

VA



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Engineering Standard ES–2019–001

COOLING TOWER WATER SYSTEMS

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**Veterans Health Administration – Healthcare
Environment and Facilities Programs
Office of Healthcare Engineering**

The Office of Healthcare Engineering (OHE | 19HEFE) within Healthcare Environment and Facilities Programs (HEFP | 19HEF) provides policy, oversight, and operational and technical consults for engineering design and operations within the Veterans Health Administration (VHA). Divisions and Programs within HEFP include the Offices of Occupational Safety and Health (19HEFB), Environmental Programs Service (19HEFC), Enterprise Support Service (19HEFD), Healthcare Engineering (19HEFE), Capital Asset Management (19HEFF), and Special Projects (19HEFG).

OHE has been delegated authority to establish and promulgate engineering associated standards and requirements for VHA's medical and support facilities.

DOCUMENT:

ES-2019-001

COOLING TOWER WATER SYSTEMS

PURPOSE and SCOPE:

This document establishes mandatory technical design and operational standards for the management of Cooling Water Systems at Veterans Health Administration owned or operated facilities or leased facilities on property providing services to VHA.

This Standard will remain in-force until superseded or rescinded.

APPROVED by:

Vincent Rizzo, PE
Director, Office of Healthcare Engineering

Table of Contents

1. Purpose and Scope	4
2. Definitions	4
3. Cooling Tower Policy	7
Water Treatment.....	7
Water Testing	8
4. Design, Construction and Operation of Infrastructure and Systems	8
5. Employee Notification.....	9
6. Operation, Maintenance and Testing.....	9
Appendix A – Cooling Tower Management Plans	10
Appendix B – Maintenance and Operation Requirements.....	14
Appendix C – Environmental Sampling Protocol and Interpretation of Results for Heterotrophic Plate Counts (HPC)	16
Appendix D – Codes, Standards, and References.....	18

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.

Scope: The Scope of this document includes all VHA owned or operated facilities or leased facilities on VHA property providing services to VHA.

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 optimal performance 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.

2. 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 and quantity 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 is done 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.
- I. **Corrective action** – Corrective action is any action to be taken when the results of monitoring indicate that a primary or supplemental control is not within the established control limits.
- J. **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).
- K. **Drift** – Water lost from a cooling tower system due to splashing and airflow.
- L. **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.
- M. **Equipment offline** – Equipment that has been shut down, locked out and drained or disconnected that cannot be readily used for the intended application.
- N. **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.
- O. **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.
- P. **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.
- Q. **Hyperhalogenation** – Introduction of high levels of a halogen to the cooling tower for remediation purposes.

- R. **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.
- S. **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.
- T. **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 fever is a milder respiratory infection without pneumonia and symptoms resolve without treatment.
- U. **Legionnaires’ disease** – See “Legionella disease.”
- V. **Makeup water** – Non-potable water used to replace water lost from the system as part of the processes of evaporation, drift, and blowdown.
- W. **Mitigation** – Actions taken to reduce the volume of pathogens, such as *Legionella*, in a water distribution system (also called “remediation”).
- X. **Monitoring** – The process of routinely checking water chemistry, physical characteristics and biological levels.
- Y. **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 with biocide and corrosion inhibitors.
- Z. **Process flow diagram** – A systematic representation of the sequence of steps or 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*.

3. Cooling Tower Policy

It is VHA policy that cooling tower water systems be operated in a safe and efficient manner, for the prevention and control of water borne pathogens. Each VA medical facility must establish a Cooling Tower Policy which specifies responsibilities and incorporates written utility system management plans no later than six months after the publication date of this Engineering standard. All systems subject to this Engineering standard must have written utility system management plans that are specific and unique to each facility. Each utility system management plan must be approved by the medical facility Director no later than eight months after the publication date of this Engineering Standard and submitted to the VISN Director for review and reference.

The written plan(s) must follow the requirements of this Engineering standard and any guidance issued by HEFP.

Facilities that own and operate cooling tower systems must ensure that a cooling tower management plan is developed for each system and remains in place at all times the system(s) are in operation. Required components of management plans are detailed in Appendix A (Cooling Tower Management Plans) and Appendix B (Cooling Tower Maintenance and Operation Requirements).

