



# Legionella/Waterborne Pathogen Risk Mitigation A Comprehensive Approach



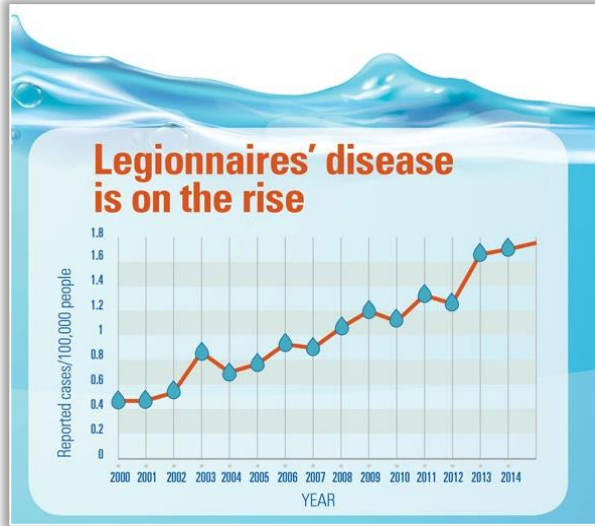
Watts Water Technologies, Inc.

- One of many waterborne pathogens
- You can't completely kill it
- You have to aspirate or breathe in the water to contract Legionnaires' disease
- Immune compromised individuals are most at risk
  - 50 or older
  - Smokers
  - Underlying medical conditions, chronic lung disease or immunosuppression

## Legionella can be spread through

- Faucets
- Showerheads
- Water Fountains
- Spas & Hot Tubs
- Ice Machines





Between 2000 and 2014, CDC reports **400% increase in infections**

When transmitted through airborne moisture, it causes **pneumonia**

**1 in 10 die; survivors have lifelong health effects**

**25,000 cases per year**

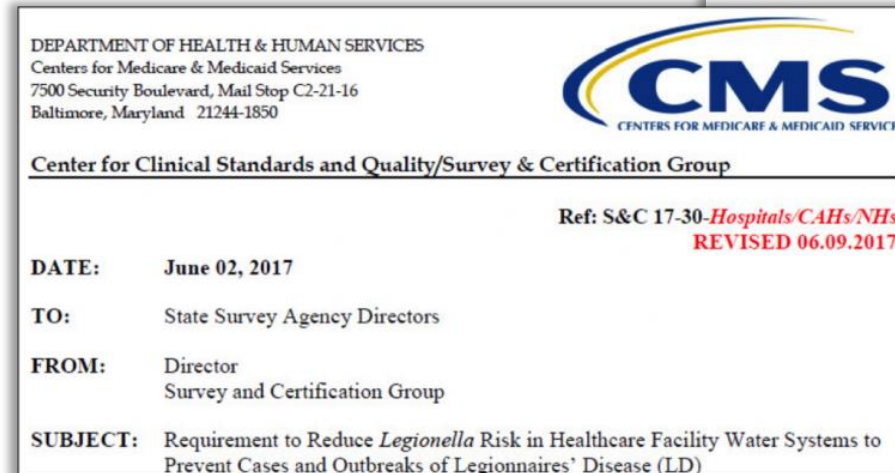
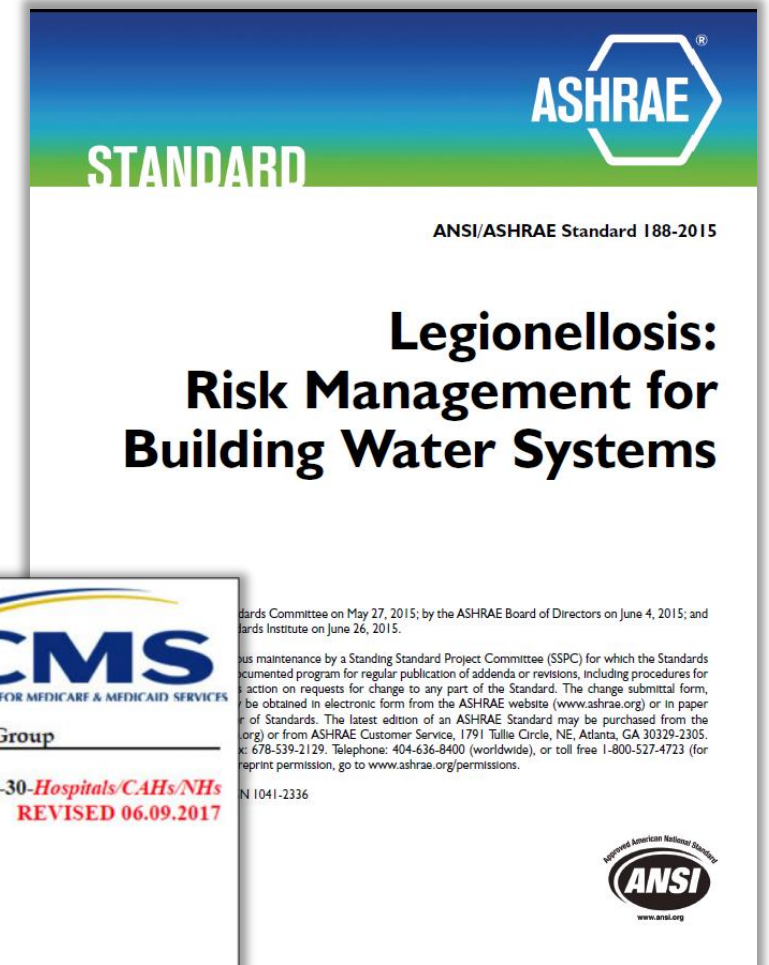


