

Ventilation Systems and Prevention of Respiratory Illness: Requirements for Heating, Ventilation and Air Conditioning in Health Care Facilities



Presented by:

Dr. Leon Genesove, Provincial Physician
Ontario Ministry of Labour

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Topics

- Review of Legionnaires' Disease
- Regulatory Review
- HVAC and Potable Water System Maintenance
- Airborne Infection Isolation (AII) Rooms
- Review of Guidelines:
 - MOL, CDC, ASHRAE, CSA
- MOL Expectations



What is Legionnaires' Disease?

- Potentially fatal pneumonia caused by infection with *Legionellae* bacteria
- Certain conditions will cause *Legionellae* growth in water systems or air handling systems with cooling towers (e.g. water temp. of 30-45 °C)
 - Refers to open, recirculating water, cooling tower systems
- Risk when bacteria grow (amplification) and spraying, splashing, misting, or bubbling of air through contaminated water creates droplets/aerosols
- Infection is caused by inhalation of water droplets or aerosols deep into lungs



Who is at risk?

- Not everyone who inhales the *Legionellae* bacteria will get Legionnaires' disease
- Factors that increase the risk include:
 - Increased age
 - Heavy smoking
 - Weakened immune system
 - Underlying medical problems
 - Heavy consumption of alcohol
- Outbreaks in health care facilities commonly reported because many patients have some of these risk factors



Sources of *Legionellae*

- *Legionellae* bacteria have been isolated from or outbreaks have been associated with:
 - Water mist from cooling towers or evaporative condensers
 - Humidifiers and grocery produce misters
 - Hot and cold potable water distribution systems
 - Hot tubs, spa baths and decorative fountains
 - Non-potable water cooling systems

Conditions for Bacterial Growth

- Conditions that promote the growth of *Legionellae* bacteria in water systems include:
 - Hot temperatures (20-45⁰C; optimal 35-45⁰C)
 - Stagnation (>3 days or used <once per week)
 - Sediment, rust, scale, sludge (as nutrient source)
 - Slime or common water organisms (which provide nutrients and protect *Legionellae*)
 - Cold water systems in which temperature is not maintained below 20⁰C



Ministry of Labour Role

- If an outbreak occurs, the local public health unit leads the investigation
- MOL coordinates with public health where there is joint jurisdiction (i.e. workers are involved)
- MOL investigates to ensure employer takes appropriate precautions to protect workers and prevent a recurrence
- MOL also has proactive role to ensure employers take steps to prevent worker exposure and illness
- MOL developing common approach to Legionella prevention with MOH-LTC



What should employers do?

- Identify and assess the risk of bacterial growth in all water and ventilation systems
- Develop a written preventive maintenance program, with appropriate control measures
- Develop non-emergency and emergency start up and shut down procedures
- Train workers who are maintaining/operating air handling and water systems in measures and procedures (including precautions and PPE)
- Monitor effectiveness of control program on scheduled basis (e.g. measure water temperature, check biocide levels, etc.)

Legislation and Guidelines

- *Occupational Health and Safety Act and Regulation for Health Care and Residential Facilities*
- *CDC Guidelines for Environmental Infection Control in Health Care Facilities (2003)*
- *CDC Guidelines for Preventing Health-Care-Associated Pneumonia (2003)*
- *ASHRAE Guideline 12-2000 Minimizing the Risk of Legionellosis Associated with Building Water Systems*
- *CSA Standard CAN/CSA-Z317.2-01. Special requirements for heating, ventilation, and air conditioning (HVAC) systems in health care facilities.*
- *CSA Standard CAN/CSA-Z317.13 Infection Control during Construction or Renovation of Health Care Facilities.*
- *Health Canada, July 2001, Construction-related Nosocomial Infections in Patients in Health Care Facilities – Decreasing the Risk of Aspergillus, Legionella and Other Infections.*



Occupational Health and Safety Act

Employers' Responsibilities

- **S. 25(1)(b)** – shall ensure that equipment, materials and protective devices are maintained in good condition (i.e. maintain water and ventilation systems to prevent *Legionellae* growth)
- **S. 25(2)(a)** – shall provide information, instruction and supervision to protect workers (e.g. workers involved in preventive maintenance or operation of water and ventilation systems)
- **S. 25(2)(h)** – shall take all reasonable precautions for the protection of workers (i.e. identify, assess and implement control measures to prevent *Legionellae* growth in water and ventilation systems)
- **S. 52(2)** – if an outbreak occurs, the employer must report occupational illnesses to MOL and JHSC, in writing within 4₁₀ days

Regulation for Health Care and Residential Facilities (HCRF Reg.)