Annual reports of the cooling tower water system operation, maintenance and monitoring, and any biological mitigation actions taken must be submitted to the Facility Water Safety and Infection Prevention and Control Committees. The Facility Water Safety Committee, at a minimum, shall review and accept the report, including providing technical support and consultation, as appropriate, regarding (1) *Legionella* prevention related to cooling tower water systems, (2) cooling tower water systems operation and maintenance, and (3) recommendations for improvements and changes to optimize the operation and biological control.

Water Treatment

The cooling tower safety policy must specify the facility's operating biocide concentration levels in the cooling tower water distribution systems. This includes documentation of minimum and maximum biocide levels, corrosion inhibitor levels, dispersant levels, biocide monitoring method and frequency, and any other requirements in accordance with Appendix A. The facility must ensure the maintenance of appropriate biocide levels for biological control in the building's cooling tower water distribution system(s) in accordance with the policy, Appendix A, applicable manufacturer's requirements for biological and corrosion control, and regulatory agency requirements for effluent concentrations.

Documentation of biocide system(s) review, design, installation, and operation shall be maintained current. Biocide-based cooling tower water treatment systems are subject to a thorough understanding of the water quality and system operation. Installed treatment systems must be specifically approved or recognized for the intended use by the regulator (US Environmental Protection Agency or delegate) and reviewed in detail relative to the water quality and operational plans. Ongoing monitoring and

documentation of biocide treatment systems and levels in the building's cooling tower water distribution systems must be implemented and maintained to ensure that the levels are within the operational guidelines established in the original design and consistent with Appendix A.

The facility must consult with the Green Environmental Management Systems (GEMS) Manager, or equivalent, to ensure (or consider) the environmental impact of the chemicals in operating and maintaining the cooling tower water system and that chemicals are used and disposed of appropriately. All debris removed from cooling tower water systems must be disposed of appropriately. Standard Operating Procedures (SOPs) for these activities must be documented in the cooling tower safety policy and tracked if required.

The facility must consult with the Safety Manager, or equivalent, and ensure that appropriate equipment and personal protective equipment (PPE) are available for employees and contractors conducting the water treatment work. Necessary training must be identified in the cooling tower safety policy and provided to employees and their supervisors. Completion of training must be documented. Safety precautions, plans and procedures must be established and maintained to protect patients, visitors, employees and VA assets in the execution of work.

Water Testing

Facilities must ensure that each system subject to this Engineering Standard undergoes water testing in accordance with the testing requirements and frequencies specified in this Engineering Standard, including Appendices B and C, and in VHA Directive 1061, and submits the results to the VISN assigned point of contact.

4. Design, Construction and Operation of Infrastructure and Systems

The policy must identify and detail a process for conducting Infection Control Risk Assessments (ICRA), in cooperation with facility stakeholders, to address the potential impact of construction and maintenance of cooling tower water systems. The ICRAs must evaluate conditions and potential impacts on the growth or transmission of waterborne pathogens and determine the extent of precautions, disinfection, and system or component commissioning requirements. This process must be included, relevant to the project scopes, as part of the planning process for all maintenance and every project executed by the facility.

The medical facility's policy must ensure that newly installed equipment, piping and distribution system components are flushed of debris and disinfected prior to being placed into service. Piping and components must be cleaned and protected from accumulation of debris and contamination prior to and during installation, and after installation before the utility is finalized and activated. Documentation of flushing and disinfection must be maintained.

Project designs and construction scopes must ensure that unused cooling tower water piping and dead-legs are removed, modified and/or capped at the appropriate location to eliminate stagnation and ensure proper circulation of treated water. This action must take place as soon as feasible following the shutdown of water circulation through the piping. Likewise, any plumbing work executed by facility management staff that impacts the cooling tower water piping must include the complete removal and capping of any abandoned piping as well.

The facility must assess and document the competency of contractors and the contractor's personnel as part of the acquisition process prior to the start of any work on facility cooling tower water systems, including water treatment. Competencies must be re-assessed on an on-going basis, or whenever there is a change in contractors or the contractor's personnel performing the work. At a minimum, the contractor's competency should be assessed and documented on an annual basis. A copy of any assessment or documentation must be submitted and retained in the contract file by the Contracting Officers Representative.