# The Cost of Legionella

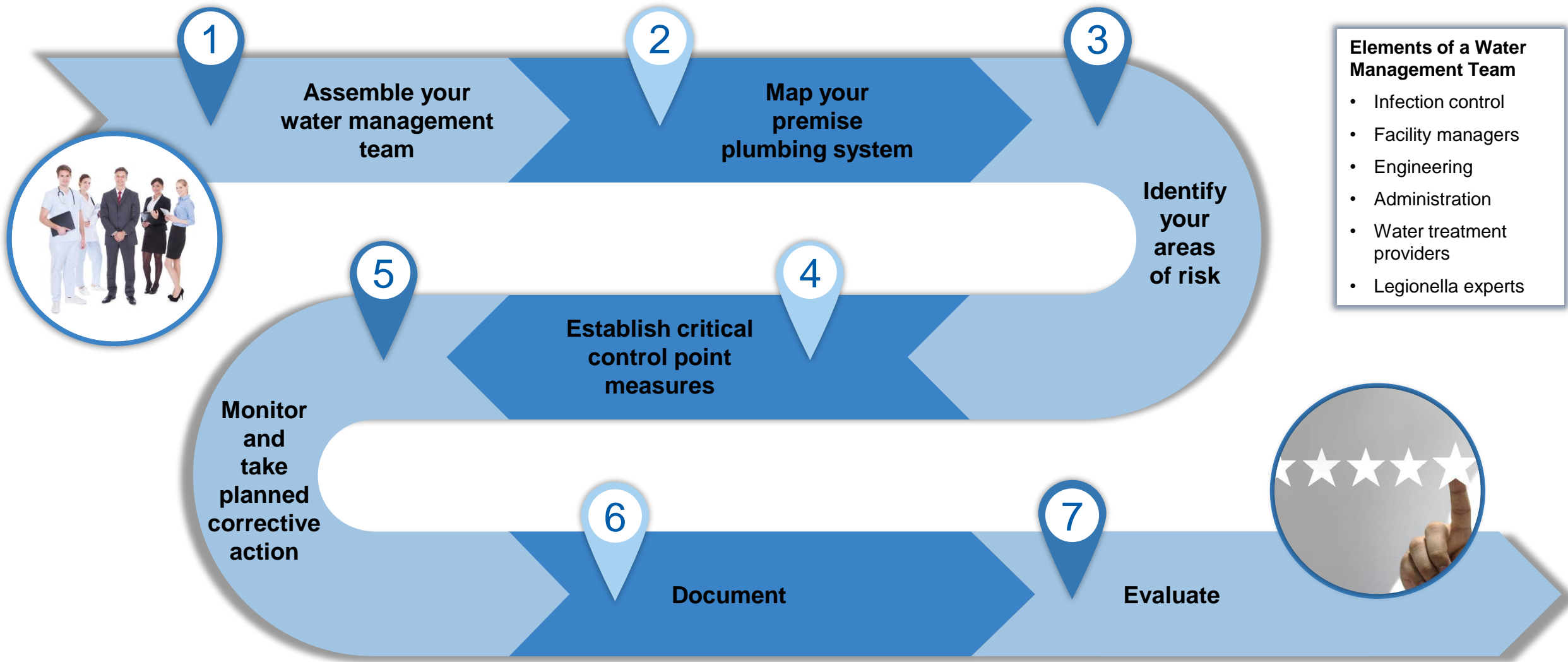
- **6100** reported cases in 2016 (CDC)
- **One in ten** Legionnaires' cases leads to death (CDC)
- Legionnaires' disease treatment at a health facility could average **\$38,000** per patient (CDC)
- Legionella is **the number one** cause of waterborne diseases outbreaks in the United States
- Reported settlements and jury awards range from **\$255,000 to \$5.2 million** (*Risk Management Magazine*)
- Waterborne illnesses including Legionella led to **>40,000** hospitalizations for an annual cost of **\$970 million**, including **\$430 million** in Medicare and Medicaid expenses ("Direct healthcare costs of selected diseases primarily or partially transmitted by water," *Epidemiology and Infection*, 2012;140(11):2003–13)
- Adding employee worktime and productivity costs to Legionella's direct healthcare costs brings the estimated total cost to well over **\$1 billion per year** (McCoy W, Pearson W. 2011. ASHRAE Standard 188P: Prevention of Legionellosis associated with building water systems)



