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# AABC Commissioning Group

AIA Provider Number 50111116



## Trends in Water Treatment Planning for Legionellosis Mitigation and Prevention

Course Number: CXENERGY1711

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# Course Description

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This presentation is designed to educate design engineers, building operations staff, maintenance staff, and building owners about how to mitigate the risk of Legionellosis, a form of pneumonia caused by the Legionella bacteria, which lives in inadequately maintained building water systems.

# Learning Objectives

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At the end of the this course, participants will:

- Understand the health concerns related to Legionellosis, a form of pneumonia caused by the Legionella bacteria.
- Learn how Legionellosis is spread in facility-wide water systems and understand the importance of proper water treatment system design.
- Understand how design and operation and maintenance, including continuous monitoring, can be performed to prevent Legionellosis.
- Understand the regulatory environment and best practices being implemented by water treatment experts.

# Overview

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- Legionellosis is an infection caused by the Legionella bacteria. It presents in pneumonic form (Legionnaire's disease), which can be fatal, and non-pneumonic form (Pontiac disease). It is typically spread through water management systems and it cannot be eradicated.
- Legionellosis can be mitigated and prevented using solid engineering design, operation, and maintenance best practices.
- Continuous monitoring, surveillance, detection, and testing of water systems – including artificial intelligence technologies – is critical to the prevention of Legionellosis outbreaks.
- Facility owners, directors, engineers, maintenance staff, and environmental staff must work together to plan and implement a water treatment strategy that includes budgeting, planning future construction, documentation, verification, and validation.

# Legionellosis: An Ongoing Public Health Issue

## The Diseases

- Legionnaires Disease (LD): Severe pneumonia
- Pontiac Fever: Flu-like symptoms

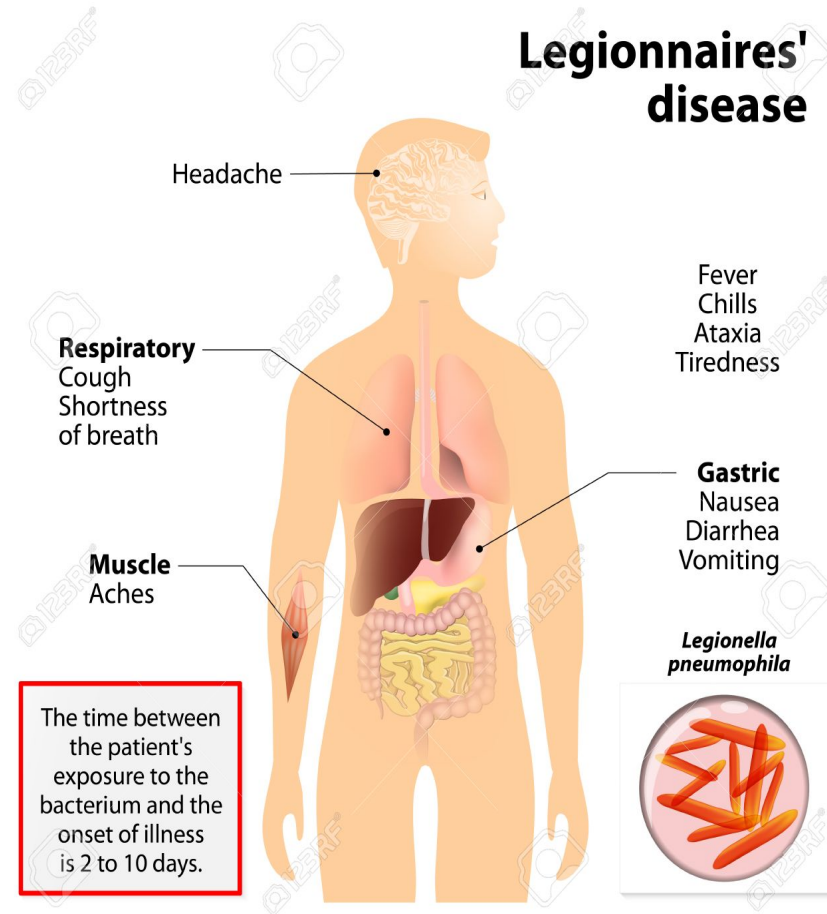
## Causes

- Transmission of Legionella bacteria via aerosol inhalation
- NOT transmitted person-to-person via contact

