

# *Legionella* Awareness and Management Strategies

- 1) Legionella Awareness
- 2) Overview
- 3) Risk Reduction Strategies

Environmental Hygiene Services Group  
Nalco | An Ecolab Company  
Naperville, IL

# Dangers to my organization

- ▲ Bad publicity with damage to company and brand image
- ▲ Accidents and incidents with associated injuries and deaths
- ▲ Litigation
- ▲ Legal costs
- ▲ Employee dissatisfaction and demotivation

## The Risks:

- Public Health Risk
- Public Image and Business Risk
- Regulatory Risk
- Legal Risk

# Dangers to my people – deaths from recognized causes

- **Bacterial agents** in food – **3,000 per year**

FDA costs \$2.4 billion per year

- **Fires** in 2010 – **2,640**
- **Workplace** in 2010 – **4,547**

Businesses spend \$35 billion annually to comply with federal workplace safety standards

## Legionnaires' Disease

- OSHA Technical Manual:

Approximately 1,000 cases are reported annually to the CDC, but it is estimated that over 25,000 cases of the illness occur each year and cause **more than 4,000 deaths**.

- Cases reported annually increased 217%, from 1,110 in 2000 to 3,522 in 2009.

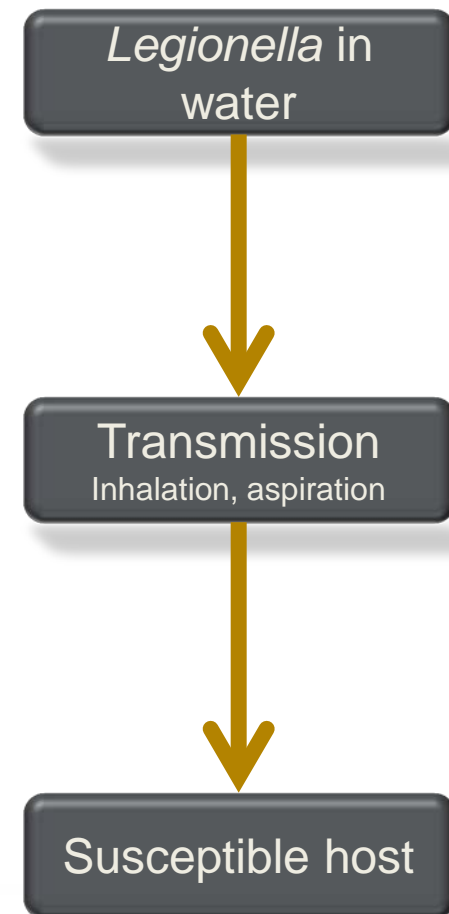
# Legionella Awareness

What is the enemy?

- ✓ *Legionella*
- ✓ Biology
- ✓ Hazards
- ✓ Guidelines
- ✓ Summary

# What is Legionellosis?

- ▲ It is the condition of being infected by *Legionella*
  - Inhaled as an aerosol or water mist (typically <5-10 micrometers)
  - Drinking contaminated water does NOT cause legionellosis
  - But aspirating contaminated water or ice chips has caused disease
  - It is not contagious
- ▲ Pontiac Fever (Humidifier Fever)
  - An acute, febrile, self-limiting illness lasting up to five days
  - Characterized by fever, fatigue, muscle pain
  - Illness is caused by several *Legionella* spp.
- ▲ Legionnaires' Disease (LD, legionellosis)
  - A severe respiratory pneumonia treatable with antibiotics
  - Characterized by malaise, anorexia, myalgia, headache, cough, fever
  - 90% of cases are caused by *L. pneumophila* SG1
  - Other species have been linked...
    - *micdadei*, *longbeachae*, *dumoffii*, *bozmanii*





# How?



Using showers



Aspirating water



Water features

...water mists



Using spas



Washing



Cooling Towers

# Who is at risk?



- ▲ CDC 2003. Summary of Notifiable Diseases – United States – 2001.
  - 87% of all reported cases were age >40 years
  - Men are twice as likely as women to be afflicted
  - Children under 15 years rarely are afflicted
- ▲ Emerging evidence of pediatric legionellosis (Neonates)

# 2 Employees Contract Legionnaires at CUNY School

Thursday, Aug 2, 2012 | Updated 10:31 AM EST  
Long Island City





## **Former cook at Lehigh University sues school after contracting Legionnaires' disease**

Thursday, December 09, 2010

**By JD MALONE**

**The Express-Times**

BETHLEHEM | A former cook at Lehigh University filed a lawsuit Tuesday claiming the university was at fault when he contracted Legionnaires' disease last year.