- CMS (Centers for Medicaid and Medicare) mandate based on ASHRAE 188 states that hospitals must have water management team and Water Management Plan in place to combat the risk of Legionella.
- Hospitals that do not comply risk losing their Medicaid and Medicare reimbursements. CMS has started inspecting.
- The mandate does not give guidance or instruction on what types of solutions a hospital should use or when and how they should be testing for Legionella.
- There are no enforceable codes or regulations for any other building type.
- ASHRAE and NSF are working together, creating new guidelines/standards. This effort has the potential to influence additional building types.



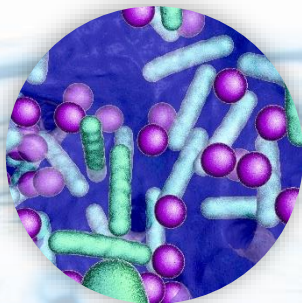
# CMS Mandate Requirements



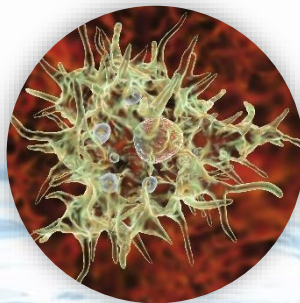
# The Dirty Dozen



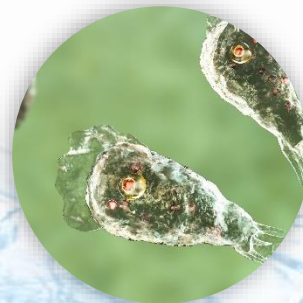
Vibrio Cholera



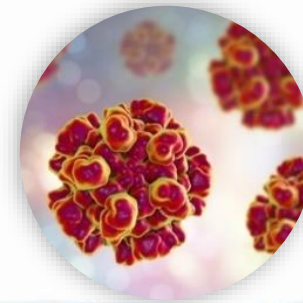
