



New Brunswick

Technical Guidelines for Water Circulation Systems

COOLING TOWERS

January 19th, 2024
Department of Health



FOREWORD

The New Brunswick Technical Guidelines for *Water Circulation Systems* (herein referred to as “The Guidelines”) were created in consultation with several industry standards and regulatory programs from around the world in an effort to create a regulatory program that is evidence based and adaptable to best industry practices.

As per section 24.3(1) of the *Public Health Act* and section 6.2 (1) of the *Water Circulation Systems Regulation*, the holder of a licence to operate a *Water Circulation System* must operate and maintain their system as per these Guidelines. This approach was taken to help *Licensees* meet regulatory requirements and to allow more flexibility for the province to update these requirements for a sector that is rapidly growing and evolving.

The Guidelines will be updated as required to reflect changes to industry standards and best practices, or for other reasons deemed appropriate by the *Minister*.

Should The Guidelines be updated, *Licensees* or their delegate will be advised, within the provincial *Registry*, and the updated document will be made available through the Government of New Brunswick (GNB) official website.

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GLOSSARY

Accredited Laboratory - for the analysis of *Legionella* samples collected as part of the Water Management Plan (WMP), means a laboratory accredited to ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories) or equivalent, and using an accredited method for the analysis and reporting of *Legionella pneumophila*.

Bacteriologic Culture Sampling and Analysis - means the collection of a water sample for the measurement of live culture growth of the aerobic bacterial populations.

Biocides - oxidizing and non-oxidizing substances that kill micro-organisms and which are registered with the Pest Management Regulatory Agency of Health Canada and have a pest control registration number on the product label.

Cleaning - physical, mechanical, chemical, or other removal of biofilm, scale, debris, rust, other corrosion products, sludge, algae, and other potential sources of contamination.

Control - management of operational conditions in order to maintain compliance with established criteria.

Control Location - a point where a physical, mechanical, operational, or chemical control measure is required.

Control Limit - a maximum and minimum value, or a range of values to which a chemical or physical parameter associated with a *control measure* must be monitored and maintained to reduce the occurrence of a hazardous condition to an acceptable level.

Control Measures - manual repairs or alterations made to *Cooling Towers* for proactive or preventative reasons, a disinfectant, heating, cooling, filtering, flushing, or other means, methods, or procedures used to maintain the physical or chemical conditions of water to within *control limits*.

Cooling System - means one or more *Cooling Towers* that share one or more components of their superstructure and includes all components, process instruments and appurtenances through which water flows or comes into contact with the *Cooling Tower*, including biocide, anti-scaling and anti-corrosion chemical applicators, valves, pumps, the tower superstructure, condensers and heat exchangers, and any other related components.

Cooling Tower - includes an evaporative condenser and fluid cooler.

Corrective Actions - procedures designed to prevent and control the growth of *Legionella* in a *Cooling Tower* system that must be implemented, including *Disinfection*, *cleaning*, flushing, and other activities to return *control* values within the *control limits* as identified through monitoring, *Inspections*, or other means as determined by the *Minister*.

Disinfection - using one or more *biocides* at a defined concentration, under specific conditions, and for an established period that will kill or inactivate pathogenic microorganisms.

Idling - turning off or limiting water circulation within the *Cooling Tower* system but not draining the system water.

(Quarterly) Inspection - examination, testing, and other activities that are required on a regular basis in accordance with the *Regulation* and *Water Management Program*, including the completion of a written or electronic checklist, and conducted by a *Qualified Operator*.

Licensee - a person who holds a licence to operate a *Water Circulation System* issued by the province of New Brunswick.

Medical Officer of Health (MOH) - appointed by the *Minister* under section 59 of the Public Health Act.

Minister - The *Minister* of Health or any person designated to act on the *Minister's* behalf.

Quantitative Polymerase Chain Reaction (qPCR) Test - a molecular diagnostic method for measuring DNA in microorganisms.

Water Quality Specialist - means a person meeting any of the following requirements; (a) a licensed and registered professional engineer in the Province of New Brunswick; (b) a certified industrial hygienist; (c) an industry expert with a valid ASSE/IAPMO/ANSI 12000 Series certification and direct experience in developing *Legionella* management programs in accordance with current standard industry protocols, including two (2) years of operational experience in water management planning and operation; or (d) other qualifications deemed acceptable by the *Minister*.

Qualified Operator - a licensed professional engineer; a certified industrial hygienist; a certified water technologist; a person with a valid ASSE/IAPMO/ANSI 12000 Series certification with applicable experience; an environmental consultant; a water treatment professional with training and experience performing *Inspections* in accordance with current standard industry protocols; or other qualifications deemed acceptable by the *Minister*.

Registry - the New Brunswick *Cooling Tower Registry*, operated by the Government of New Brunswick (GNB), and powered and managed by GroveWare Technologies Inc., under contract to GNB.

Regulation - the *Water Circulation Systems Regulation – Public Health Act*.

Responsible Person - a person employed or whose services are retained by a *Licensee*, who understands and is capable of performing the required daily water quality measurements, weekly system monitoring, and operation and maintenance of a *Cooling Tower* system in accordance with the *Water Management Program* and who makes recommendations for diagnosing anomalous conditions that require *Corrective Actions*, under the guidance of a *Water Quality Specialist*.

Risk Management Assessment - a process for comprehensively identifying, describing, and evaluating in detail all aspects of a *Cooling Tower* system that may potentially contribute to the growth and dissemination of *Legionella* bacteria.

Routine Monitoring - evaluation, visual *Inspections*, and other related activities that must be completed periodically in accordance with the maintenance program and the *Regulation*.

Stagnant Water - water that is confined, standing, experiencing a period of low flow or usage, and not being actively circulated through the *Cooling System*.

System Shutdown - shut down and drainage of the *Cooling System* when cooling is no longer needed for an extended period (greater than 5 days).

System Start-up - commissioning a new system or putting an existing *Cooling Tower* system back in operation after *System Shutdown* or *Idling*.

Validation - procedures to confirm, both initially and on an ongoing basis, that the *Water Management Program* effectively controls the hazardous conditions related to *Legionella* throughout the building water systems.

Verification - procedures to confirm, both initially and on an ongoing basis, that the *Water Management Program* is being implemented as intended.

Water Circulation System - under Section 1 of the *Public Health Act*, means a *Cooling System* as defined in the *Regulation*.