Jeffrey W. Kulls, of New York City, worked for Sodexo at Lehigh the summer of 2009 when Sept. 1 he came down with fever, chills, weakness, and aches and pains, according to the suit. Kulls was hospitalized for almost a month battling the disease, according to court papers, and spent time in the intensive care unit due to respiratory failure.

The suit claims Kulls contracted the disease toward the end of summer 2009 while working in the kitchen at the University Center. According to court papers, Kulls no longer works at Lehigh and cannot work due to poor health and other complications arising from his exposure to Legionnaires' disease.



# BIOLOGY

# Legionella – Natural habitat



Lakes



Ponds



Soils

**Legionella is a  
rod-shaped bacteria**



Rivers

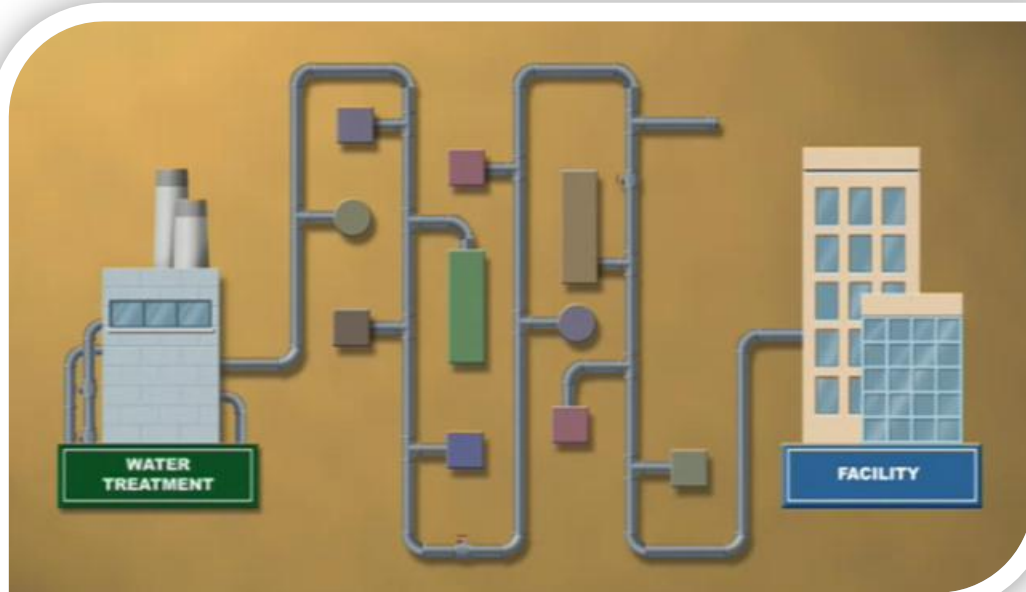
**Legionella can enter and  
proliferate in water systems**

**...from the air or through our  
city distribution systems.**

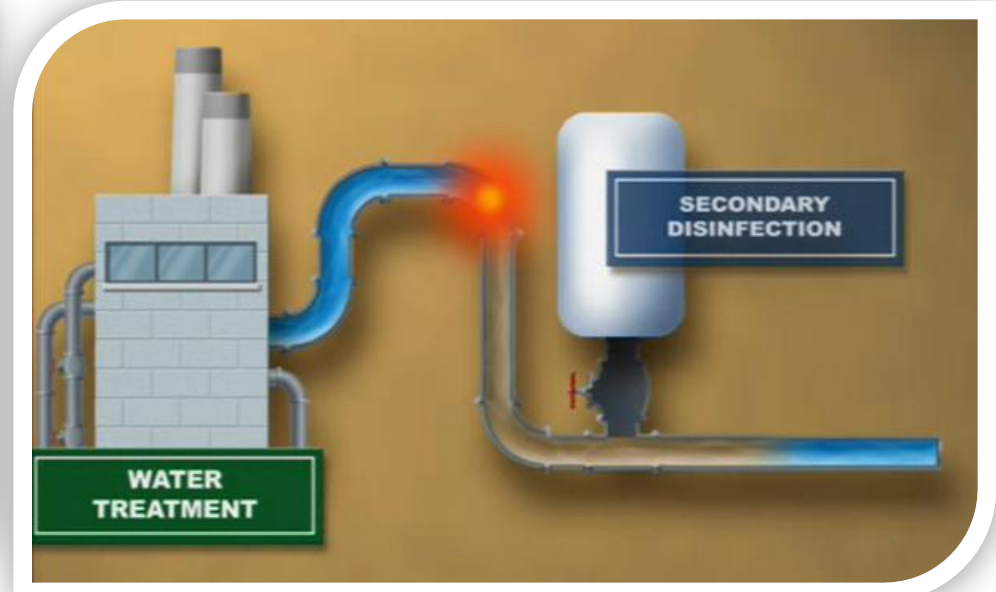
**Grows at...**  
**pH 5.1 to 9.1**  
**68-122°F (20-50°C)**