Employers' Responsibilities

- **S. 8** – in consultation with JHSC, shall develop, establish and put into effect measures and procedures to protect the health and safety of workers
- **S. 9(1) 4.** – shall reduce to writing measures and procedures for the health and safety of workers for the control of Legionellosis
- **S. 9(1) 1.** – shall reduce to writing measures and procedures to safely inspect, clean and maintain water and ventilation systems
- **S. (1) 12.** – shall reduce to writing measures and procedures for the use, wearing and care of all PPE (i.e. used by workers who operate, inspect, or maintain water and ventilation systems)
- **S. 9(4)** – in consultation with JHSC, shall develop and provide training programs on the measures and procedures

HCRF Reg. – PPE

Employers' Responsibilities

- **S. 10(1)** – shall ensure that workers who are required to wear or use any protective clothing, equipment or device (e.g. to maintain ventilation systems) are trained on its care, use and limitations before wearing or using it
- **S. 10(2)** – shall ensure that the protective equipment is properly used, maintained, inspected, stored, and is a proper fit (e.g. appropriate size, fit testing for respiratory protection, etc.)

HCRF Reg. – Ventilation

Employers' Responsibilities

- **S. 19(2)** – the mechanical ventilation system shall be inspected every 6 months to ensure it is in good condition (i.e. no potential for *Legionellae* growth)
- **S. 19(3)** – shall be inspected by a qualified person
- **S. 19(4)** – qualified person to file inspection report and provide copy to JHCS
- **S. 19(5)** – shall be serviced and maintained in good condition as recommended by manufacturer or by qualified person as per inspection report



MOL Health and Safety Guideline: Ventilation Inspection and Records for Health Care and Residential Facilities

- Requirements re: section 19 of HCRF Reg. and items for semi-annual inspection and record keeping
- HVAC system records should include description of:
 - Location of outdoor air intake and air handling units
 - Air volumes, % outdoor air (and how it is determined)
 - How fans, dampers (outside air, exhaust, supply), temperature, humidity, air distribution are controlled
 - Types of filters and their maintenance schedule
 - Maintenance program for fan/drive components, drain pans, traps, valves, nozzles, dampers, controls, any continuous monitors of contaminant concentrations
 - State type of biocide used and how frequently it is used



MOL Health and Safety Guideline:

(cont'd)

- Inspection by qualified person to ensure that ventilation system is operating properly
- Inspection items include:
 - Exhaust hoods, outdoor air intakes, ductwork, reheat coils/mixing boxes, HVAC equipment, supply air diffusers, return air grilles, fan, thermostats
 - Humidifiers, Cooling Coils, Drain Pans
 - cleanliness, no slime or mould, drains clear, no stagnant water, no odours
 - Cooling Towers
 - Drains clear, no stagnant water, no bird droppings, slime, mould, dirt build up



CDC Guidelines for Environmental Infection Control in Health Care Facilities (2003)

Recommendations – Air

- Air Handling Systems in Health Care Facilities
- Construction, Renovation, Remediation, Repair and Demolition
- Infection Control and Ventilation Requirements for:
 - PE (protective environment) rooms
 - AII (airborne infection isolation) rooms
 - Operating Rooms
- Other Infectious Aerosol Hazards in Health-Care Facilities



Airborne Infection Isolation Rooms

- Maintain continuous negative air pressure
- Monitor air pressure periodically (daily) or with permanent visual monitoring mechanism
- Ensure rooms well-sealed/no leakage
- Self-closing devices on exit doors
- ≥ 12 ACH for renovated or newly constructed rooms; or ≥ 6 ACH for existing rooms
- Direct exhaust air outside, away from intake
- HEPA filtration and/or UVGI filtered exhaust

AII Rooms (cont'd)

- Monitor and document daily the negative airflow in AII rooms
- Monitor AII rooms for ACH, filtration, and pressure differentials
- Provide backup emergency power, air-handling and pressurization systems to maintain filtration, constant ACH, and pressure differentials in AII rooms
- Whenever feasible, design and install fixed backup ventilation systems for new or renovated construction of AII rooms
- Implement environmental infection control measures for persons diagnosed/suspected of having airborne infectious disease



CDC Guidelines for Environmental Infection Control in Health Care Facilities (2003)

Recommendations – Water

- Controlling the Spread of Waterborne Microorganisms
- Routine Prevention of Waterborne Microbial Contamination Within the Distribution System
- Remediation Strategies for Distribution System Repair or Emergencies
- Additional Engineering Measures as Indicated by Epidemiologic Investigation for Controlling Waterborne HC-Associated Legionnaires Disease¹⁹