## High Risk Communities

- People with weakened immune systems
- Elderly people > 50 yrs
- Dialysis patients, lung disease patients, diabetics, people with chronic health conditions

*Point of Interest: Legionellosis is underdiagnosed among hospitalized pneumonia patients.*



# Legionellosis Outbreak: Historical

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**Discovered in 1976:** Pneumonia outbreak after American Legion Conference in Philadelphia, PA - believed to be cooling tower-related

**1990s:** 8,000 - 18,000 cases

**July-Sept 1994 :** 29 cases in Delaware - cooling tower water at hospital

**1996:** 12 cases at 11 hospitals in San Antonio, TX - potable water

**2000:** 1,127 cases

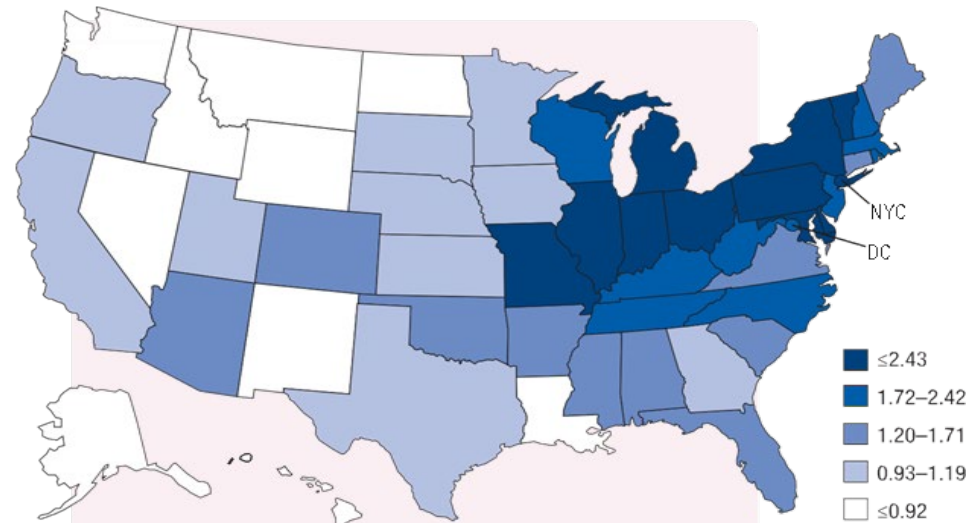
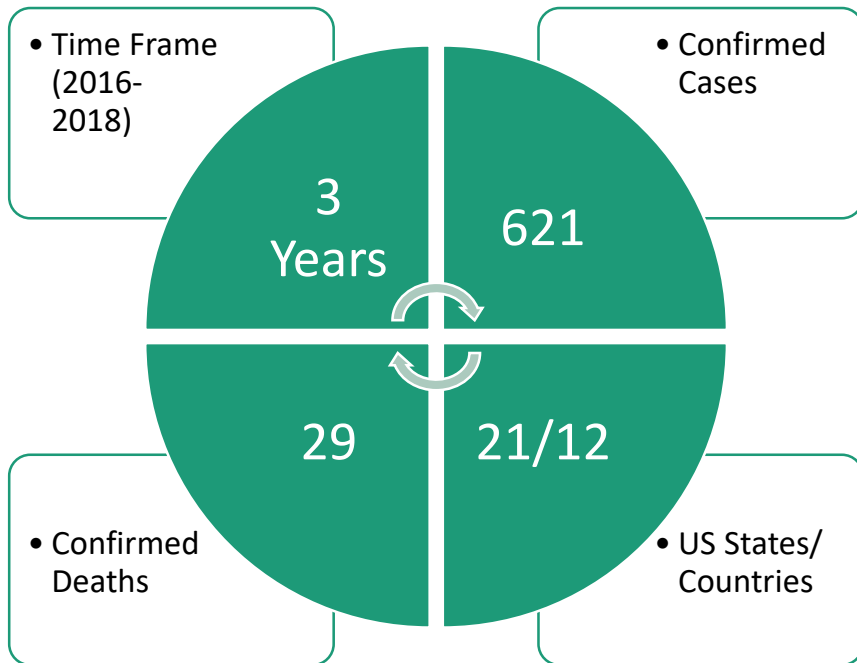
**2001:** More than 800 cases in Spain - cooling tower water