Acute Otitis Externa



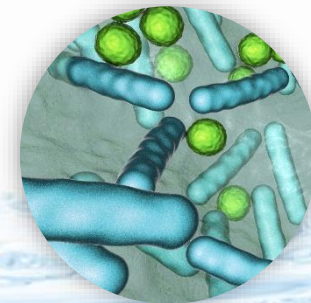
Acanthamoeba



Naegleria



Hepatitis A



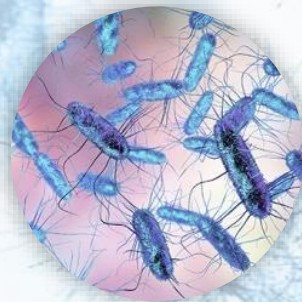
Pseudomonas



Giardia



Cryptosporidium



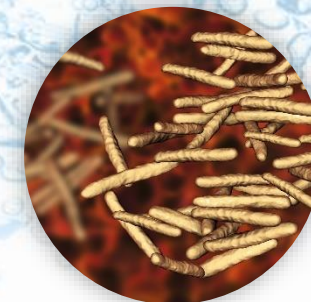
Salmonella



E.coli

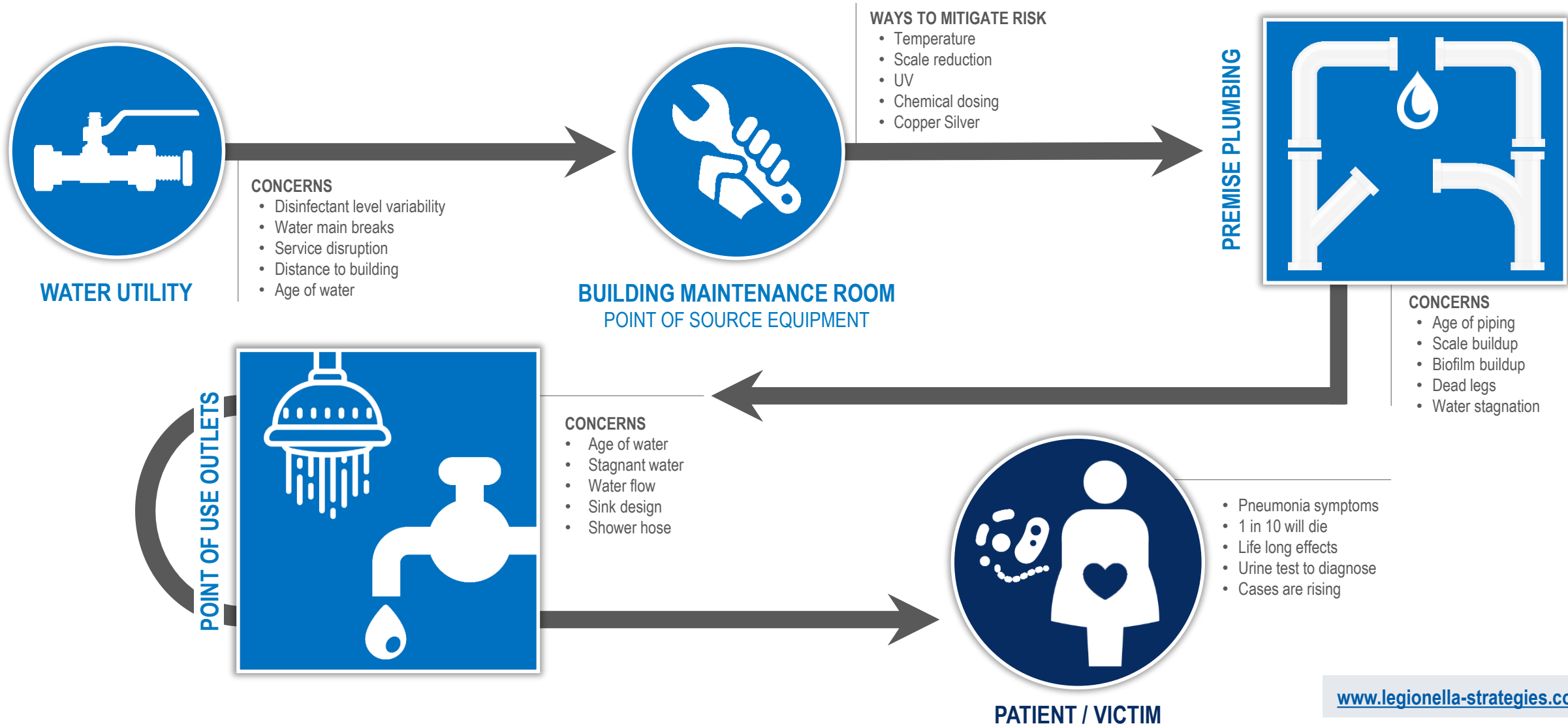


Campylobacter



Non-Tuberculous Mycobacteria

## Other Prominent Waterborne Pathogens





## Areas of Consideration

- All solutions have pros and cons
- One solution is not the answer
- Different buildings will likely need different solutions
- Organizations should consider a multi-barrier approach from Point-of-Entry to Point-of-Use
- Debate as to what are best design and solutions is ongoing



## Types of Solutions on the Market

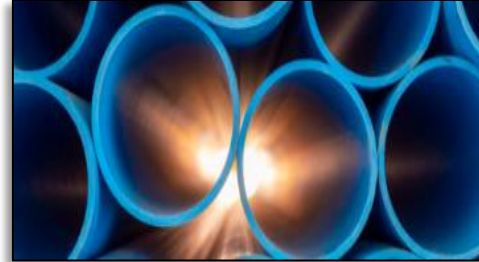
- Heat
- Copper silver ionization
- POE ultrafiltration
- UV
- Disinfectants – chlorine, chloride chloramines
- Point-of-use filters

