Legionella & Legionellosis

WSHSC

January 29, 2016

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Introduction

Larry Lee, CIH

- Certified Industrial Hygienist
- Indoor air quality
- Sewage flood ’96
- Specialize in healthcare construction & infection prevention

Introduction

- Legionella & Legionellosis
  - Bellevue Stratford Hotel, Philadephia, PA July 1976
  - American Legion Conference
  - 221 attendees hospitalized
  - 34 attendees died
  - *Legionella pneumophila* identified
    - Formerly considered to affect animals only
    - Cooling tower
  - 1968 Pontiac Fever
- Today ~8,000 to 18,000 hospitalized annually (CDC)

Introduction

- Legionellosis
  - ~50 *Legionella* species
    - 19 human pathogenic species
  - *Legionnella pneumophila*
    - Gram negative, flagellated rod, 0.3 – 0.9 x 2 microns
    - ~90% of infections
    - Serotypes 1, 4 & 6 cause most infections
    - 16 serotypes – surface antigens

Ecology

- *Legionella* species
- Fresh water & soil, dependent on biofilm
- *Legionella* Life Cycle
  - Eaten by ameoba
  - Ameoba eaten by paramecium
  - Paramecium dies & releases *Legionella*
- Survive temperatures 5 to 63˚C
  - 41 to 145 ˚F
- Thrive between 25 to 40˚C
  - 77 to 104 ˚F
- Can colonize water systems
  - Piping, cooling towers, faucets, ice machines, fountains, etc.

Ecology

- Community sources
  - Domestic water systems, spas & whirlpools, sprinklers & water features (hotels, flower shows, restaurants & cruise ships), vegetable misters, humidifiers, cooling towers (over estimated) & water cooled-equipment
- Hospital sources
  - Potable water systems, spas and jet tubs, ice machines, humidifiers, dialysis water, water features, cooling towers, emergency showers & water cooled-equipment
- Amplification in “dead legs”
  - Dead end pipes that are capped off but connected to the water system

Epidemiology

- Risk factors
  - Advanced age (Long-term care)
  - Men
  - Smoker
  - Alcohol abuse
  - Chronic pulmonary disease
  - Immune suppression (includes children)
    - Transplantation
    - AIDS
    - Underlying pediatric pulmonary disease

Epidemiology

- Modes of transmission - Healthcare
  - Aspiration/Microaspiration
    - Drinking water & ice consumption
    - Intubation
    - Surgery requiring anesthesia
    - Naso-gastric intubation
  - Inhalation
    - Nebulizers
    - Whirlpool spas
    - Water features
  - Contact
    - Wound

Clinical Presentation

- Onset
  - 2 to 10 days from exposure
- Pontiac fever
  - Self-limiting (24 – 48 hours) flu-like illness without pneumonia
- Legionellosis
  - Cough & low grade fever progresses to:
    - Pneumonia
    - Stupor
    - Organ failure
    - Fever exceeds 40 C/104 F
    - Headache
    - Confusion
    - Pleuritic chest pain
    - GI symptoms
- < 10% mortality with quinolone therapy

Diagnosis

- Urinary antigen
  - Most common
  - Sensitive for *L. pneumophila* serotype 1 only
- Culture is the gold standard
  - Speciation and serotyping
    - 10 or more days
  - Molecular subtyping
    - Not always performed
    - Cultures not always saved for reference
- PCR
  - Highly specific but not more sensitive than culture

Investigation

- Legionellosis case or outbreak
  - Investigation always includes sampling
- Sampling: Wide net or targeted sampling?
  - Wide net
    - CDC approach
    - All water systems
      - Most, if not all, distal outlets
  - Targeted sampling
    - Based on patient exposure/contact with water

Investigation

- Targeted sampling
  - Patient chart review
    - Bed control
    - Movement – for tests, outdoors, smoking
    - Food & drink consumption
    - Visitors
      - Bring drinks or gifts (flowers, washed fruit, etc.) from home?
    - ID water systems serving patient throughout their stay
    - Operable windows (e.g. long-term care or hospice)?
    - Determine primary water contacts & work backwards from source if found