# Building Water Systems



- ▲ Water distribution is complex
- ▲ Water main breaks happen
- ▲ Large complex systems are more prone to *Legionella* growth than smaller systems



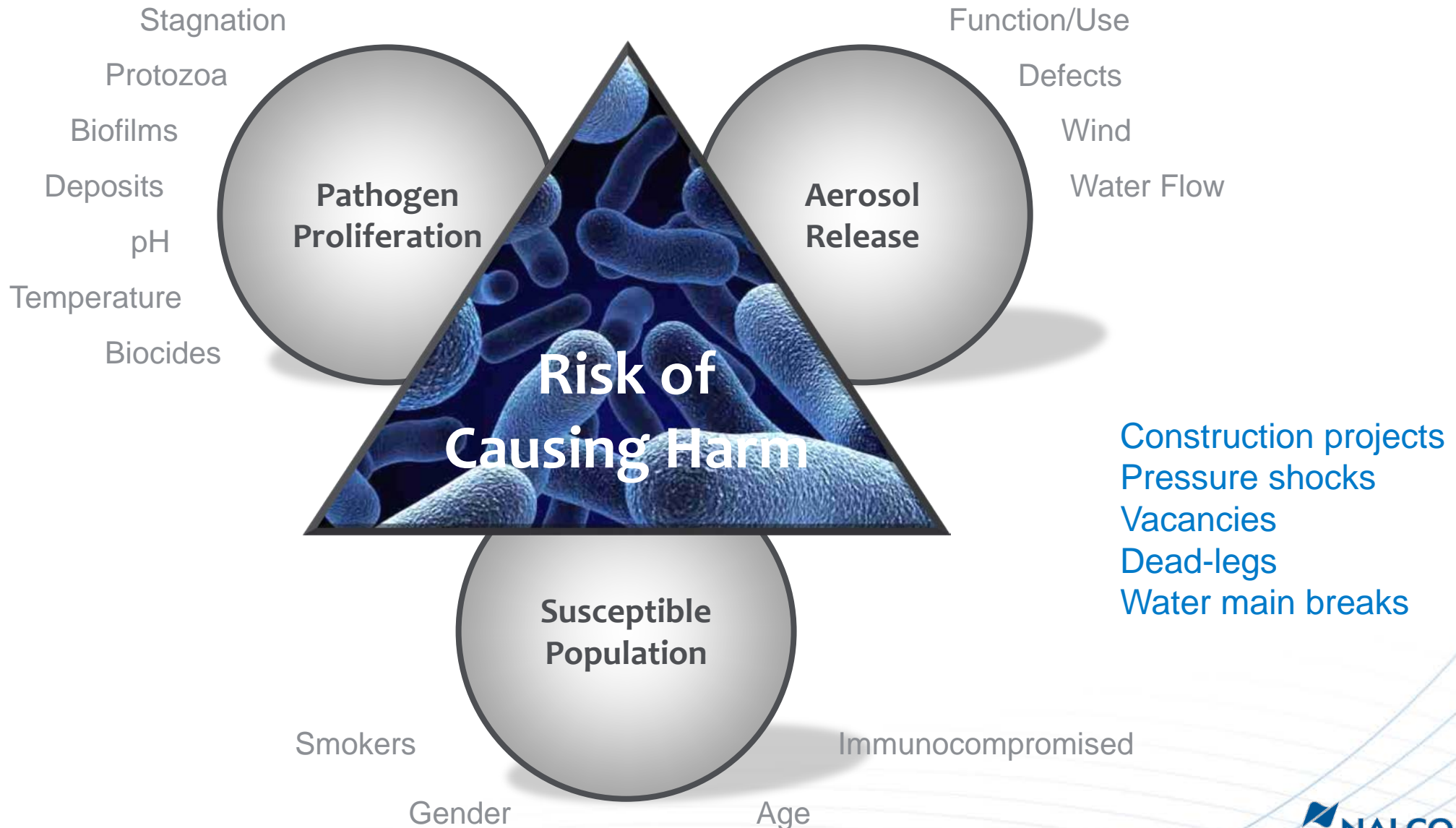
- ▲ Facility owners are responsible for water safety once the water enters the facility
- ▲ Secondary disinfection coupled with managing stagnant water conditions and water temperature is one of the most effective approaches for reducing risk