Water Management Program - a written set of measures describing system assessments, corrective and preventative measures, monitoring, testing, and sampling, *cleaning*, *Disinfection*, and all other activities necessary for the prevention and control of *Legionella* growth in a *Cooling Tower* system, that is in accordance with the *Regulation*, The Guidelines, industry standards, and manufacturer's instructions, and is developed by a *Water Quality Specialist*.

Water Quality Parameters - temperature, pH, conductivity, biocidal indicator, bacteriological indicator, and other chemical, physical, and biological indicators of system *control*.

1. Introduction

PURPOSE

Legionnaires' disease is a serious respiratory illness caused by the bacteria *Legionella*, which thrives in water. When water containing a large quantity of *Legionella* is released into the air in the form of droplets or mist, people may be exposed by breathing in the contaminated air. *Legionella* can cause fever, cough, muscle pain, and headaches, and can lead to pneumonia. Symptoms typically start within two to fourteen days of infection and can last for several months. The illness can be severe, progressing to respiratory failure and death in 10-15% of cases.

Certain conditions may exist in *Cooling Towers* that promote the growth of the bacteria. These include *Stagnant Water*, warm water temperatures (especially between 20°C and 50°C), and the presence of biofilm, scale, and sediment. *Cooling Towers* can release large quantities of water droplets to the air and spread over several kilometers, which is likely why they are often linked to outbreaks of Legionnaires' disease.

Legionella only becomes a significant public health concern when it is allowed to grow out of control in building water systems. According to US Centers for Disease Control and Prevention (US CDC) investigations almost all (9 in 10) Legionnaires' disease outbreaks were caused by problems preventable with more effective water management. The Guidelines, together with the *Water Circulation Systems Regulation – Public Health Act* and the online templates within the *Cooling Tower Registry* will help Licensees and *Cooling System* operators implement *Water Management Programs* for their systems to minimize the risk of Legionnaires' Disease associated with *Cooling Towers*.

APPLICABILITY

The Guidelines have been established as part of, and in accordance with, the *Water Circulation Systems Regulation – Public Health Act*. A "Water Circulation System", as defined in the *Water Circulation Systems Regulation*, means a "Cooling System" which in turn refers to one or more *Cooling Towers* that share one or more components of their superstructure and includes all components, process instruments and appurtenances through which water flows or comes into contact with the *Cooling Tower*, including biocide, anti-scaling and anti-corrosion chemical applicators, valves, pumps, the tower superstructure, condensers and heat exchangers, and any other

related components. A *Cooling Tower* includes an evaporative condenser and fluid cooler.

Under the Public Health Act, *"no person shall operate a Water Circulation System (Cooling System) unless the person holds a license to operate a Water Circulation System"* and *"a holder of a license ...shall operate and maintain the Water Circulation System in accordance with the standards and requirements prescribed by Regulation."*

The terms and conditions outlined in The Guidelines, including specific standards and requirements, are required under section 6.2(1) of the *Water Circulation System Regulation*, and, therefore, are binding on *Licensees* responsible for maintaining *Cooling Systems*. For the purposes of subsection 24.3(1) of the Act, the standards and requirements are those specified in The Guidelines. Please note, The Guidelines specifies when articles are recommendations rather than requirements.

2. Roles and Responsibilities

This section outlines the roles and responsibilities of stakeholders involved in the development of *Water Management Programs*, and in the management of *Cooling Systems*. Each stakeholder has an important role in ensuring that *Cooling Systems* are properly managed, comply with regulatory requirements, and that safeguards put in place by the *Water Management Program* are being followed. Table 1 summarizes these roles and responsibilities.

Table 1: Roles and Responsibilities

Stakeholder	Roles & Responsibilities
Licensee	Responsible to ensure the <i>Cooling System</i> is operated and maintained in accordance with the <i>Act</i> and <i>Regulation</i> ; that required actions are reported to the <i>Registry</i> and that the <i>Medical Officer of Health</i> (or their delegate) is advised of adverse <i>Legionella pneumophila</i> results within the established timelines.
Water Quality Specialist	Responsible for the development of all aspects of the <i>Water Management Program</i> .
Qualified Operator	Responsible for the management of the <i>Cooling System</i> on a routine basis including <i>Quarterly Inspections</i> , maintenance, <i>cleanings</i> , and <i>Disinfections</i> .
Responsible Person	Responsible for performing the required daily water quality measurements, weekly system monitoring, and operation and maintenance of a <i>Cooling Tower</i> system in accordance with the <i>Water Management Program</i> , and identifies issues that require <i>Corrective Actions</i> , under the guidance of a <i>Water Quality Specialist</i> .
Accredited laboratory	Responsible for testing <i>Legionella</i> water samples and reporting results to the <i>Licensee</i> , providing advice on how to prepare, collect and ship samples. It is also best practice for laboratories to report counts equal to or above 1,000 CFU/mL or MPN/mL to the <i>Medical Officer of Health</i> (or their designate).
Medical Officer of Health	As per the <i>Act</i> and <i>Regulation</i> , may require actions to be taken by a <i>Licensee</i> to address a potential health hazard to the public posed by their <i>Cooling System</i> , including required response to adverse sample results and initiating investigations following reported incidences of Legionnaires' Disease.

Ultimately, it is important to recognize that it is the responsibility of the *Licensee* to ensure the system is meeting all regulatory requirements. As such, the *Licensee* shall:

- Have a *Water Management Program (WMP)* prepared by a *Water Quality Specialist*
- Ensure the WMP meets the minimum requirements outlined within *The Guidelines* as amended from time to time
- Designate a *Responsible Person* to operate and maintain the *Cooling System* in accordance with the WMP
- Retain a *Qualified Operator* in accordance with the WMP

3. Understanding Risk Factors Associated with *Cooling Systems*

PURPOSE

This section provides information relating to key risk factors for *Legionella* growth and transmission in *Cooling Systems*. An understanding of these risks should underpin all aspects of the management of *Cooling Systems*, including installation, operation, maintenance, and risk assessments. As such, members of the *Water Management Program* team, as described below, are encouraged to seek out further details on how to identify, assess and control the risks associated with *Cooling Systems*.

3.1 STAGNANT WATER

Stagnant Water increases the risk of microbial growth in *Cooling Systems*. Inadequate circulation of cooling water and water treatment chemicals through the system can allow microorganisms to be left undisturbed for long periods of time, develop biofilm, and multiply at a rapid rate. A subsequent disruption to the *Stagnant Water* can seed the *Cooling System* with large numbers of microorganisms, including *Legionella* bacteria.