Investigation

- Case study
  - Two elderly patients in community long-term care facility
    - Elderly smokers with chronic alcoholism
    - Parenteral nutrition
    - ID primary water contact points
      - Ice was the only consumption of water
      - No showering, bathing, possible teeth cleaning
    - Confined to bed & unit
    - Sample primary water contacts and work backward toward source if found

Targeted sampling

- Patient room
  - Sink (teeth cleaning)
  - Hot & cold water
- Common shower
  - Unclear if both patients had showered at all
  - Hot & cold water
- Ice machines
  - Dispensed ice
  - Dispensed water
  - Stored ice
  - Water reservoir

Sinks

- Water
  - 1-liter sterile bottles
  - Sodium thiosulfate
    - Inactivates chlorine
  - Free-flowing
  - Cooled transport
- Faucets
  - Sterile swabs
- CDC ELITE Lab

Ice machines

- Source & dispensed water and ice
  - 1-liter sterile bottle
- Reservoir
  - Sterile swab
- Tubing – dispensed water & auger/ice maker
  - Bulk tube in freezer bag
  - Cut up, vortexed, eluted & plated

Ice machines

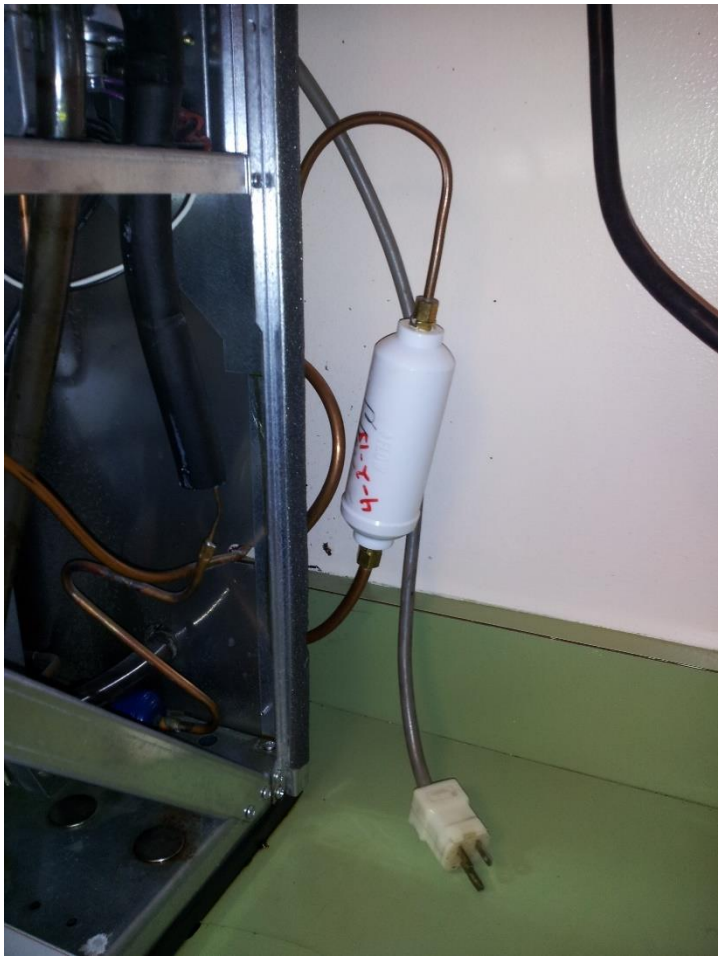
- Source water
- Filtered water
- Filter