CDC Guidelines for Environmental Infection Control in Health Care Facilities (2003)

- Recommendations – Water (cont'd)
 - General Infection Control for Preventing Legionnaires Disease
 - Preventing Legionnaires Disease in Protective Environments and Transplant Units
 - Cooling Towers and Evaporative Condensers
 - Dialysis Water Quality and Dialysate
 - Hydrotherapy Tanks and Pools
 - Miscellaneous Medical Equipment Connected to Water Systems



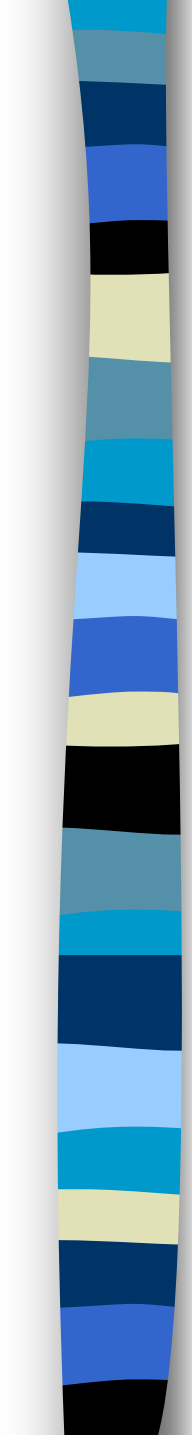
CDC Guidelines: General Infection Control for Preventing Legionnaires

- Conduct infection control risk assessment
- Implement general strategies to detect/prevent Legionnaires disease:
 - surveillance process,
 - inform HC staff re: potential for Legionnaires
 - able to provide lab tests for diagnosis
- Maintain high index for suspicion
- Report of cases of Legionnaires
- Follow up to determine source and institute measures to decontaminate/prevent *Legionella* growth
- Record keeping



CDC Guidelines: Cooling Towers/Evaporative Condensers

- Planning construction of new facilities: locate cooling towers so that drift directed away from air intake system and design towers to minimize volume of aerosol drift
- Implement infection control procedures for operational cooling towers (ASHRAE 12-2000)
 - Install drift eliminators
 - Use an effective biocide on a regular basis
 - Maintain towers according to manufacturer's recommendations and keep detailed maintenance and infection control records, including environmental test results from legionellosis outbreak investigations
- If cooling towers/evaporative condensers implicated in outbreak, decontaminate cooling tower system



CDC Guidelines for Preventing Health-Care Associated Pneumonia, 2003 (Legionnaires)

■ Primary Prevention (no identified cases)

- 1st approach: routine culturing of water samples from health care facility's potable water system
- 2nd approach: prevent/control by maintaining high index of suspicion, investigating potential sources, maintaining cooling towers and potable water systems, maintaining appropriate potable water system temperatures (e.g cold $<20^{\circ}\text{C}$, storing hot $>60^{\circ}\text{C}$, circulating minimum of 51°C)

■ Secondary Prevention (identified cases)

- Reporting
- Investigate to determine source
- Surveillance (should also include workers)
- Decontamination and/or treatment to eliminate problem



Controlling *Legionellae* in Cooling Towers – Examples of Procedures

■ Startup Procedure:

- Close the ventilation air intakes located in the vicinity
- Proceed with a visual inspection
- Add disinfectant in sufficient quantities
- Maintain a considerable amount of disinfectant during at least one day

■ Regular Maintenance:

- Proceed with monthly visual inspection
- Empty and clean the device (4 times/year)
- Treat the water using a biocide
- Log in maintenance operation and results



Controlling *Legionellae* in Cooling Towers – Examples of Procedures

(cont'd)

- Emergency Procedure:
 - Shutdown the water tower systems, except for the recycling pumps
 - Add disinfectant in sufficient quantities
 - Maintain a considerable amount of disinfectant during at least a day
 - Empty the device and repeat the disinfection operation
 - Clean the equipment and remove the grime
 - Fill with water, maintain a considerable amount of disinfectant during at least one hour, and then empty again



ASHRAE Guideline 12-2000

- Guideline 12-2000 -- *Minimizing the Risk of Legionellosis Associated with Building Water Systems*
- The purpose of this guideline is to provide information and guidance in order to minimize *Legionella* contamination in building water systems.