The risk of *Stagnant Water* can increase due to:

- The presence of water in dead legs
- The system not being in use, due to intermittent operation or seasonal usage

3.2 NUTRIENT AVAILABILITY & GROWTH

Nutrient availability can promote the rapid growth of bacteria such as *Legionella* in *Cooling Systems* and must be managed appropriately. The risk of nutrient availability and growth can increase when:

- Nutrients are present
- Biofilm is present
- Water temperature is within a range that supports microbial growth
- Water is exposed to direct sunlight which promotes algal growth

3.3 POOR WATER QUALITY

Ensuring good circulating water quality is fundamental to preventing *Legionella* growth and transmission. The risk of poor water quality can increase due to:

- High concentration of *Legionella* bacteria (all species may be considered as potential pathogens)
- High concentration of other heterotrophic bacteria
- Presence of protozoa and algae
- Poor water quality, including:
 - Cleanliness
 - pH
 - Presence of corrosion products
 - Presence of scale and fouling
 - Conductivity/total dissolved solids
 - *Control limits* out of range
 - Suspended solids (e.g., from nearby construction work)
 - Control of water treatment chemicals
 - Control of bleed
- Characteristics of make-up water (physical, chemical, microbial)
- Ineffective microbial control program

3.4 DEFICIENCIES IN THE COOLING SYSTEMS

Mechanical deficiencies in *Cooling Systems* can increase the risk of *Legionella* growth and transmission. These include:

- Smaller system size (surface area available for biofilm development compared with water volume)
- Poor physical condition of the system
- Aerosol generation and poor drift elimination

3.5 LOCATION AND ACCESS TO COOLING TOWERS

The following location and access issues can increase the risk of *Legionella* growth and transmission:

- Aerosol dispersion and public access to the *Cooling System*
- System location and environment (environmental contamination, and burden on water treatment chemicals)
- Lack of system access for *Inspection*, maintenance, and *cleaning*

4. *Water Management Program*

PURPOSE

According to the US CDC, *Water Management Programs* (WMP) identify hazardous conditions and take steps to minimize the growth and transmission of *Legionella* and other waterborne pathogens in building water systems. WMPs should comprise all practices, procedures, documents, and records pertaining to the *Cooling System*. This includes all aspects of treatment, monitoring, operating, maintenance, testing, and record keeping. Developing and maintaining a *Water Management Program* is a multi-step process that requires continuous review.

The main components of a *Legionella* WMP are:

- Establish a water management team
- Describe the building water systems using text and flow diagrams
- Perform a *Risk Management Assessment* (RMA) to identify areas where *Legionella* could grow and spread
- Determine *control locations* in the system where *control measures* are required.
- Determine for each *control measure* at each *control location* the *control limits* which may include a maximum value, minimum value, or a range of values within which a chemical or physical parameter must be monitored and maintained.
- Establish *Corrective Actions* to be taken when an assessment or subsequent monitoring indicates that the parameters are outside of the *control limits*.
- Make sure the program is running as intended (*Verification*) and is effective (*Validation*)
- Document and communicate all activities relating to the WMP

Recommendation: *Licensees* are encouraged to consider creating WMPs which address all aerosol-producing devices that are at higher risk of amplifying *Legionella* in their building including, but not limited to, showers, whirlpool spas, humidifiers, decorative fountains, and grocery store produce misters. These devices have all been associated with outbreaks of Legionnaires' disease.

4.1 WATER MANAGEMENT PROGRAM REGULATORY REQUIREMENTS

As per sections 6.3(1) to 6.3(5) of the *Regulation*, all licensed *Cooling Systems* must have and follow a WMP prepared by a *Water Quality Specialist* (WQS), or by a person working under the direct supervision of a WQS. In the case of a person working under the supervision of a WQS, the WQS must review the work and sign off on the WMP. The WMP must be revised at least once every five (5) years, or in any of the following situations:

- Alteration to the *Cooling Tower* affecting the WMP
- A change in procedures for maintaining the quality of water
- The use of *Corrective Actions*
- Changes to applicable laws, regulations, standards, or guidelines
- As required by the *Minister* or a *Medical Officer of Health*

Recommendation: For *Cooling Systems* identified through the *Risk Management Assessment* (RMA) as being at higher risk of amplifying *Legionella* because of age, design, location, or history of adverse results, it is recommended that the elements of the WMP should be reviewed on an annual basis.

At a minimum, each system's WMP shall include the following key elements:

- WMP team
- Description of the *Cooling System*
- Process Flow Diagram
- *Risk Management Assessment*
- *Control Measures* (including locations and limits)
- *Corrective Actions & Contingency Planning*
- Operational procedures
- *Verification & Validation*

Each section of the WMP, as specified in this document, must be submitted to the *Minister* via the *Registry* by completing fillable fields. Whenever possible, the *Registry* will not allow users to input information into the WMP that is not harmonious with regulatory requirements. Should any modifications be made to the WMP, the online version uploaded to the *Registry* must be updated to include the applicable modifications within 21 days of the changes being adopted.

4.2 UNIQUE COOLING TOWER IDENTIFICATION NUMBER

When a *Cooling Tower* is registered within the *Registry* it is assigned a unique *Cooling Tower* identification number.

As per section 6(2) of the *Regulation*:

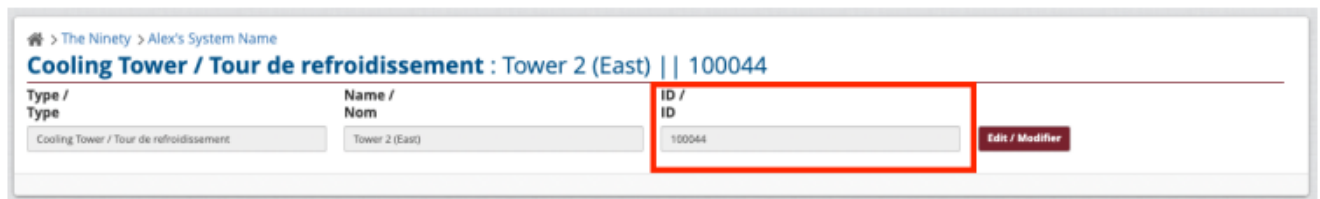
"The holder of the licence shall display on each Cooling Tower the assigned identification number on a sign or plate that is

- (a) no less than 20 cm by 25 cm in size,*
- (b) securely fastened in a clearly visible location, and*
- (c) constructed of a durable, weather-resistant materials*

Every registered Cooling Tower has an identification number generated by the Registry which can be found on the Cooling Tower dashboard."