## Water



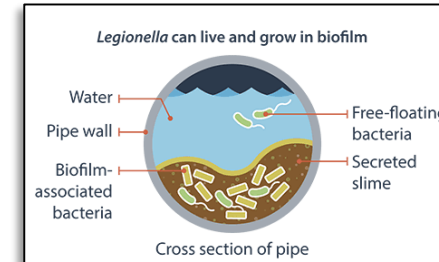
- Old water, stagnant water
- Lukewarm water
- Water temperature fluctuations
- Low disinfectant residuals
- pH level
- Low flow rates
- Sensor faucets

## Design



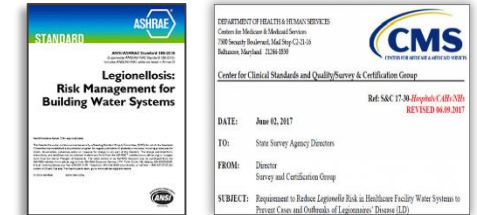
- Dead legs
- Complex plumbing systems
- Construction
- Piping size
- Piping material
- Re-circulation
- New or renovation
- Water heater – tank or no tank
- Temperature from digital mixing valve
  - 140 from DMV; Record at 131
  - Higher than 140 from DMV
- Type of facility

## Bacteria



- Biofilm
- Presence of legionella
- Water main break / disruptions
- Scale and sediment
- Other bacteria and pathogens
- Are you testing?

## Guidelines & Standards



- ASHRAE 188
- ASHRAE Guideline 12
- 2018 Plumbing Code
- 2017 WE-Stand water efficiency standard
- ASPE
- IAPMO
- Water Quality Research Foundation
- FGI Guidelines
- Safe Drinking Water Act
- AWWA C651-14
- CDC



## Heat – Water Temperature

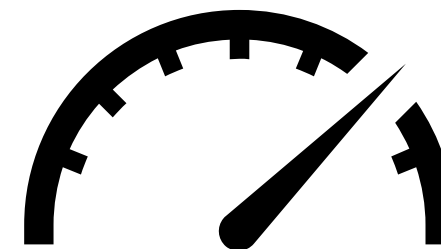
- Considered very effective at killing Legionella
- Can kill quickly
- ASHRAE 188 recommended
- Doesn't address dead legs
- Scalding safety is a concern; can be addressed by POU T/P mixing valves
- Flush water waste needs to be considered
- Energy use can be high, depending on solution
- Does not penetrate slime or biofilm
- Legionella can re-populate easily once temperature is dropped back below 122°F
- Can be labor / risk intensive
- Equipment longevity and efficiency reduced (scale, corrosion)
- Heat and flush can be effective provided water is over 154°F