5. Employee Notification

The facility's cooling tower safety policy must include notification to all medical facility employees when (1) maintenance and repair procedures will be taking place that could affect the cooling tower water system, (2) maintenance and repair procedures have been completed, and (3) affected systems have been tested and are returned to normal operation.

6. Operation, Maintenance and Testing

Maintenance and operation policies and procedures must be developed, and training conducted, to ensure operators and attendants are competent and qualified with the specific equipment on site. Appendix B outlines the requirements for maintenance and operational procedures, which must be incorporated into the facility's policies and SOPs. Appendices B and C define the required testing for chemical and biological parameters and associated actions on operational and operation ready systems and equipment.

Appendix A – Cooling Tower Management Plans

A written Cooling Tower Management Plan, including policies and procedures, must be established, reviewed annually, and updated whenever significant changes are made. At a minimum, they must include the requirements of VHA Directive 1061 and the following:

1. Inventory of cooling towers
2. Risk Analysis
3. Operational Plan and Procedure
4. Maintenance Plan and Procedures
5. Procedures/Plans for emergency action related to biological exceedances
6. Testing requirements, frequencies and procedures
7. Data evaluation and recordkeeping requirements and procedures
8. Annual Update

1. **Inventory of Cooling Towers:** The facility must have a complete listing of the cooling towers and associated equipment complete with unique identification and location. The inventory must include all major equipment associated with the cooling tower such as pumps, strainers, and chemical treatment.
2. **System Risk Analysis:** The System Risk Analysis must at a minimum address the following five critical risks. All reviews shall be documented with an annual review conducted to confirm continued applicability.

A. System Design and Operation:

- i) *Risk Analysis:* The design of the system (whether new installation or existing) must undergo a documented risk analysis to ensure both that the performance criteria are met and that the design addresses the risks discussed below.
- ii) *Siting and Access:* A cooling tower/cooling tower system must be reviewed for impact of drift and water vapor discharge relative to HVAC air intakes, door and window openings, and common paths of travel and congregation of patients, staff and visitors. Additionally, the impacts of structures, local climate/environmental conditions, and other equipment on the operation of the equipment and systems must be reviewed.
- iii) *Sequence of Operation:* The sequence of operation must be evaluated to verify that the equipment can be operated as designed and that the operation addresses the risks discussed below.
- iv) *System Schematic:* The plan must include a current system schematic with detail on the system interconnection, equipment and instruments, along with a written sequence of operation for the system and the chemical treatment systems.
- v) *Resilience:* The system design must address continued facility operation and resilience of operations, such as duplex pump systems and equipment redundancies.

- B. **Flow Analysis:**
 - i) *Circulation:* The systems must be reviewed for proper circulation in all branches of the system and the presence of dead-end piping and stagnant areas.
 - ii) *System Valves and Controls:* The systems must be reviewed for potential stagnation and low flow caused by reduced or stopped flow due to operation of system valves and controls. The review must be documented.
- C. **Biological/Organic Material:**
 - i) *Biologic Contaminants:* The presence of biofilm, algae and protozoa in a cooling tower water system will be accelerated by the presence of required nutrients and optimal growth conditions. The system must be reviewed to minimize these conditions and ensure optimal system control.
 - ii) *Exposure to Sunlight:* The exposure of the water of a cooling tower system to direct sunlight may also accelerate biological growth and fouling and should be evaluated.
- D. **Poor Water Quality:**
 - i) *Adjacencies:* Cooling towers remove particulates from the air stream (air scrubber) due to the design of the system. Organic and inorganic material near the tower must therefore be managed in order to address contamination of the tower if these substances were to become airborne. An evaluation of these impacts must be conducted to develop a plan to minimize their affect.
 - ii) *Water Supply:* Municipal/Facility supply quality must be evaluated and documented to manage chemical additions (i.e., chemical compatibility and effectiveness), maintain reasonable chemical and mineral levels, and optimize blowdown, makeup and treatment options.
- E. **Equipment Deficiencies:**
 - i) *Equipment Damage:* Damaged equipment, such as broken drift eliminators and disintegrated fill, can adversely impact the operation of the cooling tower and impact the associated drift and evaporation. Protection from physical harm is a basic design element that must be reviewed and addressed through proper operations and maintenance.
 - ii) *Operations and Maintenance:* Proper operation and maintenance procedures ensure optimal performance and operation and must consider damage, degradation and environmental impacts.
- 3. **Operating Plan and Procedure:** Each Facility must have a current written operating plan for each system in place when operating the equipment. Refer to Appendix B for additional details. The plan(s) must include the following at a minimum:
 - A. System schematic 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.
 - B. Detailed sequence of operation for all modes of operation, including the chemical treatment system. Sequence of operation must reference and be correlated with the system schematic. The sequence of operation must include the following either in tabular form or within the document:
 - i) Nominal operating point for all equipment.