See **Figure 1** below which depicts a screenshot of an example *Cooling Tower* dashboard with the *Cooling Tower* identification number identified by a red box.

Figure 1: Cooling Tower Identification Number



This unique identification number will allow all stakeholders to quickly identify *Cooling Towers* when on location and accurately document and report required actions and outcomes associated with that individual tower.

When a *Cooling Tower* is described within the WMP and on any required forms or documentation such as *Inspections*, *cleanings*, sampling requisition forms and reports, the identification number of the tower must be noted.

4.3 WATER MANAGEMENT PROGRAM TEAM

Licensees are responsible for assigning and delegating roles, responsibilities and authority for the actions required by the WMP. The members of the team shall be familiar with the *Cooling System* and the operating and maintenance requirements required by the WMP. In addition, team members should be familiar with pertinent rules and regulations associated with the operation of *Cooling Systems* within the province of New Brunswick.

Certain skills, experience, and knowledge are needed to develop and implement a *Water Management Program* which are typically provided by a combination of people, some of whom may meet multiple necessary criteria. Examples of applicable skills, knowledge and experience include knowledge of *Cooling Systems*, experience overseeing programs, the ability to communicate regularly and effectively, and the ability to identify and take *Corrective Actions*. Consider who, among your employees, partners, and outside experts, would be able to provide the skills, experience, and knowledge to help develop the most effective program possible. At minimum, the WMP team shall include the following members and shall be submitted to the *Registry*:

- *Licensee*
- *Responsible Person*
- *Water Quality Specialist*
- *Qualified Operator*
- *Accredited Laboratory*

Additional members could include:

- Maintenance and Engineering personnel
- Equipment or chemical suppliers
- Microbiologist
- Environmental Health Specialist
- Other

The *Registry* will require the name, role, and contact information for each team member entered for the WMP, as well as offer the option to include descriptions of specific responsibilities, applicable certifications, or other pertinent information.

4.4 DESCRIPTION AND PROCESS FLOW DIAGRAM

A simple written description of the cooling equipment and devices associated with your *Cooling System* is required as part of the WMP. This description may include details such as:

- Where the building connects to the municipal water supply
- How water is distributed
- Locations prone to water stagnation
- Purpose served (such as comfort cooling or process cooling)
- Number of *Cooling Towers*
- Location and accessibility of equipment
- Source and type of water supply

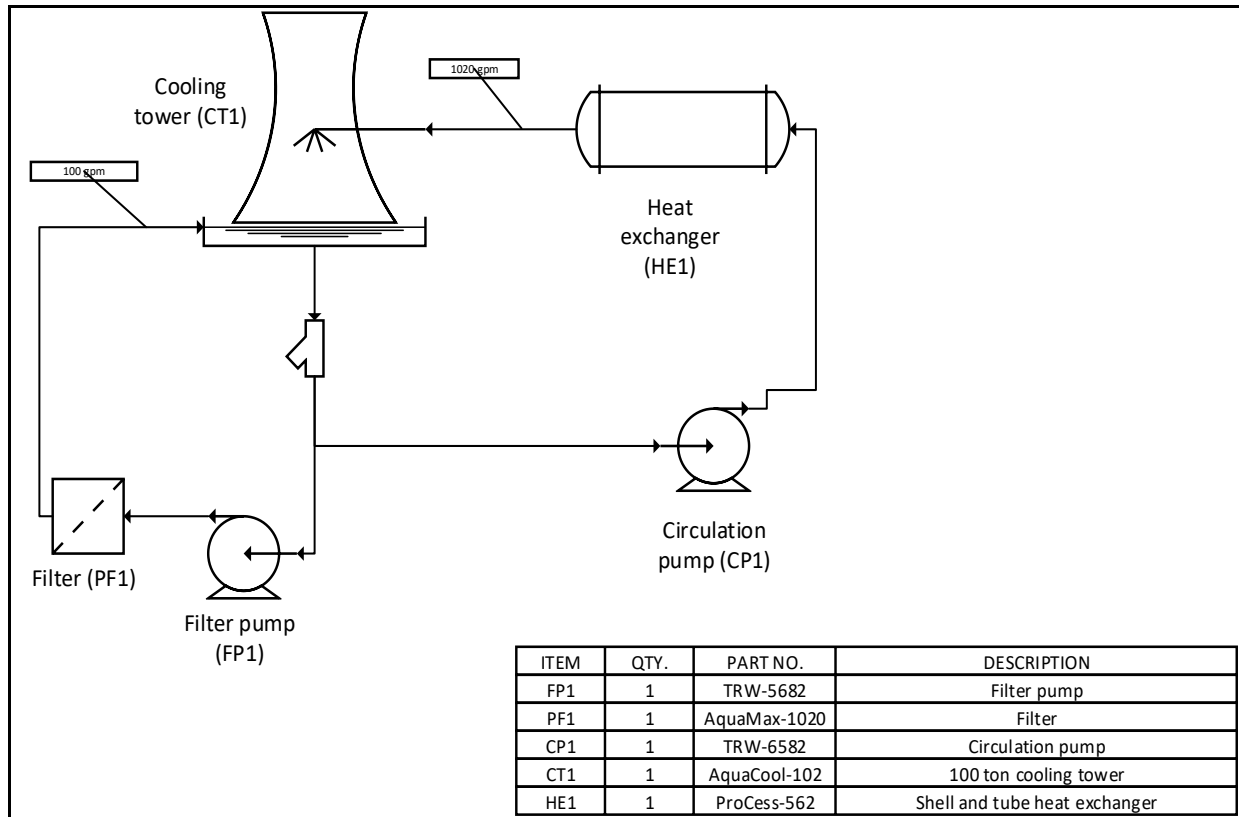
In addition to the written description of the *Cooling System*, the WMP shall include a process flow diagram showing the major components of the *Cooling System*. The diagram should accurately depict the *Cooling System*, show the progressive flow of water, and identify important locations and elements. In particular, the diagram should identify:

- *Cooling Towers* and evaporative condensers (identified by the unique *Cooling Tower* ID number)
- Chillers, heat exchangers, and other heat-transfer devices
- Pumps
- Chemical injection points
- Sampling and monitoring locations
- Valve locations (shut off, float, draining, etc.)
- Water lines
- *Control* mechanisms

Note, the diagrams do not need to be overly detailed. The best diagrams are typically simple schematics that can be readily understood by the WMP team members.

Process flow diagrams shall be submitted to the *Registry* in PDF format, or as an image-based file.