## Watts Solution

### IntelliStation



# How Water Temperature Affects Legionella



**Below  
68°F**

Dormant

**68°F -  
122°F**

Thrive

**Above  
122°F**

Survive but  
don't multiply

**131°F**

Die within 5-6  
hours

**140°F**

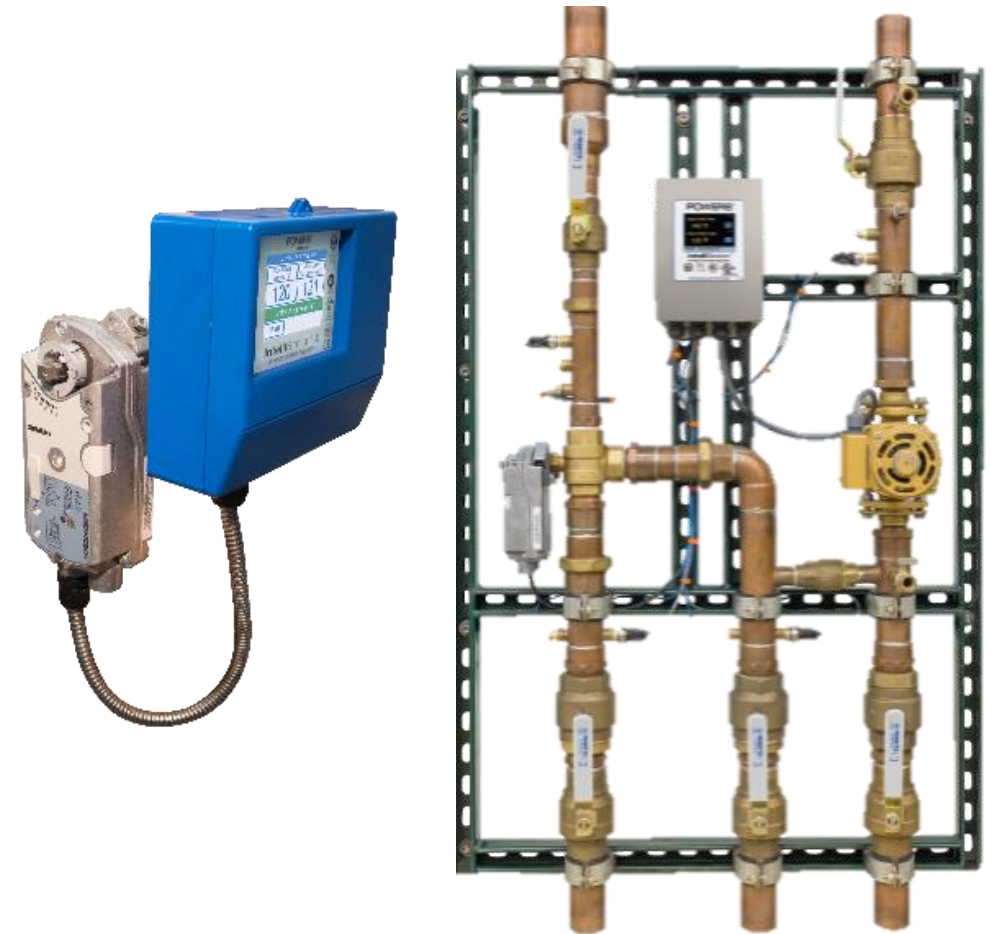
Die within  
32 minutes

**158°F**

Rapid kill

- Control an entire water distribution loop or major sections of a loop
- Can be installed between tanks and taps to maintain a high temperature in tanks but lower temperatures at taps; can kill legionella without scalding risk
- Digital water mixing and recirculation solutions can be integrated into a building automation system to allow facility managers complete control of and visibility into their domestic hot water delivery.
- Provide precise control of hot water delivery within 2 degrees of the set point, surpassing industry standards for mechanical systems.
- When coupled with point-of-use heating, such as a localized tank-less heater, they can help mitigate any potential issue from dead legs in the system.
- Digital mixing eliminates temperature creep within the system, thus eliminating the need for balancing valves.
- A sanitization or disinfectant mode can be triggered to briefly raise the temperature above 158 degrees F to induce a “rapid kill” and purge all legionella bacteria.
- **All of this means that it can more precisely be controlled to mitigate legionella growth in the heated water.**

## [IntelliStation](#) / [IntelliStation Jr.](#)



## Considerations

- No scale, biofilm or sediment in a tankless
- Even without a tank dead legs are still a concern
- Disruptions will cause dislodgement of sediment, scale and biofilm
- Temperature must be maintained through the entire circulation loop. Testing at the very end of the return line is vital.
- Chlorine or other disinfectant injection should be considered.
- Store at or above 140° Fahrenheit
- POU mixing to mitigate scalding
- Be aware of temperature ranges that can occur within the tank. In some cases approximately 65% of the tank will be at the set temperature; the other 35% will be cooler. There is the possibility of a warm zone at the bottom of the tank and scale and sediment can accumulate.
- Install multiple thermometers in the tank at varying locations to track any temperature range.
- Some say instantaneous have more maintenance concerns



## AERCO Innovation Water Heater

- Delivers instantaneous hot water with no storage tank or standing water and temperature control to +4oF
- Delivers a 30:1 turndown ratio,
- Innovation 1350 has operating efficiency of 99%

## PVI Power VTX Condensing Water Heater

- Has up to 97% thermal efficiency from 40°F to 140°F at full rate
- Can qualify for LEED certification & may contribute to additional LEED points due to efficiency



## PVI Conquest Water Heater

- Provides up to 97% thermal efficiency operating up to 140°F, the recommended storage temperature by ASHRAE, OSHA and the CDC to control Legionella.