- ii) Range of operation for all equipment, flow, pressure, temperature, and biocide levels.
- iii) Alarm points for all equipment and systems.
- C. A complete equipment/instrumentation list with the following information:
 - i) Manufacturer, make, model and serial number
 - ii) System served
 - iii) Equipment rated and operating capacity, rated and operating flow, rated and operating pressure
 - iv) Instrumentation rated and operating flow, temperature and/or pressure
 - v) Unique tag number referenced to the schematic
 - vi) Installation date
- D. Details on the equipment's operational and performance data, including chemical treatment
- E. Standard operating procedures (SOPs) for each piece of equipment and device including chemical treatment
- F. Emergency procedures for equipment or system failure, along with alarm conditions.
- G. Procedures for shutdown and startup of equipment and systems
- H. Methods for monitoring system(s) and equipment operation and parameters, where data is displayed and the frequency of data collection
- I. Standard data collection source, frequency and testing requirements
- J. Process to address any deficiencies or concerns raised in a report related to the control measures being inadequate or requiring improvement
- 4. **Maintenance Plan and Procedures:** There must be current written maintenance plans and records of the same for each piece of equipment and system that complies with the requirements of this Engineering Standard, the manufacturer's recommendations and industry standards. The plan must include the following at a minimum:
 - A. A list of all equipment and systems with maintenance frequency and requirements. All equipment shall be maintained as defined in this Engineering Standard or per the manufacturer, whichever is more stringent, including frequency.
 - B. Written standard maintenance procedures for each piece of equipment and device including chemical treatment. Procedures must include specific procedures for:
 - i) Equipment shutdown and/or isolation, Lock Out/Tag Out (LOTO)
 - ii) Personal protective equipment (PPE) required when performing the work
 - iii) Materials, tools and supplies required to complete the work
 - iv) Detailed description of work to be conducted
 - C. Process to address any deficiencies or concerns raised in a report related to the maintenance process.

5. **Procedures/Plans for emergency action related to biological exceedances:** Each facility must develop and maintain written emergency action plans for each system that complies with the requirements of this Engineering Standard, the manufacturer's recommendations and industry standards. The plan must include the following at a minimum:
 - A. Procedures to address positive biological findings during testing
 - B. SOPs for remediation of equipment and procedures for the operation of system equipment during remediation process
 - C. PPE required during remediation
 - D. Materials, equipment and supplies required to properly remediate
 - E. Details on the intended outcome, and a method of documentation and evaluation
 - F. Process to address any deficiencies or concerns raised in a report related to the remediation process
6. **Testing requirements, frequencies and procedures:** There must be written testing plan for each system. The plan must address the requirements of Appendices B and C and include the following at a minimum:
 - A. A list of all systems with testing frequency, thresholds and requirements. All systems in operation or operational ready shall be tested as defined in this Engineering Standard or per the manufacturer's instruction, whichever is more stringent, including frequency.
 - B. Written standard testing procedures for each system. These must include the specific procedures for:
 - i) Process to obtain sample, sample size and chain of custody process
 - ii) Required PPE
 - iii) Required material, tools and supplies to complete the work properly
 - C. Process to address any deficiencies or concerns raised in a report related to the testing process
7. **Data evaluation and recordkeeping requirements and procedures:** There must be a written recordkeeping and evaluation plan for each system. The plan must include the following at a minimum:
 - A. Definition of the data to be collected and the format in which it will be collected
 - B. Method used to evaluate the data, and any actions to be taken relative to any deviation or trends associated with the data
 - C. Responsible Point of Contact for the process
 - D. Method for filing and data retention
8. **Annual Update:** The plan, including all components, must be reviewed, updated and certified annually.