Figure 2: Process Flow Diagram example



Source: New York State Department of Health- Bureau of Water Supply Protection, August 2017

4.5 RISK MANAGEMENT ASSESSMENT

A *Risk Management Assessment (RMA)* is used to comprehensively identify, describe, and evaluate, in detail, all aspects of a *Cooling System* that may potentially contribute to the growth and dissemination of *Legionella* bacteria. It is a central and vital component of an effective WMP. *Risk Management Assessments* improve the understanding of a *Cooling System* and assist facility management with minimizing risks associated with *Legionella*. It should be used, along with manufacturer’s recommendations, to inform what *control measures* are required to ensure the safe operation of the *Cooling System* as well as the frequency of monitoring for these *control measures*.

Risk management assessments must be prepared by a *Water Quality Specialist (WQS)*, or by a person working under the direct supervision of a WQS. In the case of a person working under the supervision of a WQS, the WQS must review the work and sign off on the WMP. Additionally, an RMA must include at least one (1) site visit of the applicable system for which the assessment was conducted.

The RMA shall take into consideration specific elements relating to the *Cooling System*, such as those outlined below:

- General *Cooling System Disinfection*, Operation and Maintenance Characteristics
 - Current water treatment measures (biocide usage and dosing, corrosion *control measures*, monitoring and sampling practices, etc.)
 - Areas of water stagnation (dead legs, intermittent or seasonal usage)
 - Nutrient availability and growth (presence of nutrients, biofilm, water temperature, direct sunlight)
 - Water quality characteristics (concentration of *Legionella*, heterotrophic bacteria, algae, cleanliness, pH, corrosion products, scale and fouling, conductivity/total dissolved solids)
 - General condition of system and equipment
- *Cooling Tower* drift and proximity factors
 - Height of *Cooling Tower*
 - Presence of drift eliminators
 - Potential drift radius
 - Proximity to other *Cooling Towers*
 - Proximity to general population/downtowns
 - Proximity to at-risk population (hospitals, schools, retirement facilities, etc.)
- System History
 - Cases of legionnaire's disease relating to the *Cooling System*
 - History of *Legionella* colonization within the *Cooling System*
 - Review of historical sample data
- Evaluation of makeup water infrastructure
 - Source type (private or municipal, ground water or surface water)
 - Recent/history of water main breaks
 - Age of infrastructure

Water Quality Specialists are encouraged to consult other industry standards and guidelines prior to conducting RMAs to identify other potential hazardous characteristics that are not identified above.

4.6 CONTROL MEASURES

Aspects which could contribute to *Legionella* growth within the *Cooling System* will have been identified once the *Cooling System* has been evaluated through the RMA. The results of the RMA, as well as the manufacturer's recommendations, must be used to determine *control measures*, *control limits* and *control locations* required to prevent *Legionella* growth and spread within the *Cooling System*.

Control measures are the actions that are carried out in your *Cooling System* to limit growth and spread of *Legionella*, such as flushing, adding disinfectant, or *cleaning*.

Control limits are the maximum, minimum, or range of values that are acceptable for the control measures that you are monitoring.

Control locations are areas in the *Cooling Systems* where control measures can be applied.

Safe operation and regular *Cooling System* maintenance can help reduce the risk to building operators, staff, visitors, and the adjacent community from exposure to *Legionella*. The necessary frequency of these activities depends on the cooling load, the environmental conditions present in the area, and the *Cooling System's* design. The use of a *Water Management Program* provides a method to establish, track, and improve operation and maintenance activities.

Control measures typically fall within two categories: one-time actions, or ongoing measures. Examples of one-time actions include installing high-efficiency drift eliminators or automating the addition of *biocides*. Ongoing measures are practices that are adopted and used throughout the operating life of the *Cooling System*. In addition, ongoing *control measures* often include *control limits* for normal or optimal system operation. Users are encouraged to establish the *control measures* for operation and maintenance of the *Cooling Systems* with the following guidelines in mind:

- Follow manufacturer recommendations for *cleaning* and *Disinfection* prior to commissioning, before start-up, when *Idling*, and after shutdown.
- Operate *Cooling Tower* systems at the lowest possible water temperature, and below the most favorable *Legionella pneumophila* growth range (77–113°F, 25–45°C), if possible.
- Automate anti-corrosion, anti-scale, and disinfectant addition and monitoring.

- Monitor *Water Quality Parameters*, like disinfectant residual and pH, on a regular basis.
- Flush low-flow pipe runs and dead legs at least weekly.
- Balance operating times among *Cooling Towers* to prevent stagnation when multiple *Cooling Towers* or cells exist.
- Implement automated blowdowns (intentional discharge of system water and replacement with supply water) to maintain system water quality.
- Consider filtration to reduce the level of suspended solids in the cooling water based on system factors (e.g., *Cooling Tower* location, particle load).
- Consider performing an off-line *Disinfection* and *cleaning* annually.
- Monitor *Cooling Towers* for water service disruptions and develop plans to respond accordingly.
- Consider annual summertime hyperhalogenation

Monitoring and measurement frequencies for *control measures* should be based on the performance of the *Cooling System*, the *Water Management Program*, and *Legionella* performance indicators. The frequencies should also be adjusted according to the state and stability of these performance indicator values. For example, the measurement frequency should be increased if there is a high degree of measurement variability.

Performance monitoring is an essential part of the risk management process. Such monitoring will provide valuable information regarding the effectiveness of the current *control* program and more specifically, the efficacy of the *control measures* in place. Performance monitoring is not restricted to just biological *control* parameters. All aspects within a *control* program should be monitored to ensure they remain effective, and the risk is managed. This should include any mechanical, operational and/or chemical aspects of the overall program. Any monitoring to determine scale or corrosion will provide additional information.

In order to promote consistency and clarity, *Licensees* should physically label *control locations* within the *Cooling System*. These should include sampling locations and injection points. This will help to ensure that samples are being collected and chemicals are being added at the correct locations within the system.

4.6.1 WATER QUALITY PARAMETER MONITORING

An important aspect of the operation of *Cooling Systems* is water quality. Water quality affects system performance and maintenance requirements and is an important indicator of the overall system health and condition. *Water Quality Parameter* monitoring is a valid monitoring tool for the continued and intended operation of the microbial *control* program. Increasing trends are indicative of a need to address all aspects of the microbial *control* program to assess the causes.