**2013:** 4,548 cases



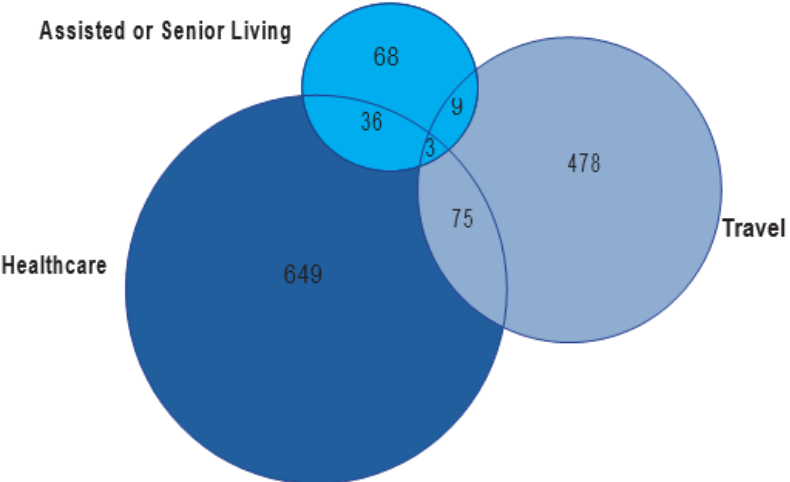
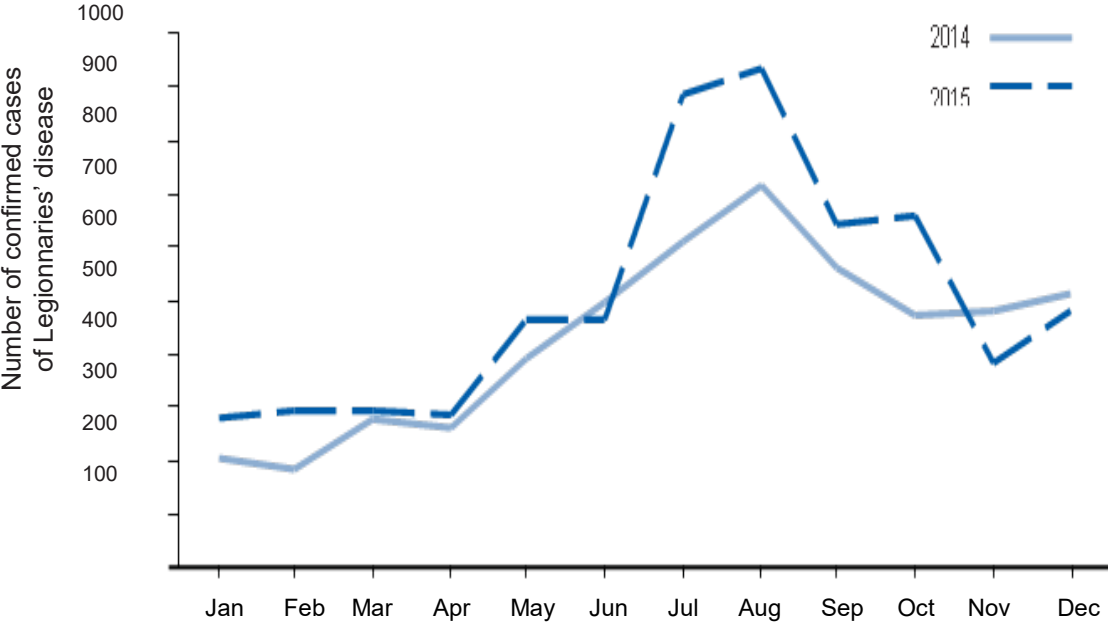
# Legionellosis Outbreak: Recent Occurrences

Source: Legionnaires' Disease Surveillance  
Summary Report,  
United States—2014 and 2015  
Updated October 2018



Geographical: Cases per 100,000 population

# Legionellosis Outbreak: Occurrences



Source: Legionnaires' Disease Surveillance Summary Report, United States—2014 and 2015 Updated October 2018