Appendix B – Maintenance and Operation Requirements

1. **Cooling Towers:** Pathogen growth, such as *Legionella*, in cooling tower water systems is primarily suppressed by implementation of engineering controls and other measures. Proper monitoring and maintenance according to this Engineering Standard and manufacturers' recommendations are important for management of risk. The following list identifies required maintenance activities to support this effort.
 - A. Operations: All equipment (towers, pumps etc.) shall be rotated into operation to ensure equal wear and reduce stagnation, at a minimum monthly frequency.
 - B. Monitoring and Data Collection: The following operational conditions must be monitored, documented and alarmed by a building control system or equal. All alarms must be documented, and operational conditions must be documented at least hourly and upon significant change in state.
 - i) Water flow to each cooling tower and in the system
 - ii) Fan speed and/or status
 - iii) Sump level in each cooling tower
 - iv) Water temperature entering and leaving each cooling tower
 - v) On/Off status of each piece of equipment
 - C. Maintenance, Inspection and Documentation
 - i) 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:
 - (a) Semiannual preventive maintenance (PM) as part of the startup/shutdown process, including:
 - (1) Cleaning of the sump and fill: the system must be disinfected, cleaned and re-disinfected
 - (i) immediately prior to initial startup following commissioning or any shutdown period of greater than one month
 - (ii) at intervals not exceeding 6 months
 - (2) Inspection of the fill and drift eliminators for damage and biofilm
 - (3) Inspection and lubrication of the fan(s)
 - (4) Inspection and PM of the sump level control and valve(s)
 - (5) Inspection, cleaning and adjustment of the flow control valve(s) and equalization valve(s)
 - (b) Monthly PM including:
 - (1) Inspection of the sump fill and drift eliminators and cleaning if required
 - (2) Inspection and lubrication of the fan
 - (3) Inspection of the level controls and valves
 - ii) Each cooling tower system (i.e., piping, pumps, etc.) must be cleaned, maintained and inspected to ensure proper operation. All actions must be documented, with records retained for three years. This includes the following:
 - (a) Annual PM including:
 - (1) Flushing the cooling tower system for debris and cleaning of cooling tower system strainers. During startup, it may be necessary to clean strainers more than once.
 - (2) Inspection and lubrication of pump and motor bearings

- (3) Exercising of all valves to ensure operation
- (4) Testing and calibration of all instrumentation
- (5) Testing and verification of controls
- (b) Monthly PM including:
 - (1) Lubrication of pump and motor bearings
 - (2) Cleaning of system strainers
 - (3) Blowdown of sample lines
- D. Biological Testing: The following biological testing shall be conducted and documented.
 - (a) Heterotrophic Plate Count (HPC): A water sample must be taken from the cooling tower system at least one time each month that the unit is operational and sent to an environmental-accredited laboratory for HPC testing. Refer to Appendix C for interpretation and action based on test results.
 - (b) *Legionella*: For *Legionella* testing and frequency requirements, refer to VHA Directive 1061