## Chlorine

- Chlorine commonly used in water treatment
- Works regardless of temperature (more difficult at higher temperatures)
- Chlorine added at building must be monitored and tested; too much is harmful and too little is ineffective
- Must consider distal effectiveness
- Can affect water taste and color; can have human health reactions
- Inadequate penetration of the agent into biofilms
- Not a preferred method for irrigation systems
- Plumbing impacts from hyper-chlorination
  - Water is acidic
  - More corrosion to plumbing – pinhole leaks
  - Mixed metals prone to galvanic corrosion
  - Potential for leaks and damage

## Mono-chloramines (NH<sub>2</sub>Cl)



- Seen as safer than straight chlorine, however, known to create carcinogenic byproducts
- Can convert organic materials and cause health and plumbing issues
- Penetrates biofilm better
- Less effective on protozoa and some other bacteria
- Oxidates slower than chlorine



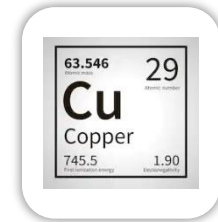
## Chlorine Dioxide (ClO<sub>2</sub>)

- High solubility and remains in water
- Performs well when pH is above 7
- Works well in all temperatures
- Licensed individual needed to use it
- Material is toxic and can be volatile; expensive
- Slow acting on Legionella
- More effective at penetrating biofilms than chlorine



## All Disinfectants

- Effectiveness will vary from one disinfectant to another
- Some will be more effective on Legionella while others will be more effective on biofilms or other bacteria/waterborne pathogens
- All disinfectants will dilute as they travel through the premise plumbing system
- Unintended consequences such as the taste and color of the water and negative interactions with other equipment should be considered
- Different disinfectants will require licenses and maintenance by licensed individuals (can vary from state to state)
- You can never rely on disinfectants injected in the water by municipalities because you do not know their distal effectiveness



## Copper Silver, CuAg

- Highly effective in in-activating cysts, bacteria, viruses and parasites including legionella (up to 99.9999% 6-log)
- Simple, rapid process
- Chemical free method of disinfecting water
- No creation of harmful disinfection by-products
- No storage or holding tank; small footprint
- Stainless steel construction
- High output/intensity
- Automatic lamp dimming for cooler operation
- Informative controller displays
- Radio frequency lamp identification
- Automatic lamp calendar (replace annually)
- Multi color system status lights
- Positive lamp insertion detection
- Alarm relay and 4-20 mA outputs
- Minimal maintenance/no moving parts



- Originally developed by NASA for space program
- Uses positively charged ions from copper and silver plates
- Bonding of positively charged ions with negatively charged cell wall kills bacteria
- Requires small amount of electricity to operate
- Metal plates will need occasional replacement
- Alternative to chlorine; considered safer
- Can be used in hot or cold water
- Reduces side effects of chlorine
- Known to maintain residual longer than other disinfectants; prolonged effect up to 3 months
- May not be effective against other bacteria
- Applicable to both hot and cold water
- Eradication of 100% to below 30% LP positivity
- Only validated method
- Expensive higher cost to purchase and to maintain
- Compromised efficacy by elevated PH (above 8.5) and low concentration
- EPA registration required as biocide
- Personnel State issued water treatment license required in many states

DNA Before



DNA After







## POU Filters

- Can be used at faucets, showerheads
- Patient rooms/public facilities
- Costly replacement - sometimes replacing every 6 weeks
- Helps reduce risk of dead legs and dilution of disinfectants
- Better than turning taps on after non-use
- Can be seen as providing extra protection and “full solution” for Water Management Plan
- Many hospitals implement in all patient rooms after a breakout
- Future will most likely see all high-risk areas (ICU, NICU, etc.) and ice machines with POU filters, regardless of whether an outbreak has occurred
- Recently the industry has been promoting POU filters in high risk areas and also during outbreaks



## POE Ultrafiltration

- Can reduce dirt and sediment at POE
- Does not reduce efficacy of disinfectants
- Can remove microorganisms, including Legionella
- Sizing the flow rate is critical
- Pressure differential is critical
- Can be used as a redundant microbial filter
- No negative effects on piping or equipment
- Can be used in new and existing buildings
- Currently limited options



## Sediment Removal: Big Bubba®

- Effectively removes sediment, assisting other equipment to function properly.
- Reduces sediment and sediment shadows, which increases effectiveness of UV.
- Commercial filtration with optional activated carbon cartridge removes chlorine bad tastes, foul odors and sediment.
- Pre-filtration for reverse osmosis equipment
- 100% efficient because no backwashing is required. Valuable water is conserved with no waste.