# Legionellosis: Case Studies

## Ohio

- 2013 outbreak
- Long-term care facility
- Patients: 39 infected, 6 died with LD
- Cooling tower water system
- Faulty water treatment controls

## Rome, Italy

- 2015 study (samples 2004-2010)
- Tertiary care hospital
- 28 out of 97 samples positive (14 samples from 2008 during construction)
- Domestic cold and hot water system
- Scarce use of fixtures
- Low chlorine levels
- Distance of water heater from fixtures

## New Zealand

- 2015 outbreak at dairy processing plant
- Patients: 4/13 (LD) confirmed & 7 probable PF
- Newly commissioned cooling tower connected to existing condenser water system
- Manual in-operating water treatment system
- False-negative testing

# Legionellosis: Environmental/Infection Sources

- Biofilms of potable water loop - resistant to chlorine concentration
- Hydrotherapy pools & Dialysis Systems in healthcare facilities
- 68° F - 122° F: Higher during the summer due to water chemistry changes
- Cooling tower water
- Slow moving/stagnant water
- *Poorly Managed Water Systems = Perfect Environment for Legionella*



# Regulatory Standards and Guidelines

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- ANSI/ASHRAE Standard 188-2018 Legionellosis: Risk Management for Building Water Systems
- New York State Department of Environmental Conservation (NYS DEC): Local Law 77 of 2015
- CDC: “Guidelines for Environmental Infection Control in Health-Care Facilities”
- OSHA Technical Manual Section III Chapter 7 “Legionnaires Disease”
- VHA: VHA Directive 2008-2010 “Prevention of Legionella Disease”
- Maryland Department of Health and Mental Hygiene
- California Code of Regulations Title 22
- JCAHO Environmental Care Standards and AIHA

## **Miscellaneous:**

1. States require quarterly testing of hospital water systems
2. NY State and NY City: Registration of all cooling towers with Department of Buildings

# Legionella Prevention: Strategy

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FM + AE

- Create program team and prevention plan
- Develop water system diagrams
- Analyze open and closed-loop systems

AE + WTC

- Determine control points and control measures
- Perform testing and data analysis
- Establish monitoring protocols

AE + WTC  
+ FM

- Prepare documentation, including data logs
- Ensure verification, including corrective actions
- Perform validation

# Legionella Prevention: Design Practices

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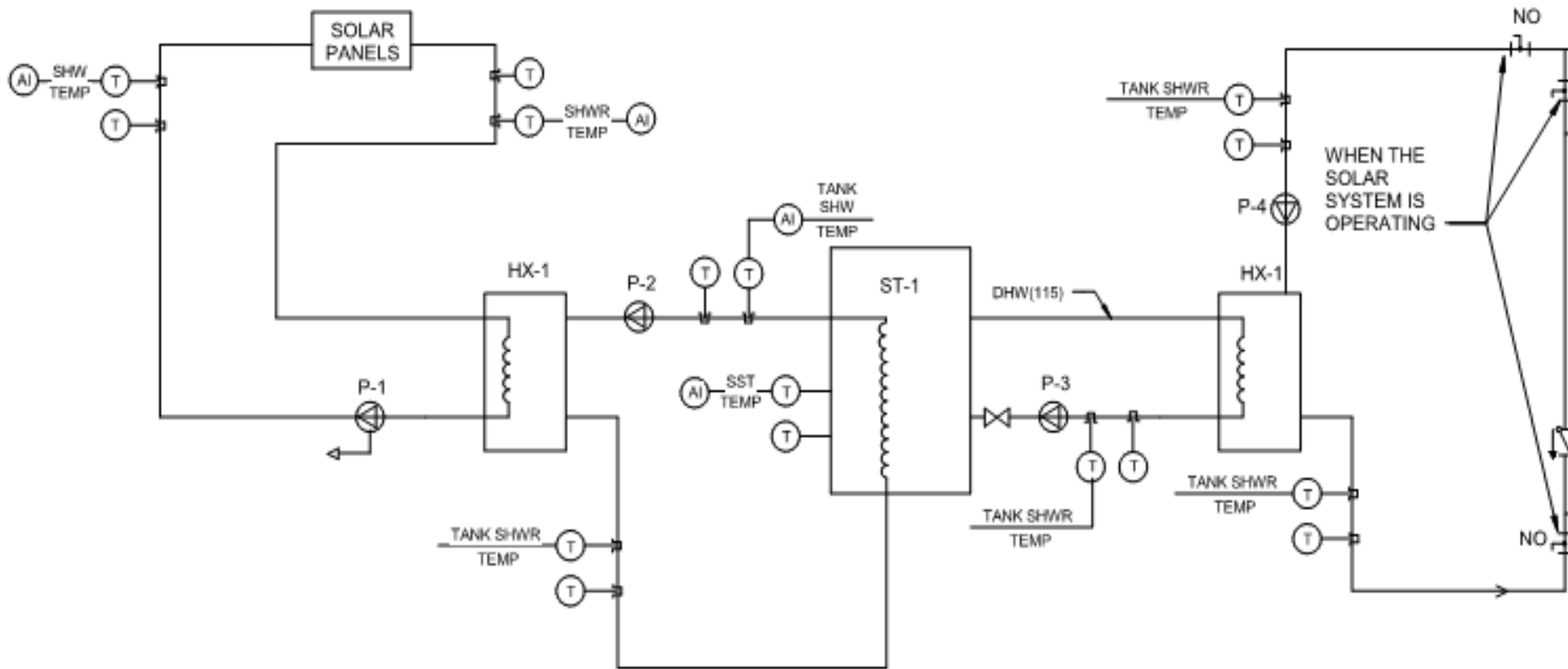
## **Schematic/Design Development Phase/Retrofit**