2. Chemical Treatment System

- A. Operations: The water in the cooling tower system must be continuously treated based on measured levels of biocide in the system (dosing based on flow is prohibited). At a minimum the treatment must include the following:
 - i) Use of one or more biocides to effectively control the growth of pathogens including *Legionella*
 - ii) Chemical or other agents to minimize scale formation, corrosion and fouling
 - iii) A bio-dispersant must be used in conjunction with the biocide to ensure proper treatment
- B. Monitoring and Data Collection: The following operational conditions must be monitored, documented and alarmed by a building control system or equal. All alarms must be documented, and operational conditions must be documented at least hourly and upon significant change in state.
 - i) Biocide levels in the system
 - ii) Water chemistry including pH and conductivity
 - iii) Corrosion inhibitor levels
- C. Maintenance, Inspection and Documentation
 - i) Inspect and adjust chemical metering pumps monthly
 - ii) Inspect and clean sample lines monthly
 - iii) Inspect and calibrate continuous water chemistry analysis equipment monthly
 - iv) Inspect and clean chemical injection quills quarterly
 - v) Inspect and clean secondary chemical containment semi-annually
 - vi) Inspect and calibrate instrumentation annually
- D. Testing: In addition to the continuous monitoring noted above, the following monthly testing must be performed and documented by a third party.
 - i) Test makeup water quality for water chemistry, with adjustments to the chemistry based on results.
 - ii) Test system water quality to confirm desired chemistry and dose rates
 - iii) Measure corrosion byproducts to ensure corrosion inhibitors are effective.

Appendix C – Environmental Sampling Protocol and Interpretation of Results for Heterotrophic Plate Counts (HPC)

NOTE: Both HPC and *Legionella* testing are required for cooling tower systems. This appendix pertains to requirements for HPC testing. For requirements pertaining to *Legionella* testing, see VHA Directive 1061.

Sampling Requirements:

Analyte: Total Bacteria (HPC)

Method: Dip Slides

Notes:

1) HPC testing is time sensitive. The sample must be processed at a certified lab as soon as possible after it is collected. Samples held for longer than 24 hours are to be considered invalid.

2) Dip slides must be processed 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 size: 100 ml

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

- Storage tanks and reservoirs in cooling tower system
- Cooling tower sump
- Exit of chiller equipment

Corrective actions required for bacteriological indicator results

Level	Heterotrophic Plate Count ¹	Process Triggered by Test Results
1	<10,000 CFU/ml	<ul style="list-style-type: none"> • Maintain water chemistry and biocide levels per the Cooling Tower Management Plan.
2	≥ 10,000 CFU/ml to <100,000 CFU/ml	<ul style="list-style-type: none"> • 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.

Level	Heterotrophic Plate Count ¹	Process Triggered by Test Results
3	≥ 100,000 CFU/ml	<ul style="list-style-type: none"> • 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, hyperhalogenating², 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.

1. Performed by an appropriately accredited Laboratory (e.g. NELAP, AALA)

2. At a minimum, dose the cooling water system with 5 to 10 ppm Free Halogen Residual for at least 1 hour; pH 7.0 to 7.6.

Appendix D – Codes, Standards, and References

The following documents were used in the development of this standard:

- A. VA HVAC Design Manual, November 1, 2017, Rev. May 1, 2019
- B. VHA Plumbing Design Manual, November 2014, Rev. May 1, 2018
- C. American Society for Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Guideline 12-2000 *Minimizing the Risk of Legionellosis Associated with Building Water Systems*; 2000.
- D. Centers for Disease Control and Prevention. *Guidelines for Environmental Infection Control in Health-care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*. Morbidity and Mortality Weekly Reports. 52 (RR10):1-42; 2003.
www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm.
- E. Centers for Disease Control and Prevention. *Guidelines for Preventing Healthcare-associated Pneumonia: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee*. Morbidity and Mortality Weekly Reports. 53(RR03):1-36; 2003.
www.cdc.gov/mmwr/preview/mmwrhtml/rr5303a1.htm.
- F. Cooling Technology Institute (CTI) *Legionellosis Guideline: Best Practices for Control of Legionella*. CTI Guidelines WTB-148 (08); July 2008.
<http://www.cti.org/downloads/WTP-148.pdf>.
- G. Department of Health and Human Services, State Government of Victoria, Australia. *Legionella Risk Management* Web site, located at <https://www2.health.vic.gov.au/public-health/water/legionella-risk-management-guidelines>. Resources include:
 - a. A guide to developing risk management plans for cooling tower systems
 - b. Template for cooling tower system risk management plan
 - c. Guidelines for Legionella control in health and aged care facilities (to be read in conjunction with Water delivery system – fact sheet June 2015)
 - d. Risk management plan for Legionella control in health and aged care facilities
- H. Queensland Government Office of Industrial Relations *Guide to Legionella control in cooling water systems, including cooling towers*. November 2018.
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