The parameters to be monitored, as well as the methods and frequencies of monitoring, shall be established by a *Water Quality Specialist* during the development of the WMP. They may include parameters such as:

- Temperature
- pH
- Conductivity
- Bacteriologic culture sampling
- Biocidal indicator or treatment chemical residuals
- other chemical, physical, and biological indicators of system *control*

When establishing the *Water Quality Parameter* monitoring requirements, it is important to also establish *control limits* for normal or optimal system operation.

4.6.2 BACTERIOLOGIC CULTURE SAMPLING AND ANALYSIS

Bacteriologic culture sampling and analysis is a practical tool for monitoring the health and condition of a *Cooling System*. Trending of the concentrations of bacterial populations in the bulk water can be used to confirm that amplification is being controlled. Monitoring these bulk water planktonic populations is not a proxy for *Legionella* populations, but it is a valid monitoring tool for the continued and intended operation of the microbial *control* program. Increasing trends are indicative of a need to address all aspects of the microbial *control* program to assess the causes.

The WMP must include *control measures* related to *bacteriologic culture sampling and analysis* including a prescribed method, a monitoring frequency and performance objectives. In the case of *bacteriologic culture sampling and analysis*, performance objectives should include normal operating levels and actionable limits (i.e., maximum concentration limit).

Table 2: EXAMPLE - Bacteriologic Culture Control Measures

Total Bacterial Count (cfu/mL)	Example of possible responses
Below 10,000	Maintain operations
Between 10,000 & 100,000	<ul style="list-style-type: none"> • Increase dosage rate of <i>biocides</i> to reduce the count to <10,000 cfu/mL • Resample • Document efforts required to return to normal operating levels • Review WMP
Greater than 100,000	<ul style="list-style-type: none"> • Perform an on-line <i>Disinfection</i> • Resample 2-7 days after system has returned to normal operating conditions • Document efforts required to return to normal operating levels • Review WMP

4.6.3 VISUAL INSPECTIONS

It is important to maintain the cleanliness of both the system and the water within it. Visual *Inspections* of readily accessible areas provide a qualitative *Verification* of the *Cooling System's* cleanliness and its potential risk for fouling. Safe access is required to all areas to be inspected. In addition, when undertaking such *Inspections* additional care should be applied to ensure proper use of personal protective equipment.

Visual *Inspection* of sections of the system may only be possible at predetermined intervals, for example, at *System Shutdown* or when *cleaning* operations are undertaken. Visual *Inspection* can provide evidence of the presence of biofilm within the system, as well as inorganic and/or non-microbial foulants (for example, airborne or process contamination).

During the visual *Inspection* certain mechanical failures may also be identified. Particular attention should be paid to any visible damage to the drift eliminators, which may lead to emission of excessive drift or water spray.

As part of the WMP, a *Water Quality Specialist* shall identify the frequency, methods, and locations for routine visual *Inspections*. In addition, the visual *Inspections* must take into account and include any manufacturer's recommendations for such *Inspections*.

4.6.4 QUARTERLY INSPECTIONS

Quarterly Inspections (QI) must be included and detailed by a *Water Quality Specialist* within a WMP. QIs must include visual observations of the *Cooling System* and its components which can be seen safely without requiring draining or otherwise interrupting system operations. This includes observations which require entering the *Cooling Tower*. *Inspections* shall include evaluations of the *Cooling System* exterior, interior, hot deck, basin, accessible components, and chemical dosing and control equipment.

Quarterly Inspections are required for all *Cooling Systems* which are in operation based on the following minimum frequency parameters:

- Required within 15 calendar days of bringing a system online
Note: the QI can be done as part of the start-up/reopening procedures
- Minimum of 45 calendar days between *Inspections*
- Maximum of 90 calendar days between *Inspections*
- Must have a QI in July or August of every year

Quarterly Inspections must meet the following requirements:

- Conducted or overseen by *Qualified Operator*
- Include a comprehensive visual *Inspection*
- Summarise notable activities & events relating to the *Cooling System* which occurred since last *Quarterly Inspection* (e.g., replaced parts, water main breaks/water supply issues, etc.)
- Determine if any *cleaning* or maintenance is required for the *Cooling System* as per limits identified as part of the WMP

Note: Consideration should be given for *Quarterly Inspections* to be conducted by different *Qualified Operators* to ensure they provide an unbiased evaluation of the *Cooling System's* physical and operational condition.

4.6.5 **LEGIONELLA TESTING**

Legionella testing is a valuable *Validation* tool for confirming the effectiveness of the WMP's ability to control *Legionella pneumophila* growth within the system, as well as for confirming that *Corrective Actions*, and *cleaning* and *Disinfection* procedures have been carried out successfully. Although, trending *Legionella* testing results for a system can be used as a performance indicator for the control of growth, it is important to recognize that test results are not a definitive indicator of safe operation. Low *Legionella pneumophila* concentrations do not imply that the system cannot cause disease. Sampling results are to be used to provide feedback about the current program's ability and effectiveness in controlling *Legionella* growth.

When conducting testing, all test procedures and sample preparations must be appropriately documented in order to demonstrate that testing was carried out in accordance with the laboratory and manufacturer's instructions, and *The Guidelines*.

Cooling Systems must be tested at least once per thirty (30) days of operation for ***Legionella pneumophila*** (LP). Samples must be collected and analyzed in accordance with the following:

- Samples must be sent to an *accredited laboratory* for analysis and accompanied by a form approved by the *Minister* (sampling date, time, location, person responsible)
- Samples must be analyzed using a validated method that is accredited to ISO 17025 standards. Examples of such methods include, but are not limited to: ISO 11731:2017, validated qPCR or ASTM D8429-21 test platforms
- Sample results must be reported in CFU/mL or MPN/mL
- A sample must be collected within ten (10) days of bringing a system online as part of a *System Start-up*
- If there is an indication that interfering flora may have affected the results, a running *Disinfection* within 48 hrs and a resample within 2-7 days of *Disinfection* is required
- If the *Cooling System* does not use continuous *Disinfection*, samples must not be taken less than 48 hours after the application of *biocides*
- Resampling following *Corrective Actions* must be collected **between 2 and 5 days** of the actions being completed
- All test results received for LP sampling of the *Cooling System* must be reported to the *Registry* within 5 days of the laboratory reporting date

Note, *Licensees* must **immediately** notify the *Medical Officer of Health* when *Legionella pneumophila* sample results are equal to or exceed 1,000 CFU/mL or MPN/mL.

Contact information for notification to regional MOHs can be found within the *Registry*.

At a minimum, the actionable limits and responses relating to LP test results must be in accordance with the following table.