- Study local/state code mandates and determine most stringent requirements
- Survey existing water systems: pipe routing, water heater settings, pumping sequences
- Perform microbiological water systems analysis
- Test existing water temperatures and investigate any issues (e.g., missing insulation)
- Discuss code compliance requirements and their cost implications with owner/prime (DB/DBB)

## **Construction Documents & Construction Phase**

- Master Spec Plumbing Sections 223200, 223400, 223500,
- Master Spec HVAC Sections 232500, 232513, 232516, 232519, 232523, 232533
- Strategize locations of equipment and control measures & limits
- Ensure that testing, adjusting, and balancing & commissioning is included
- Eliminate “dead legs” and cross contamination
- Specify inspection & O+M: disinfection and monitoring protocols (e.g., “Wisconsin Protocol”)
- Specify regular flushing and active water treatment
- Ensure cooling tower make-up water valve location is correct
- Maintain adequate separation between cooling tower and kitchen exhaust location

# Legionella Prevention: Design Example

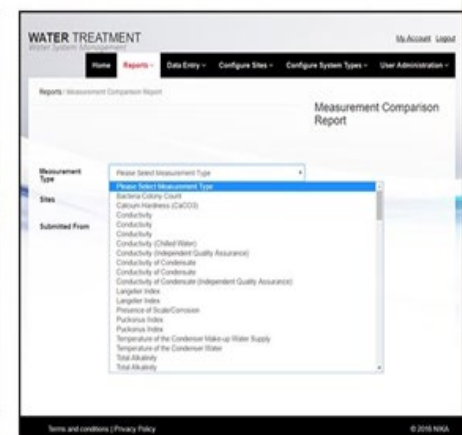
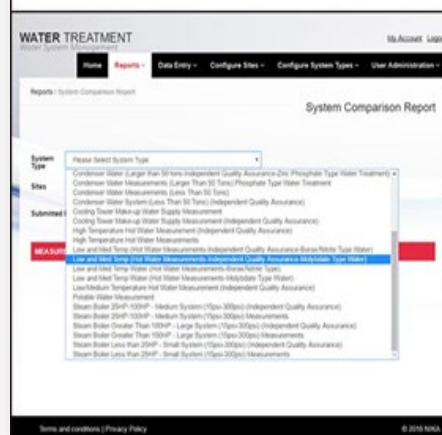
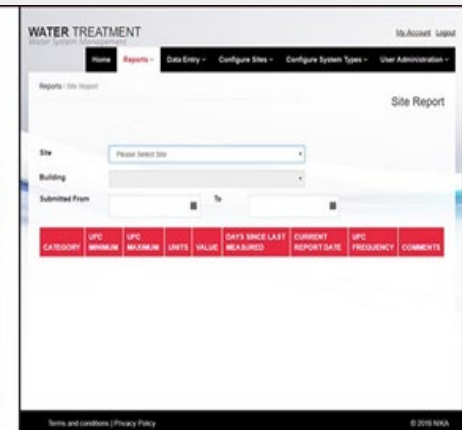
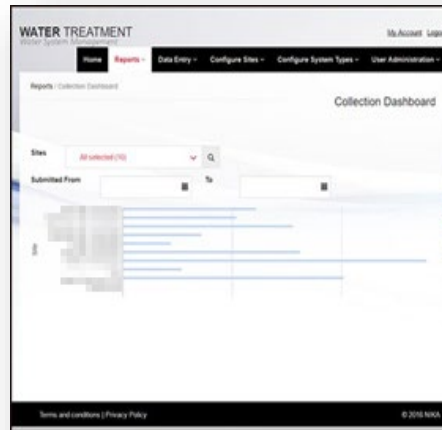