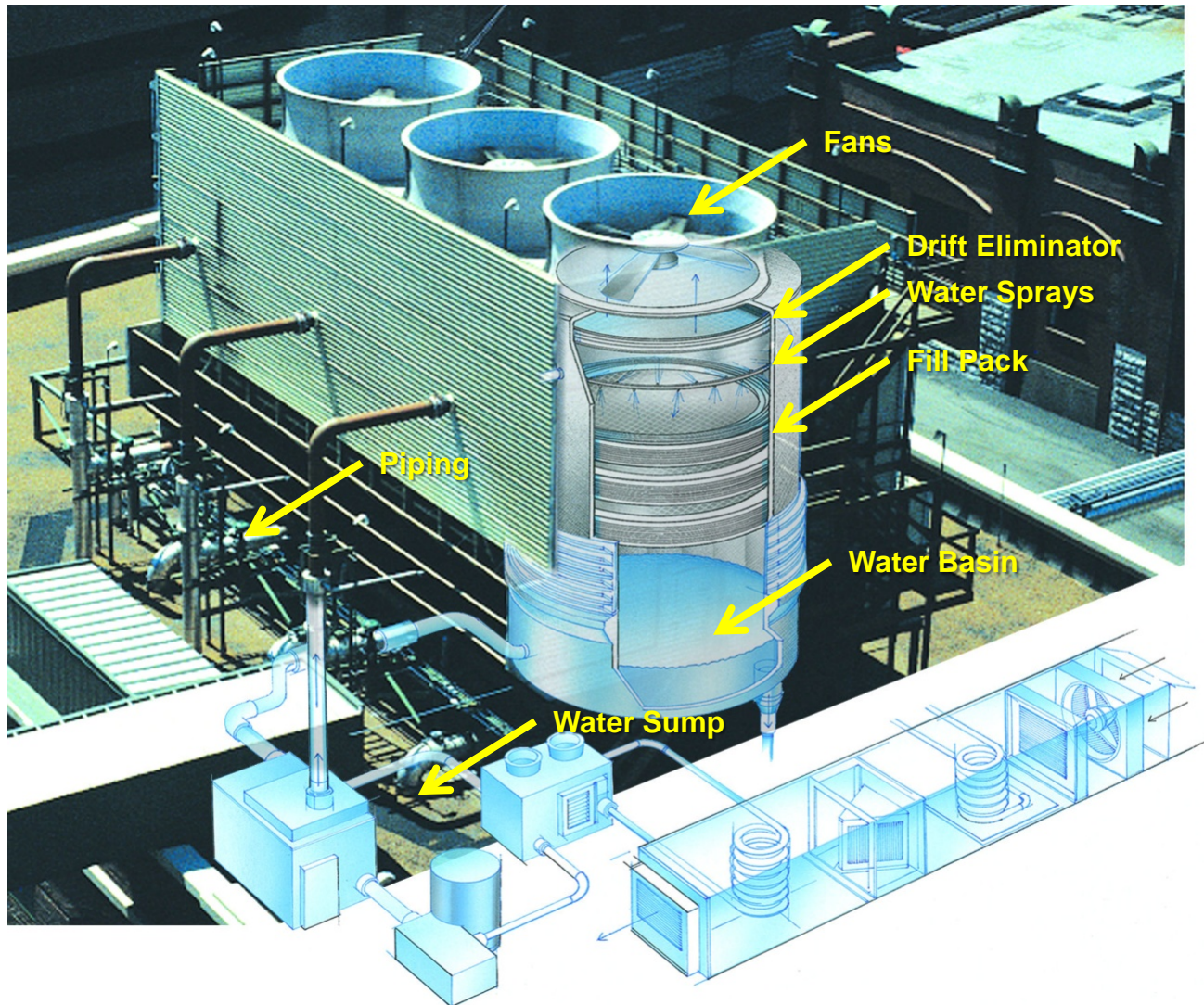
# HAZARDS

# Conditions that increase risk of causing harm...





# Cooling Towers



Drift Eliminator  
Use the best technology



# Do I have issues with deposits or scale?





# Do I operate within design?



# Do I operate systems near people or entry points?





# Domestic Water Services



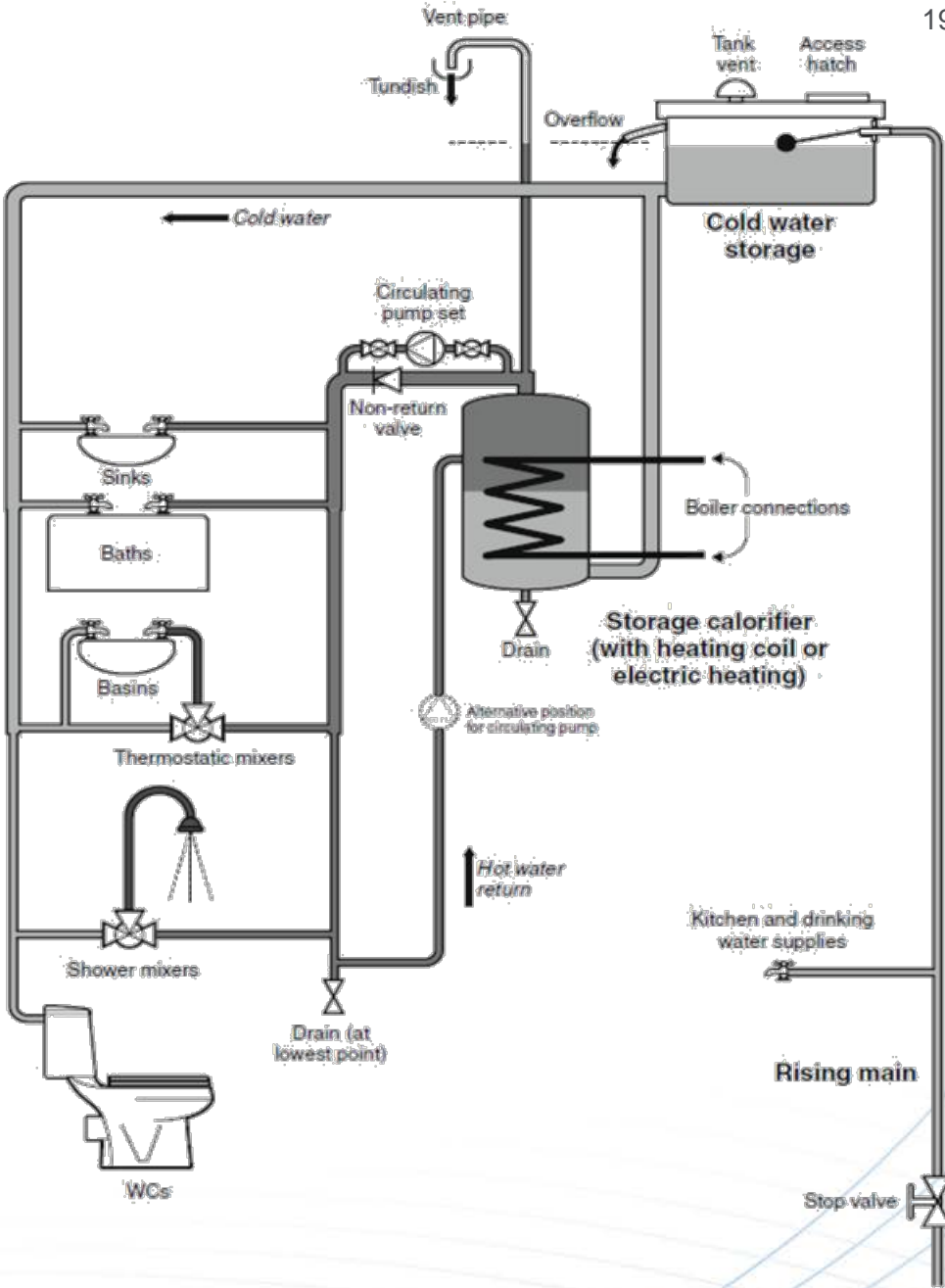
Water Storage



Heat Exchangers



Point-of-use



# Domestic Water Service Hazards





# Developing a Site *Legionella* Management Plan

- ✓ Purpose, Scope, Intended Use
- ✓ HACCP Principles
- ✓ Developing a Plan
- ✓ Documentation, Verification, Validation
- ✓ Where to start...