Ice machines

Ice machines

Ice machines

Ice machines



Ice machines

- Storage
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- Water tube
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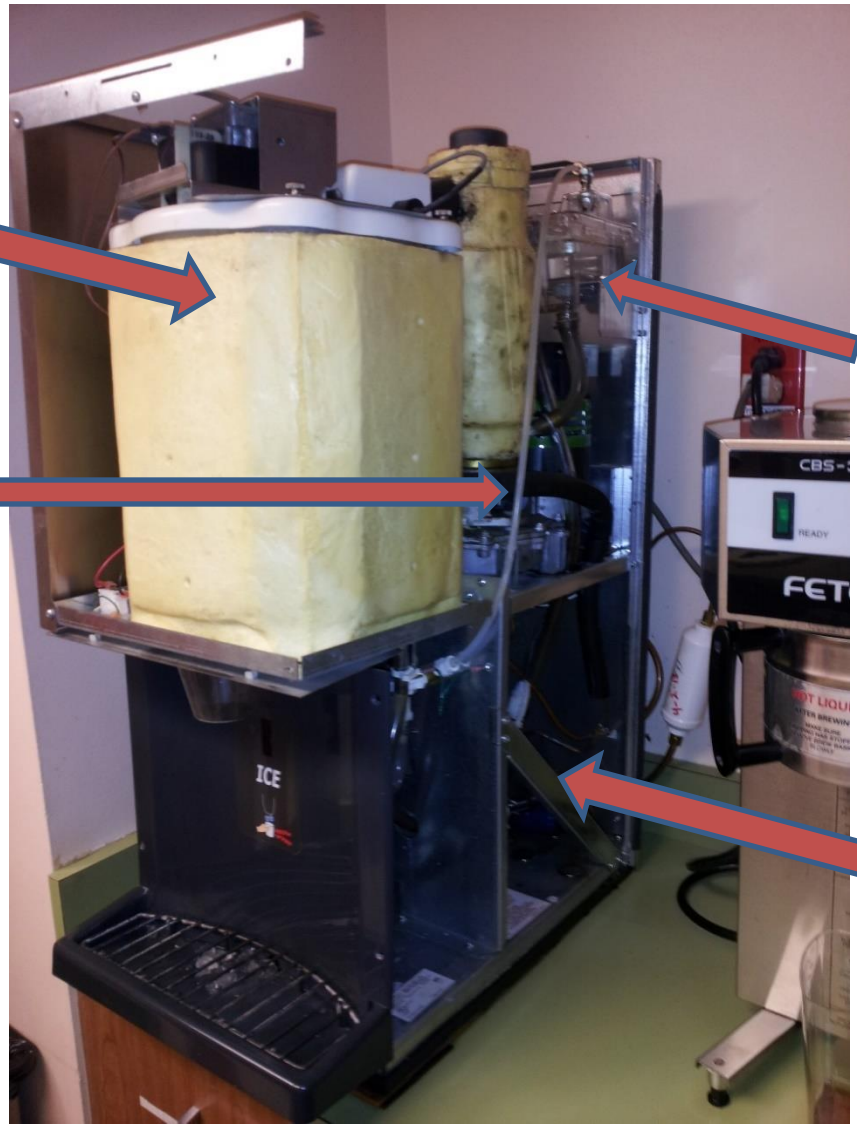
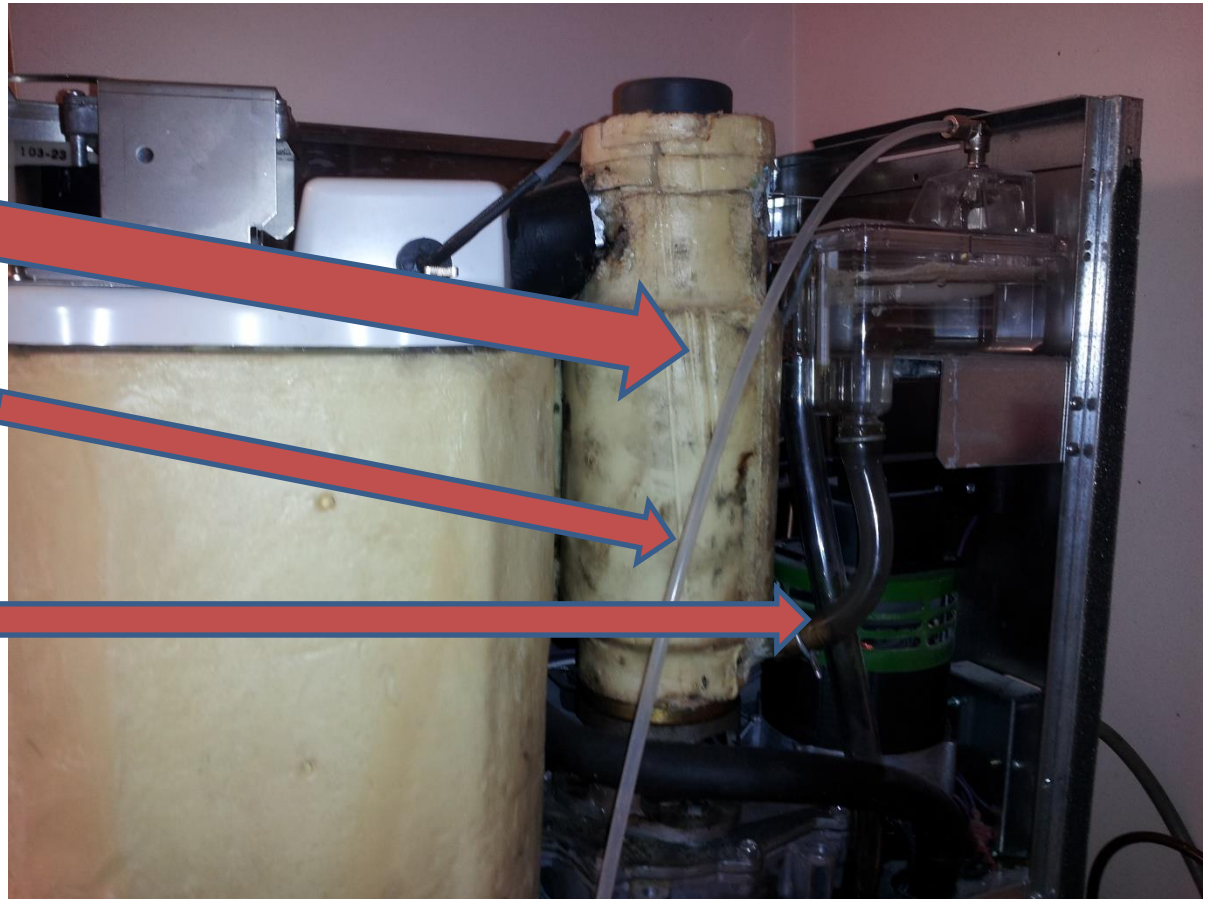