**Solar Panel Domestic Hot Water Heating**



# Prevention Automation: Continuous Monitoring

- **WT Contractor:** Perform facility walk-thru
- **Adhere** to prevention plan
- **Inspect** control points
- **Use** software to select appropriate control measures
- **Monitor** through building automation work station dashboard
- **Artificial Intelligence (AI) Based Automatic Flushing**



# Prevention: Monitoring System Control Points

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## 1. Temperature, Stagnation

- Hot Water Storage Tanks
- Domestic Hot Water Heaters
- Sinks
- Showers
- Kitchen Equipment
- Solar Panel Heating Systems

## 2. Disinfectant, Biocides

- Cooling Towers
- Decorative Fountains

## 3. Temperature

- Cooling Towers
- Ice Makers
- Hot Tubs
- Dead Legs
- Domestic Water Service Entrance
- Bioreactors in Net Zero Water Systems

# Legionella Prevention: O+M Practices

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## High Capacity Filtration Systems

Purpose: Reduce biofilms via removal of viruses, bacteria, parasites strategic locations

## Testing and Corrective Actions

Purpose: Ensure control measures are operating within limits

Action	Control Limit	Approach	Frequency
Cleaning	Inspection	Visual Inspection	Annual
Disinfection	Pre-established Limits	Chlorination	Monthly
Legionella Treatment	<100 cfu/ml	Laboratory Culture	Every Other Month

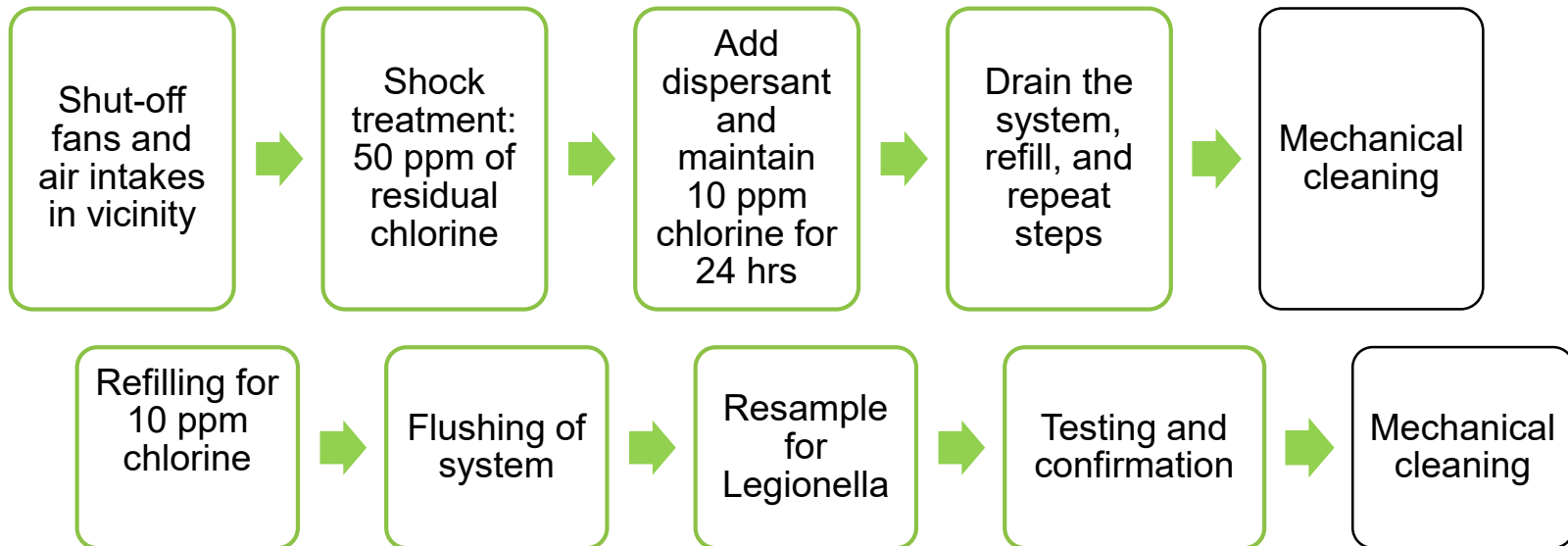
# Legionella Mitigation: Cooling Tower Practices

