-hour blow-down period.

Follow up

The tower water needs to be re-tested within 3-7 days after return to service. Depend on the results of the biological testing, further disinfection or disinfection and cleaning may be needed. If needed, the system will again need to be tested and treated until the bacteria are within acceptable levels.

Seasonal or Scheduled Shutdown Procedure

1. Bleed the system to 1.5 - 2.0 cycles of concentration
2. Perform one of the following remedial procedures:
    a. *On-Line Disinfection*
    b. *Off-Line Cleaning & Disinfection*
3. Flush the system to remove any chlorine residual.
4. Perform one of the following lay-up procedures:

Wet
A Add an appropriate corrosion inhibitor at an appropriate level and circulate the water for 24 h
B. At the same time add a non-oxidizing biocide at label maximum or at a level that will be effective.
C. Drain system to below freeze level

Dry
A Add an appropriate corrosion inhibitor at an appropriate level for dry lay-up and circulate the water for 24 hours.
B. Drain system to below free

Seasonal or Scheduled Start-Up Procedure

Use for seasonal start-up for system coming out of seasonal lay-up or out of a scheduled shutdown. Thisprocedure needs to be completed prior to operating cooling tower fans.
1. Perform *Off-Line Cleaning & Disinfection* prior to seasonal start-up
2 . If Action 1 is not performed within 15 days of anticipated start-up, perform *Re-start Procedure* or circulate system daily with regular biocide feed program.
3. Restart includes physical cleaning and disinfection.
4. Completely fill system to normal operating level.
5. Bleed System for 2-4 hours.
6. Add a non-oxidizing biocide at a level that will be effective.
7. Circulate 24 hours.
8. Perform a cooling tower inspection and remediate any problems.
9. Turn on the feed and control system and begin normal testing.
The system is now ready for normal operation.

Idling Procedure
Use for systems that have been idle 5-days or longer. This procedure needs to be completed prior to operating cooling tower fans.

a. Perform *On-Line Disinfection.*
b. Return to normal operations.

Re-Start Procedure

Use this procedure when a cooling tower has completed an *Off-Line Cleaning & Disinfection* but for operational reasons, the cooling system was not able to be started within 15 days after the procedure wascompleted. This procedure needs to be completed prior to operating cooling tower fans.

1. Physically clean any visible contaminants.
2. Completely fill system to normal operating level.

3. Bleed system for 2-hours.
4. Add a corrosion inhibitor to achieve 2 times normal corrosion inhibitor level. This will help re-passivate the system.
5. Add a non-oxidizing biocide at a level that will be effective.
6. Circulate 24 hours.
7. The system is now ready for normal operation.

APPENDIX B – COOLING TOWER OPERATIONS AND TREATMENT LOGS

COOLING TOWER MONITORING AND OPERATIONS LOG

DATE				
MAKEUP CONDUCTIVITY				
CONTROLLER CONDUCTIVITY (6 x City)				
HAND METER CONDUCTIVITY (6 x City)				
CONTROLLER PTSA(100-150)				
HAND METER PTSA				
pH				
Temp				
CONTROLLER ORP				
HAND HELD ORP				
TOTAL CHLORINE PPM (0.1 - 0.5)				
TOTAL PLATE COUNT < 10,000				
CYCLES				
INHIBITOR CA 3115 INVENTORY GAL				
NON-OX CA 40215 INVENTORY GAL				
BROMINE CA 42171 INVENTORY GAL				
INHIBITOR CA3115 RECEIVED GAL				
NON OX 40215 RECEIVED GAL				
BROMINE CA 42171 RECEIVED GAL				
MAKEUP METER				
BLEED METER				
ON/OFF				

INSPECTION: Cooling Water Systems (Monthly)

Date		
Name of inspector		
	yes/ no	
Inspection Results		Comments
Cooling tower equipment and basin free of visible contaminants		
Cooling tower general condition observed as satisfactory		
Basin observed as satisfactory		
Packing material observed as satisfactory		
Drift eliminator observed as satisfactory		
Quality of the water make-up connections and control maintained		
Proper functioning of the conductivity control maintained		
Proper functioning of all dosing equipment (pumps and strain gauges) maintained		
Routine maintenance records reviewed to ensure proper implementation of required and corrective actions as needed		

INSPECTION: Cooling Water Systems (Monthly)

Date		
Name of inspector		
	yes/ no	
Inspection Results		Comments
Cooling tower equipment and basin free of visible contaminants		
Cooling tower general condition observed as satisfactory		
Basin observed as satisfactory		
Packing material observed as satisfactory		
Drift eliminator observed as satisfactory		
Quality of the water make-up connections and control maintained		
Proper functioning of the conductivity control maintained		
Proper functioning of all dosing equipment (pumps and strain gauges) maintained		
Routine maintenance records reviewed to ensure proper implementation of required and corrective actions as needed		

INSPECTION: Cooling Water Systems (Monthly)

Date		
Name of inspector		
	yes/ no	
Inspection Results		Comments
Cooling tower equipment and basin free of visible contaminants		
Cooling tower general condition observed as satisfactory		
Basin observed as satisfactory		
Packing material observed as satisfactory		
Drift eliminator observed as satisfactory		
Quality of the water make-up connections and control maintained		
Proper functioning of the conductivity control maintained		
Proper functioning of all dosing equipment (pumps and strain gauges) maintained		
Routine maintenance records reviewed to ensure proper implementation of required and corrective actions as needed		

PROGRAM ACTION LOG

Use to record corrective actions for the water treatment program and system maintenance.

INITIALS	DATE	COMMENTS

HETEROTROPHIC PLATE COUNT LOG

LABORATORY USED	System	Test Method	Frequency
	Tower 2	PLATE COUNT	MONTHLY

Date Sampled (mm/dd/yy)	Time Taken (hh:mm AM/PM)	Sampled by (initials)	Sample Location	Test Result, Total LG (CFU/mL)	Comment or Remedial Actions

LEGIONELLA PLATE COUNT LOG

Name of the Monitoring Staff (Responsible Person):	System	Test Method	Frequency
LABORATORY USED	Tower 2	LEGIONELLA CULTURE TEST	QUARTERLY

Date Sampled (mm/dd/yy)	Time Taken (hh:mm AM/PM)	Sampled by (initials)	Sample Location	Test Result, Total LG (CFU/mL)	Comment or Remedial Actions