Reservoir

Compressor

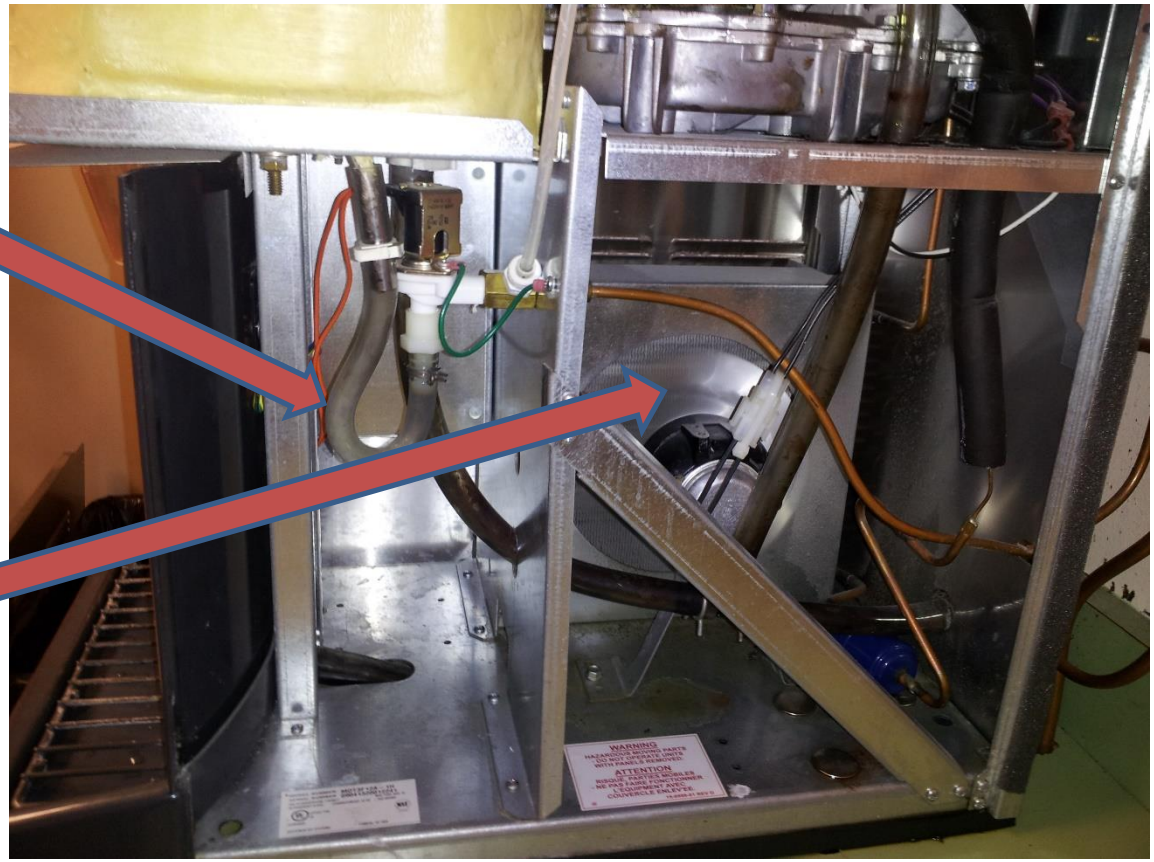
Ice machines

- Auger
- Water supply
- Ice supply



Ice machines

- Dispensed H2O
- Compressor
- Design flaw?