## Unified Facilities Guide Specifications

- pH: 7.5 – 8.5
- Legionella testing:
  - every 6 months minimum
- Proper Biocide concentration



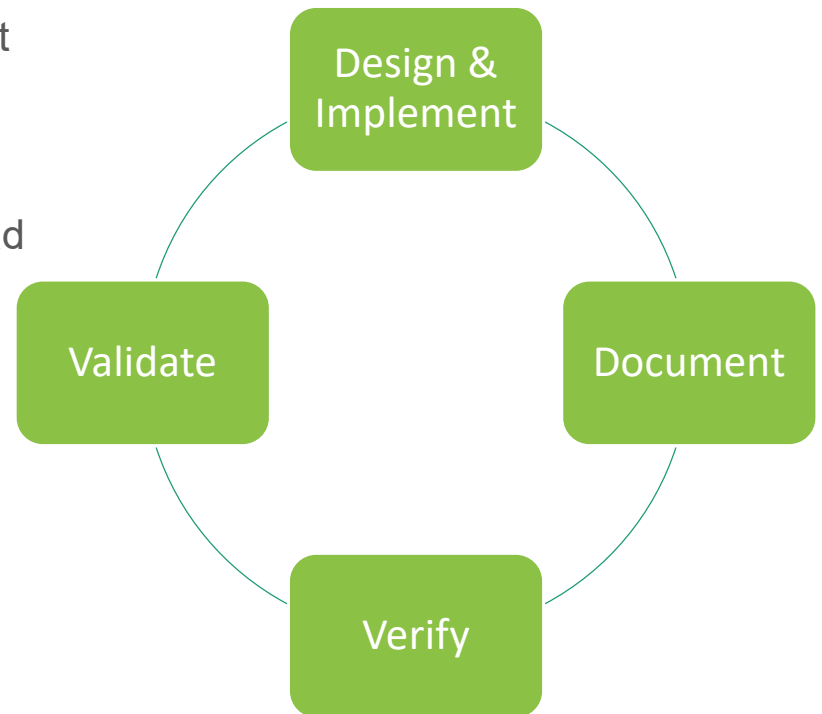
## “Wisconsin Protocol”



# Conclusion

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- Legionellosis, a notifiable deadly disease caused by Legionella bacteria, is on the rise. It is an urgent public health concern in the built environment.
- Early detection is important, but it can also lead to operational shutdown at facility.
- Facility owners, directors, engineers, maintenance and environmental staff need to work together to plan and implement a water treatment strategy that includes budgeting, planning future construction, documentation, verification and validation.



# References

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- “Comparison of Legionella longbeachae and Legionella pneumophila cases in Scotland; implications for diagnosis, treatment and public health response.” R.L. Cameron et al 2015 *Journal of Medical Microbiology* (2016). 65, 142-146
- ANSI/ASHRAE Standard 188-2018 Legionellosis: Risk Management for Building Water Systems

# Discussion

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This concludes The American Institute of Architects Continuing  
Education Systems Course

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