# What is HACCP?

**H**azard  
**A**nalysis  
**C**ritical  
**C**ontrol  
**P**oints

Systematic  
approach

Food safety for  
astronauts

Intent is to apply  
control measures

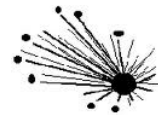
Reduce significant  
hazards to an  
acceptable level



Chemical



Biological



Physical



# (1) Form a HACCP Team

- ▲ The team should include up to ten members who will oversee the plan and make key decisions
- ▲ Appoint a team leader who will oversee the plan and ensure it is followed

## HEALTHCARE

*Hosp. , LTC, etc.*

### Team Members

- Facilities director
- Administrator
- Infection control
- Health & Safety
- Environmental Services
- Medical director
- Chief Engineer

## INSTITUTIONAL

*Edu., Hotels, Casinos, etc.*

### Team Members

- Facilities director
- Health & Safety
- Housekeeping
- Maintenance & Engineering

## INDUSTRIAL

*F&B, Pharma, Mfg., etc.*

### Team Members

- Plant manager
- Health & Safety
- Maintenance & Engineering

- ▲ Many others will be needed for implementation



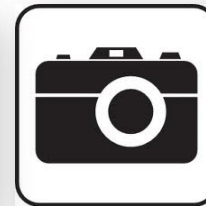
## (2) Water system inventory & flow diagrams

- ▲ Domestic services (potable)
  - Water heaters
  - Water storage
  - Points of Use (POU)
    - Sinks, showers, etc.
- ▲ Cooling towers
- ▲ Pools & Spas
- ▲ Decorative fountains
- ▲ Water filters
- ▲ Irrigation
- ▲ Plumbing & distribution
- ▲ Ice machines
- ▲ Cross-connections
- ▲ Fire protection
- ▲ Swamp coolers
- ▲ Drinking water fountains & coolers
- ▲ Other water using devices

Verify inventory and flow diagrams with a facility walk-through...



Notes



Photos



Water Temp



Chlorine

## (3) Hazard analysis

- ▲ Hazard analysis examines the chemical, physical and biological hazards.
- ▲ **The intent is to assess the biological hazard associated with *Legionella*.**
- ▲ Chemical and physical hazards will be addressed by limitations of control practices.
  - The physical hazard associated with hot water is limited to a max temperature to prevent scalding
  - Chemical hazards such as when secondary disinfection (e.g.,  $\text{ClO}_2$ ) is applied will be limited per EPA drinking water standards
- ▲ As an added benefit, control measures for *Legionella* will also reduce risk of most other biological hazards.
- ▲ Steps in the flow process outlined in the flow diagram is evaluated for...
  - Potential for growth
  - Potential for aerosol release & exposure

## (4) Define Critical Control Points

### Hazard Analysis

Use the process flow diagrams and walk through information (chlorine residual, water temperatures, noted dead-legs/stagnation/vacancies/construction, etc.) to determine...

- Control Points (CP), and
- Critical Control Points (CCP)

*Legionella* proliferation potential and water aerosol potential should also be used to help define CP and CCP.

### Control Points

A hazard potential where aerosol risk, bacterial risk, or both may be significant is a CP.

Control points are notable potential hazard points that require monitoring and implementation of risk reduction strategies to reduce risk.

### Critical Control Points

A hazard potential that presents a significant risk is considered a CCP and is assigned a number.

A CCP is an operational step in water flow process at which control can be applied and is essential to prevent or eliminate a hazard or reduce it to an acceptable level.

Critical control points require implementation of risk reduction strategies and methods for verification and validation.



## (5) Define Monitoring & Control Limits

... for the CP and CCP's

### CONTROL MEASURES

Control measures are evidence based industry best practices that have proven to be effective for reducing risk associated with *Legionella*.

### MONITORING TASKS

Monitoring is necessary to verify the control measures work.

### MONITORING FREQUENCY

Set a reasonable frequency for monitoring tasks. Reference industry guidelines.

### CRITICAL LIMITS

Set critical control limits for each monitoring task . Establish goals to control within.

### CONTINGENCY PLANS

Define corrective action when critical limits are not met.

## (6) Documentation, Verification, Validation

### Documentation

Defined requirements in the HACCP Plan

Methods may include:

- Building automation system
- Preventive maintenance work orders
- Housekeeping work orders
- Vendor reports
- Paper or electronic logs

### Verification

Designate a responsible person to ensure that...