Table 3: *Legionella pneumophila* Limits & Required Responses

Minimum requirements for <i>Legionella pneumophila</i> Culture Results	
<i>Legionella pneumophila</i> Test Results (CFU/mL or MPN/mL)	Minimum Required Response
10 – 999	<ul style="list-style-type: none"> • Perform <i>cleaning</i> and <i>Disinfection</i> of the <i>Cooling System</i>, as prescribed by WMP for this scenario, within 15 days of receiving the sample results • Perform a visual <i>Inspection</i> of the <i>Cooling System</i> • Within no less than 48 hours and no more than five (5) days after <i>cleaning</i> and <i>Disinfection</i>, perform a <i>Legionella pneumophila</i> test • Investigate cause of contamination • Review and adjust the management program if deemed necessary
Equal to or greater than 1,000	<ul style="list-style-type: none"> • Immediately notify the regional MOH of the result and other relevant information • Immediately implement measures to eliminate water dispersion by aerosol from the affected <i>Cooling System</i> • Perform <i>cleaning</i> and <i>Disinfection</i> of the <i>Cooling System</i> as prescribed by WMP for this scenario • Perform a <i>Legionella pneumophila</i> culture test within no less than 48 hours and no more than five (5) days after <i>cleaning</i> and <i>Disinfection</i> • Investigate cause of contamination • Review and adjust the WMP as needed

It is important to note that test results cannot be used as clinical indicators of “safe” operation. Low *Legionella* concentrations do not imply that the system cannot cause disease. Results provide feedback to the operator about whether the current program is effectively controlling growth or requires adjustments.

4.7 CORRECTIVE ACTIONS AND CONTINGENCY PLANNING

Corrective Actions are taken in response to systems performing outside of *control limits* and must be established as part of the WMP to address these situations when they are encountered. For example, what should the *Responsible Person* do if there is an elevation in water temperature, or an exceedance of a monitoring parameter? It is important to note that when in difficult situations people tend to forget which steps need to be taken and in what order due to stress. For that reason, it is important that the *Corrective Actions* established as part of the WMP are clear and simple to understand, while including as much detail as possible. The *Corrective Actions* will also need to outline who is responsible to carry out each action, and who must be contacted along with their contact information.

As such, a contingency response plan must be established within the WMP and include, as a minimum, the following sections:

- *Water Quality Parameters* do not meet established levels/limits (limit established in WMP)
- Exceedance in established limit for bacteriologic culture samples (limit established in WMP)
- Actions required following visual *Inspections*
- Exceedance of established limit for LP (see minimum requirements in previous section)
- Exceedance of established limit for LSPEC (see minimum requirements in previous section)

At a minimum, each section of the contingency response plan must include the following information:

- The actionable limits/criteria
- Reporting requirements (who must be contacted and how)
- People responsible for reporting
- The necessary *Corrective Actions* which must be carried out
- The people/qualifications required to carry out the necessary *Corrective Actions*
- Record keeping instructions

4.8 OPERATIONAL PROCEDURES

Operational procedures are extremely helpful tools to help ensure that specific tasks are carried out effectively and safely while maintaining *Cooling Systems* as part of WMP. Operational procedures can be used to outline the minimum requirements, such as personnel and qualifications, methods to be used, limiting criteria, equipment, and Personal Protective Equipment (PPE), for each essential task required by the WMP. Operational procedures also provide an opportunity to include helpful information such as who to contact if you have any issues or questions, where to find and how to use the required equipment, or how long each step may take. Operational procedures are intended to identify the key factors to consider when carrying out important tasks required by the WMP.

When developing the operational procedure, the *Water Quality Specialist* must also ensure that the manufacturer's recommendations are being met by the procedures developed as part of the WMP to ensure proper care and maintenance of the equipment.

As part of the WMP, the following operational procedures must be developed and included in the *Registry*:

- System start-up
- *System Shutdown*
- Sampling
- *Cleaning*
- *Disinfection*

4.8.1 SYSTEM START-UP PROCEDURE

The following outlines the minimum requirements for the system start-up procedures:

- Reasons for initiating the procedure
- Reporting requirements (Who needs to be notified, when and how)
- People responsible for carrying out each step of the procedure
- Sequential action plan for bringing system back online, including:
 - *Visual Inspection, cleaning and Disinfection of Cooling System*
 - *Verification* of system components (presence, condition, etc.)
 - Maintenance (if required)
 - *Legionella pneumophila* testing (confirmatory sample)
- Recording keeping

When a *Cooling System* is brought online, the system must be activated within the *Registry*. If a system is in operation without its status being listed as such within the *Registry*, it will be considered in a state of non-compliance with provincial regulatory requirements.

When bringing the system online through the *Registry*, users will be required to submit the following information:

- Date system was brought back online
- Confirmatory statement and signature (electronic) that the reopening procedures were carried out in accordance with the requirements of the WMP
- Date of *Legionella pneumophila* sample collection
- Sample results – including a PDF copy of the report

4.8.2 SYSTEM SHUTDOWN PROCEDURE

The following outlines the minimum requirements for the *System Shutdown* procedures:

- Reasons for initiating the procedure
- Reporting requirements (who needs to be notified, when and how)
- People responsible for carrying out each step of the procedure
- Sequential action plan including the following:
 - Visual *Inspection and cleaning*
 - System draining
- Record Keeping
- Reporting requirements

Once completed, shut-down procedures must be reported through the *Registry* in order for the regulatory requirements to no longer be in force while the system is not in operation. If the system is not listed as offline in the *Registry*, the system is considered in operation for regulatory purposes.

In order for the *Cooling System* to be reported as being offline through the *Registry*, users will be required to submit the following information:

- Date of system shut down
- Reason for shut down
- Anticipated date for bringing system back online (month)
- Confirmatory statement that the procedures were carried out in accordance with the requirements of the WMP
- Date of *Legionella* test collection (if applicable)

- Type of test (if applicable)
- Test results (if applicable)

4.8.3 SAMPLING PROCEDURES

The sampling procedures are required to be outlined within the WMP in order to promote proper sample collection strategies, techniques, and methods. Note, it is the *Responsible Person's* responsibility to ensure the samples are collected as per the requirements of the WMP, and at the required frequency.

It is recommended to contact the *accredited laboratory* analysing the samples to obtain additional information on specific sampling methods or considerations they may require.