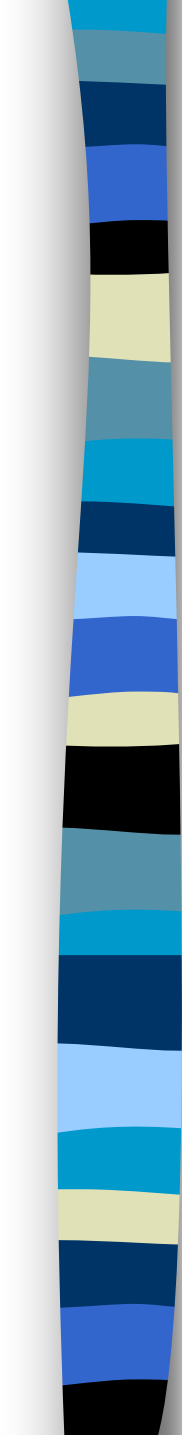
ASHRAE – Potable and Emergency Water Systems

- Factors that may influence growth of legionellae:
 - Chlorine concentration
 - Temperature (25-42°C favourable range)
 - Plumbing system design (e.g. portions with infrequent use, stagnant water, tepid temperature)
 - Plumbing materials (e.g. rubber washers and fittings have been shown to provide sites for legionellae growth)
- Greatest risk when contaminated potable water systems disperse small droplets into air (e.g. shower nozzles, aerators, water impacting hard surface)
- Nutrients – common to detect microbes in sediment in hot water tanks, etc.



ASHRAE – Potable and Emergency Water Systems (cont'd)

- Recommended treatment:
 - Cold water distributed below 20⁰C
 - Hot water stored above 60⁰C and circulated with minimum return temperature of 51⁰C
 - Take great care to avoid scalding
 - Alternative: consider periodically increasing temperature to 66⁰C or chlorination followed by flushing
 - Inspect/clean holding tanks annually
 - Water heaters/storage vessels have drainage at lowest point
 - Pipe runs should be as short as practical
 - Recirculation: insulate pipe runs and avoid dead legs
 - New approach: copper-silver ionization in hot water systems



ASHRAE – Potable and Emergency Water Systems (cont'd)

- High risk patient rooms: monthly removal of shower heads and tap aerators to clean out sediment and scale and clean with chlorine bleach recommended
- Repair/construction: flushing procedures for water systems opened for repair or if systems subjected to pressure changes associated with construction
- If decontamination of hot water system is necessary (e.g. outbreak of Legionnaires):
 - Steps include raising water temperature to 71-77°C
 - Maintain temperature while flushing each outlet
 - If thermal shock treatment is not possible, shock chlorination may provide an alternative



ASHRAE Guideline 12-2000

- Guideline includes recommendations for system design, operation and treatment for the following:
 - Heated spas
 - Architectural fountains and waterfall systems
 - Cooling towers and evaporative condensers
 - Direct evaporative air coolers, misters, air washers, and humidifiers
 - Indirect evaporative air coolers
 - Metalworking systems



ASHRAE – Cooling Towers and Evaporative Condensers

- System maintenance recommendations:
 - Regular visual inspections
 - Cold water basin cleaned when dirt, organic matter or debris visible or found through sampling
 - Mechanical filtration may be used to reduce solids
 - Drift eliminators inspected and cleaned regularly or replaced if deteriorated or damaged
 - Operation and maintenance records



ASHRAE – Cooling Towers and Evaporative Condensers

- Operation and inspection records must include:
 - System schematic
 - System water volume, date and method of determination
 - Manufacturer's instructions for equipment operation
 - Regular water treatment procedures
 - MSDS for chemicals used
 - Names of persons responsible for operation/shutdown
 - Dates of inspections and written inspection results
 - Dates and nature of routine maintenance
 - Dates of equipment repairs/modifications, with a description of the work



ASHRAE – Cooling Towers and Evaporative Condensers

- Water treatment:
 - Effective water treatment program is required
 - Control of scaling and corrosion is necessary
 - Must keep system clean and free of sediment
 - Strategies may include: site of cooling tower (relative to exhausts), corrosion inhibitors, filtration and/or separation
 - Microbial growth controlled by use of biocides (2 main groups: oxidizers and non-oxidizers)
 - Generally good practice to alternate biocides used for a cooling water system to avoid selection/growth of resistant strains of microbes
 - More information available in “Water Treatment” chapter of Applications volume of ASHRAE Handbook



CSA Standard CAN/CSA-Z317.2-01.