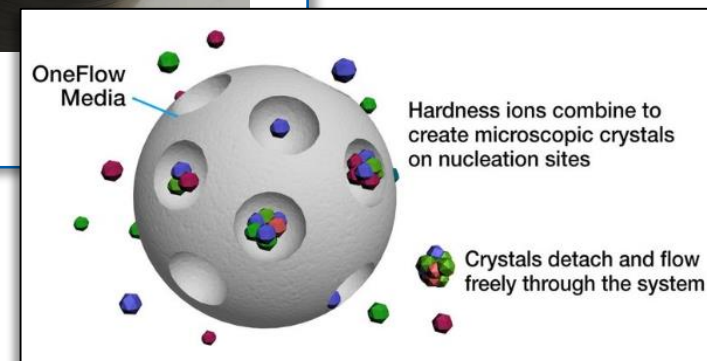
## Scale Reduction

- Enables all other solutions to work more effectively
- Reduces the food for Legionella, bacteria and biofilm growth
- Reduces places for legionella to hide
- Does not directly kill or reduce Legionella, but reduces the food source
- Prevents mineral build-up inside pipes, fixtures and equipment
- Should be considered in all multi-barrier Legionella risk reduction plans

## Watts Solution



OneFlow<sup>®</sup>



- Through Template Assisted Crystallization (TAC), minerals are brought together to form microscopic crystals that can flow through the system without attaching to fixtures, pipes and appliance components
- Prevent mineral build-up inside pipes, fixtures and appliances
- Do not require salt, chemicals, or electricity
- Have no regeneration cycle to flush water down the drain

## BLÜCHER Piping & Drainage

- Non-porous
- Significantly lower growth of bacteria on stainless steel than on other materials, making it the ideal solution for applications where hygiene is a concern
- The smooth surface of stainless steel does not harbor bacteria.
- Decreased labor for renovation / installation
- With the decrease in labor associated with installation of Blucher push-fit piping, hospitals decrease shut down time of rooms/floors for renovation
  - The design/maintenance director for a large healthcare system estimates they save roughly \$5000-\$10,000 in decreased shut down time per renovation.



## HygienicPro & HygienicClean™

- Reduces splashing and water molecules traveling through the air
- Controlled cleaning – no bacteria will be spread to the food production area. Special nozzles ensure correct direction and pressure of water and soap.
- Channel and grating cleaned in one and the same process
- HygienicClean is designed specifically for HygienicPro.
- Special nozzles ensure correct amount of water is used.



# Watts Multi-Barrier Legionella Solution



MUNICIPAL WATER

MECHANICAL ROOM



POE Filtration  
**Big Bubba®**

- Reduction of sediment increases efficiency and effectiveness of other solutions
- Reducing sediment can lower conduits for biofilm growth



Anti-Scale Treatment  
**OneFlow®**

- Reduction in scale increases efficacy of other solutions
- Reduction in scale can aid in the reduction of food for bacteria growth



Hot Water Heating

- [Tankless water heaters](#) can reduce biofilm buildup and stagnant water
- Water heaters aid in accurately controlling water temperature



Digital Hot Water Mixing  
**IntelliStation**

- The [IntelliStation](#) delivers precisely controlled hot water within +/- 2 °F in accordance with ASSE 17
- The [IntelliStation](#) can deliver a hot water flush in case of emergency, killing Legionella in minutes
- Operational data can be fed into a hospital's Water Management Plan



UV  
**SmartStream®**

- UV de-activates pathogens in the water supply as it passes through the UV media

POU Mixing



Non-traditional healthcare companies entering market and bringing new technologies



Telehealth – Technology allows for doctor/patient communication at the patient's home

Aging population – Increases in healthcare demands and infrastructure (medical office buildings - MOB) to serve these patients

Modular Design is more prevalent; especially for patient rooms

In a shift away from their traditional inpatient facilities, health care providers are investing in outpatient clinics, same-day surgery centers, free-standing emergency rooms and micro hospitals, which offer as few as eight beds for overnight stays.



### Go with the Flow

Best practices for maintaining water movement in plumbing systems.

February 23, 2018 David Desjardins No Comments



### Legionellosis: An Inconvenient Disease

Working toward prevention is the best way to address the problem.

February 21, 2018 Ron George No Comments



Legionella and possible mitigation solutions continue to make headlines

Facility directors, engineers, and infection control professionals still have a high level of confusion about solutions for mitigating the risk of Legionella and other waterborne pathogens

- They continue to get a range of opinions on all Legionella solutions
  - Heat is always used
  - Chlorine is almost always/not liked/corrosive
  - Copper Silver Ionization is too expensive but works
  - UV isn't trusted
- CMS has started conducting inspections for water quality management teams and plans
- Hospitals are installing POU filters in high risk areas when cases have occurred



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