At a minimum, the sampling procedures must include the following information:

- Person responsible for collecting the sample
- Person responsible to ensure the samples are sent to the laboratory in the required time frame, and in a safe manner
- Frequency of sampling required (all parameters)
- Collection point for each sample
- Collection methods
- Collection bottles/containers required
- How samples are stored from the time the samples are collected until received by the lab
- Address and contact information for the lab
- How the samples will be delivered to the lab
- What information needs to be filled out on the sample submission form.
- Personal safety and protective equipment requirements
- Record keeping
- Reporting requirements

4.8.4 CLEANING PROCEDURES

Organic material, biofilm, algae, and debris can all provide a place for *Legionella* to grow. As such, offline *cleaning* and *Disinfection* of a *Cooling Tower* will need to be carried out, at a minimum, for any system start-up, at any time; and when required based on *Legionella pneumophila* sample results.

It is important to outline the minimum *cleaning* requirements to ensure it is carried out properly and safely. Note, it is the *Qualified Operator's* responsibility to ensure *cleaning* procedures are conducted as per the requirements of the WMP, and the

Responsible Person's responsibility to ensure they are carried out at the required times or frequencies.

The *cleaning* procedures must include the following minimum requirements:

- People responsible for conducting the *cleanings*
- Frequency or situations which require a system *cleaning*
- Equipment and products required to conduct the *cleaning*
- Components that need to be cleaned
- *Cleaning* methods and techniques
- Personal safety considerations (including PPE)
- Record keeping
- Reporting requirements

If the *cleaning* procedures include a physical *cleaning* of the components of the *Cooling System* that come into direct contact with the system water, the *Disinfection* procedure should also be initiated in order to ensure the *Cooling System* was not compromised during the *cleaning* process.

The *cleaning* procedures must be reported to the *Registry* as part of the WMP.

4.8.5 DISINFECTION PROCEDURES

It is important to outline the minimum system *Disinfection* requirements to ensure it is done properly and safely. Note, it is the *Qualified Operator's* responsibility to ensure system *Disinfections* are carried out as per the requirements of the WMP.

The *Disinfection* procedures must be developed for at least three (3) different scenarios or methods:

- a shock treatment or slug method
- an online or running *Disinfection* method
- an offline *Disinfection* method

Each method shall include the following minimum requirements:

- People responsible for conducting the *Disinfection*
- Frequency or situations which require a system *Disinfection*
- Equipment and products required to conduct the *Disinfection*
- Components that need to be disinfected
- Dosing and holding times
- Personal safety considerations (including PPE)

- Record keeping
- Reporting requirements

The *Disinfection* procedures must be reported to the *Registry* as part of the WMP.

4.9 VALIDATION AND VERIFICATION

The *Validation* and *Verification* (V&V) process allows the WMP team to ensure that the program is being implemented as intended, and to determine whether it is effective in managing the risk factors associated with *Legionella* in the *Cooling System*. The WMP must outline the methods to be used and the frequencies for *Validations* and *Verifications*.

The V&V section of the WMP shall include:

- Outline of the methods to be used to verify that the WMP is being implemented as documented
- Outline of the methods required to validate that the WMP is effectively managing risk factors associated with *Legionella* in *Cooling Systems* as intended
- How the data collected as part of the WMP will be used to verify and validate the WMP's effectiveness

5. Record Keeping

Licensees must keep records of sample results, *Inspection* reports, monitoring data and reports, and any other records pertaining to the *Cooling System's* operations and maintenance for a minimum of three (3) years.

All records must be provided to the *Minister* upon request.

6. Reporting

The following information must be reported to the *Minister* as per the requirements of The Guidelines within the time frames listed below:

- *Legionella pneumophila* sampling and testing results
 - All *Legionella* sampling results collected within a *Cooling System* and analyzed by an *accredited laboratory* must be reported to the *Minister* through the *Registry* within five (5) days of reception.
 - *Legionella pneumophila* test results equal to or exceeding 1,000 CFU/mL or MPN/mL must be reported immediately to the MOH

- System Start-ups
 - Must be reported to the *Registry* within five (5) days of operations starting.

- System Shutdowns
 - Must be reported to the *Registry* within ten (10) days of operations ending.

- Quarterly Inspections
 - Must be reported to the *Registry* within fifteen (15) days.

- System *Cleaning* and *Disinfection* Activities
 - Must be reported to the *Registry* within fifteen (15) days.

- *Corrective Actions* & Contingency Responses
 - Must be reported within the *Registry* within fifteen (15) days of the *Corrective Actions* being completed.

7. Resources & References

- The US Centers for Disease Control and Prevention (US CDC) provides a lot of quality information, forms, toolkits, and training materials that are available for free on their website. The US CDC focuses on controlling the growth of *Legionella* throughout entire building systems, not just in Cooling Systems. <https://www.cdc.gov/Legionella/index.html>
- Public Services and Procurement Canada (PSPC) has played an important role in establishing procedures aimed at preventing outbreaks of Legionnaires' disease (legionellosis) including a published standard, Mechanical Design 15161 – 2013 Control of *Legionella* in Mechanical Systems (standard MD 15161). <https://www.tpsgc-pwgsc.gc.ca/biens-property/Legionella-bacteria-eng.html>
- Managing the risk of legionellosis associated with building water systems. ASHRAE Guideline 12-2020. Atlanta, GA: ASHRAE; 2020
- Cooling Technology Institute. Legionellosis guideline: Best practices for control of *Legionella*. 2008
- Cooling Technology Institute, 2020. Guideline (GDL) 159 – Practices to Reduce the Risk of Legionellosis from Evaporative Heat Rejection Equipment Systems. 2020.
- NSF protocol P453 - 2017: *Cooling Tower Water Systems – Treatment, Operation, and Maintenance to Prevent Legionellosis*.
- Province of Quebec Regulations for water *Cooling Towers* (in French only). <https://www.rbq.gouv.qc.ca/les-grands-dossiers/tours-de-refroidissement-a-leau/reglement-sur-lentretien-dune-installation-de-tour-de-refroidissement-a-leau/>
- City of Vancouver by-laws for water system operating permits. <https://vancouver.ca/home-property-development/operating-permit.aspx>

- New York State, regulatory requirements of the New York State Sanitary Code Title: Part 4-Protection Against *Legionella*.
<https://www.health.ny.gov/environmental/water/drinking/Legionella/index.htm>
- New York City *Legionella* Laws governed by Local Law 77 - 2015 and Title 24 Chapter 8 of the Rules of The City of New York
- Health Protection NSW. NSW Guidelines for *Legionella* Control in Cooling Water Systems. Sydney: NSW Ministry of Health, 2018.