- control measures,
- monitoring, and
- corrective action

...is being carried out.

The responsible person must directly review the documentation and verify implementation.

### Validation

The effectiveness of the HACCP plan must be validated.

- Is the plan being followed?
- Is the plan working as intended?
- Is there any new scientific evidence to validate selection of the CCP or control limits?

# Validation Methods

## Option A

Cite studies that demonstrate reduced prevalence of *Legionella* as a result of implementing similar control measures.

*This method is passive as it does not provide direct evidence of control based on testing specific to the system.*

## Option B

Monitor cases of facility-acquired legionellosis.

*This method is essential for hospitals and LTC facilities.*

*This method is not feasible for most other facilities such as hotels, casinos, institutional facilities, manufacturing, etc.*

## Option C

Test the water systems routinely for *Legionella* and evaluate effectiveness of the control measures based on criteria defined in the HACCP plan.

*This method provides direct evidence of control and can help facilities justify changing the CCP, the control limits, or the frequency of testing.*



# Legionella Risk Reduction Strategies

- ✓ Utility Water Systems
- ✓ Domestic Services
- ✓ Other “At Risk” Water Systems



## Cooling Towers

# CLEAN & DISINFECT

# Clean & Disinfect: Cooling Towers

<p><b>OFF-LINE (Seasonal)</b></p> <ul style="list-style-type: none"> <li>✓ Dose to achieve 10 ppm free halogen and maintain 5 ppm free for 6 hrs</li> <li>✓ Alternatively, dose to achieve 25 ppm free halogen and maintain for 1 hr</li> <li>✓ Apply biodispersant (optional)</li> </ul> <p>Recommended for seasonal (at startup or shutdown) off-line clean and disinfect, in response to heavy persistent microbial activity, or per plan contingency.</p>	<p><b>ON-LINE (Remedial)</b></p> <ul style="list-style-type: none"> <li>✓ Maintain 5 ppm free halogen for 6 hrs</li> <li>✓ Apply biodispersant (optional)</li> </ul> <p>Recommended for periodic on-line disinfection to respond to heavy biofouling, process leaks, or other issues that may contribute to excessive microbial activity.</p>
<p><b>OFF-LINE (Emergency)</b></p> <ul style="list-style-type: none"> <li>✓ Dose to achieve 25-50 ppm free halogen and maintain 10 ppm free for 24 hrs</li> <li>✓ Apply biodispersant</li> </ul> <p>Recommended for emergency disinfection to respond to an outbreak situation or heavy persistent microbial activity.</p>	<p><b>ON-LINE (Shock Dose)</b></p> <ul style="list-style-type: none"> <li>✓ Dose to achieve 5 ppm free halogen</li> <li>✓ Apply biodispersant (optional)</li> </ul> <p>Recommended for periodic on-line disinfection to respond to persistent biofouling, process leaks, or other issues that may contribute to excessive microbial activity.</p> <p>May also be used weekly to monthly as a pre-emptive control strategy during warmer summer months when microbial activity is highest.</p>



# Off-Line Cooling System Clean & Disinfect



## Safety & Training

- Nalco P<sup>4</sup> Training
- OSHA Safety Training
- Respiratory Protection
- Confined Space
- PPE



## Standardized Method

- Follow industry best practice
- Consistent approach
- System disinfection before & after physical cleaning
- Biodetergents to aid clean & disinfect

## Benefits

- Free up labor resources
- Employee safety
- Helps reduce risk
- Optimize performance
- Documentation



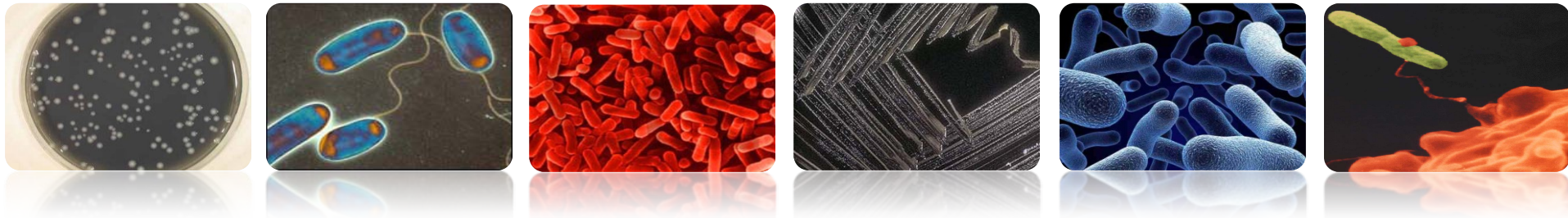
**BEFORE**



**DURING**



**AFTER**



Verify Control

# LEGIONELLA CULTURING

# Legionella Culturing

- ▲ Culture testing is the “gold standard” (ISO 11731 Method)
  - Quality
  - Standardization
  - Consistency
- ▲ Not all labs follow ISO 11731
- ▲ **Nalco Lab is CDC ELITE certified**
- ▲ Test requires up to 12-14 days
- ▲ Bacteria colonies are confirmed via serotyping