- *Special requirements for heating, ventilation, and air conditioning (HVAC) systems in health care facilities.*
- Criteria for aspects of HVAC systems that are particular to health care facilities
- 4.2 Special requirements in health care result from the need to protect patients, staff and visitors from infectious diseases; fire and smoke; hazards created by specialized equipment and processes; failure of HVAC with loss of environmental control
- 5.5 Infection Control – HVAC systems shall be designed, installed, operated and maintained to minimize the potential for infection via airborne transmission (e.g. legionella spread from environmental sources)

CSA Standard CAN/CSA-Z317.2-01.

- 6.4 Cooling Plant – general, design requirements and specific equipment
- 6.6.8.1 Outdoor air intakes shall be located to avoid sources of contamination. The placement of intakes shall take into consideration the relative location of standing water, etc.
- 6.6.8.2 Outdoor air intakes shall be located at least 7.5 m from cooling towers, etc.
- 6.7.2.1 Air handling units shall be configured to continuously drain water ingested through outdoor air intakes and condensed from cooling coils and humidifiers....



CSA Standard CAN/CSA-Z317.2-01.

- 6.8.2 Air filters and associated systems shall be designed, installed and located so as to avoid wetting from humidifiers, cooling coils, or other sources of moisture....
- 6.9.1.4 Spray, evaporative media, or pan-type humidifiers shall not be permitted (i.e. to reduce potential for bacterial contamination)
- 6.11.4.1 Isolation Rooms – General
- 6.11.5 Airborne Isolation Rooms requirements
- 6.11.6 Protective Isolation Room requirements

CSA Standard CAN/CSA-Z317.2-01.

- 8.1.3 HVAC Performance – HVAC system parameters shall be tested and recorded regularly to determine conformance with design. Consideration should be given to an interval of once a week.
- 8.1.6 Filter Inspection – Condition of all filters in Class I and II areas shall be verified by visual inspection at least once a month.
- 8.2.1 General – The expertise and training of operations and maintenance personnel shall reflect the complexity of the systems.
- 8.2.2 Maintenance - Schedules and procedures shall be prepared for regular cleaning, decontamination, repair, and maintenance of all components.



CSA Standard CAN/CSA-Z317.2-01.

- 8.2.4 Chemical treatments shall be provided as required to ensure the effectiveness and performance of HVAC and piping systems and shall be monitored regularly to ensure effectiveness of performance.

- 8.4 Construction-Related Nosocomial Infections
 - Procedures shall ensure that during renovations, dust, dirt, and contaminants are captured near the source, and the air filtered or exhausted to the outside. Procedures shall protect areas and all occupants from airborne contaminants during renovations and construction.

Construction and Renovation

- Health Canada, July 2001, Construction-related Nosocomial Infections in Patients in Health Care Facilities – *Decreasing the Risk of Aspergillus, Legionella and Other Infections.*
- CSA Standard CAN/CSA-Z317.13 *Infection Control during Construction or Renovation of Health Care Facilities.*
- General requirement to conduct a risk assessment during the planning design phase of the project so that appropriate preventive measures are put in place. Steps include:
 - Identify the construction activity
 - Identify the population risk group
 - Refer to the risk group matrix
 - Determine specifications for infection prevention and control measures
 - Implement the prevention and control measures
- Submit notice of project for construction or major renovation³⁹



Other Relevant Standards

- Ontario Building Code
 - Ventilation and Plumbing Requirements
- CSA Standard CAN/CSA-Z317.1-99. *Special requirements for plumbing installations in health care facilities.*



MOL's Expectations – Bottom Line

- Compliance with the OSHA and Regulations
- Worker training/education and protection
- JHSC involvement
- Implementation of regular preventive maintenance, routine maintenance and emergency maintenance procedures based on CDC, ASHRAE, CSA and/or other acceptable guidelines

Resources:

Toronto Public Health: www.toronto.ca/health/legionnaires.htm

Canadian Centre for Occupational Health and Safety www.ccohs.ca

U.S. Department of Labour--Occupational Safety and Health Administration www.osha.gov/dts/osta/otm/legionnaires/index.html

Legionella 2003: An Update and Statement by the Association of Water Technologies (AWT) www.awt.org/legionella03.pdf

Centers for Disease Control and Prevention (CDC)
http://www.cdc.gov/ncidod/dbmd/diseaseinfo/legionellosis_g.htm

Control of Legionellosis--Health and Safety Executive, United Kingdom
http://www.bangor.ac.uk/ohs/safety_pages/inflink/legion.pdf

Report of the Maryland Scientific Working Group to Study Legionella in Water Systems in Healthcare Institutions, June 14, 2000
<http://www.dhmh.state.md.us/html/legionella.htm>