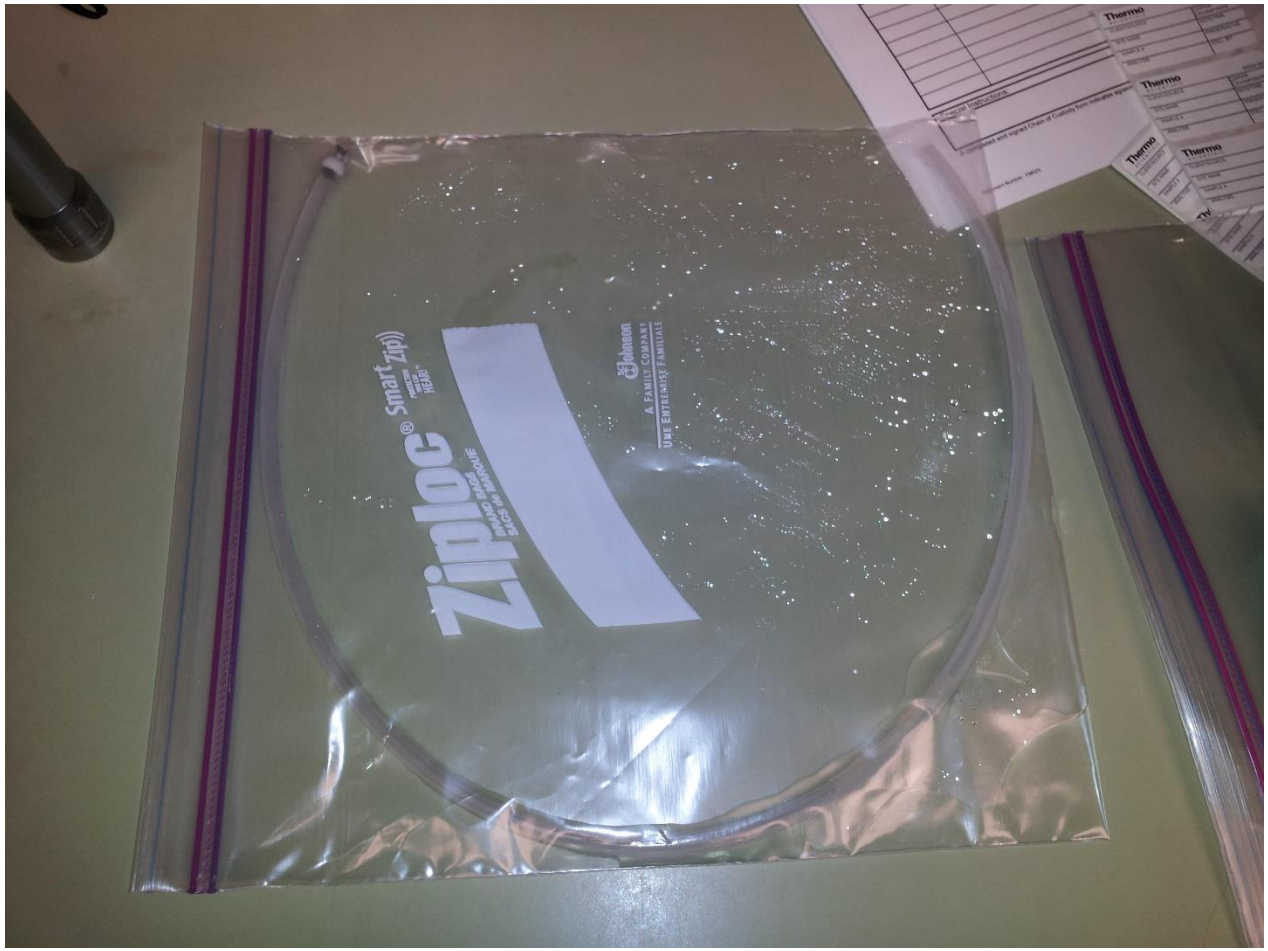


Ice machines

- Reservoir swab

Ice machines

- Supply tube sample



Sample results

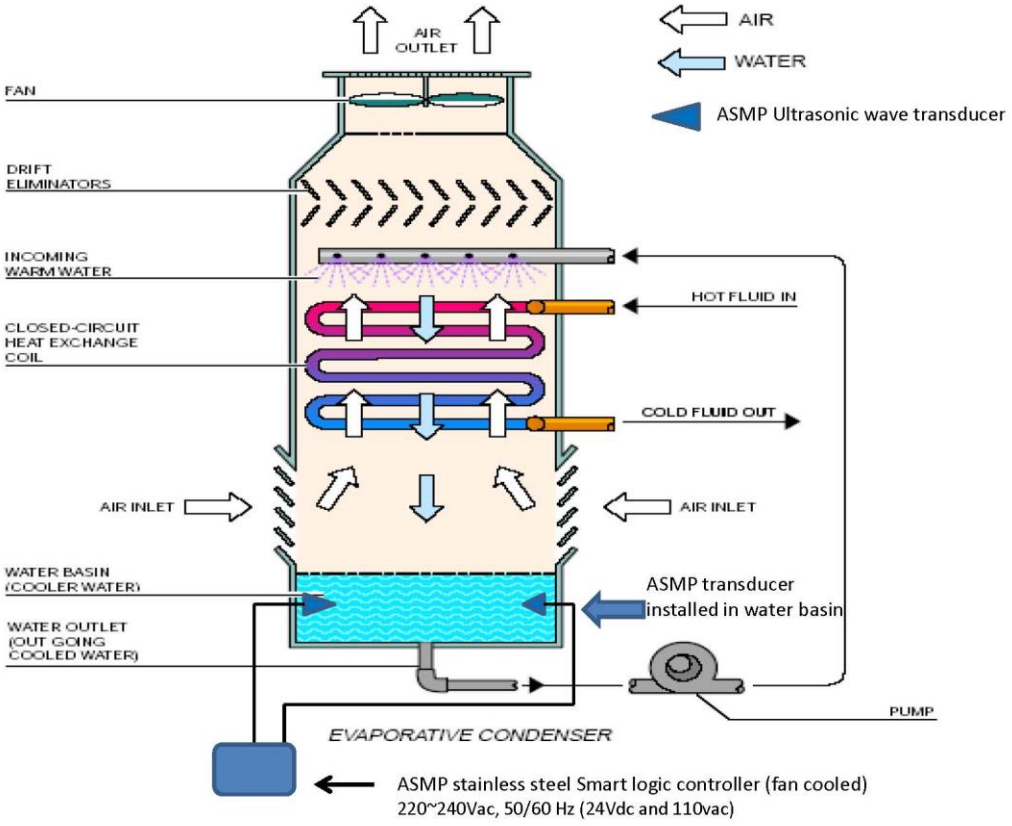
- Ice machine
  - Ice (water) supply tubing – **750 CFU/tube**
  - Reservoir float – **900 CFU/swab**
  - Drinking water supply tubing – **3,160 CFU/swab**
  - Dispensed water – **4.4 CFU/ml**
  - Source water – none detected
  - Filter(s) & post-filter water - none detected

- Sinks & showers
  - Hot & cold water – none detected
  - Faucets/tap – none detected
  - Shower heads – none detected

Response actions

- Point source
  - Take out of service
  - Clean, de-scale, & disinfect
  - Test/sample
  - Validate
    - Monthly
    - Quarterly
    - Annually
  - Review PM frequency & procedures

Cooling Towers



Cooling towers

- Amplification of bacteria in cooling water loop
  - Pool
  - Cooling water piping
  - Interior surfaces
- Aerosolization
  - Mist
- Must address biofilm
  - Clean & treat
  - Removing biofilm is a primary goal
- PPE
  - N-95 filtering facepiece respirator
  - Gloves

Response actions & treatments

Unit, loop, or facility

- Thermal shock
  - 160 F as measured at distal outlets
  - 3 to 5 days
  - Flush each faucet/tap & shower head for 30 minutes
  - Cool and flush entire system – may need to repeat every 3 to 5 weeks
- Hyperchlorination
  - 50 ppm free chlorine
  - 12 – 24 hours
  - Flush
- Copper-silver ion treatment
  - Water treatment facility requirement
- Chlorine dioxide
  - 2 – 6 ppm
- Monochloramine
- Point of use filters
- Validation & Maintenance Plan

Response actions & treatments

- ID and vet response action before an outbreak
  - Can your system deliver thermal shock?
  - Can your system handle thermal shock?
  - Is your water better suited for:
    - Hyperchlorination
    - Copper-silver ion
    - Monochloramine
  - Do you have a pre-qualified vendor?
  - Disinfection validation plan

Helpful References

- ASHRAE Std-188, Prevention of Legionellosis Associated with Building Water Systems
- Controlling *Legionella* in Hospital Drinking Water: An Evidence-Based Review of Disinfection Methods, Lin, Y., Stout J. and Yu. V, *Infection Control and Hospital Epidemiology,* 2011; 32 (2) : 166-173
- *Recognition, Evaluation, and Control of Legionella in Building Water Systems,* AIHA (2015)
- Sound Microbiology Lab, Bainbridge Island, WA
- APIC Text of Infection Control and Epidemiology (4th Edition) 2014
- CDC