INTERNATIONAL  
STANDARD

ISO  
11731

First edition  
1998-5-01

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Water quality — Detection and enumeration  
of *Legionella*



*Legionella* colonies on selective agar



# Should I test?

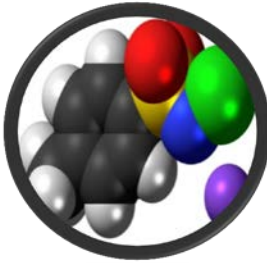
- ▲ Expert opinion on routine *Legionella* testing are divided.
- ▲ Although not required, testing is highly recommended to verify control practices.
- ▲ Random testing in the absence of an assessment and management program is unwise, and annual “spot-checks” are rarely if ever meaningful.
- ▲ *Legionella* testing must be combined with other monitoring strategies.
- ▲ Perform testing within the context of a HACCP plan with control limits and a define contingency plan.

System	Frequency*
Cooling Water	Quarterly
Domestic Hot Water Storage	Monthly to Quarterly
Domestic Showers	Monthly to Quarterly
Sink Outlets	As needed

\* More frequent testing is recommended for higher risk devices or when verifying post remediation efficacy.



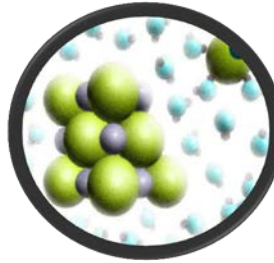
Chlorine Dioxide



Chloramine



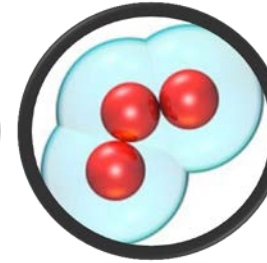
Chlorine



Copper-Silver Ions



Super Heat &amp; Flush



Ozone

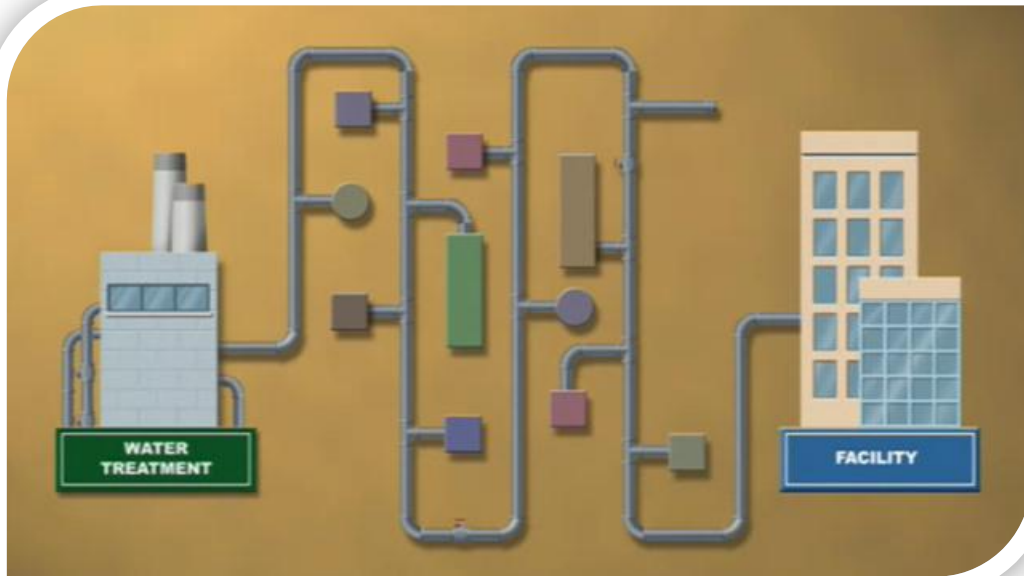


UV light

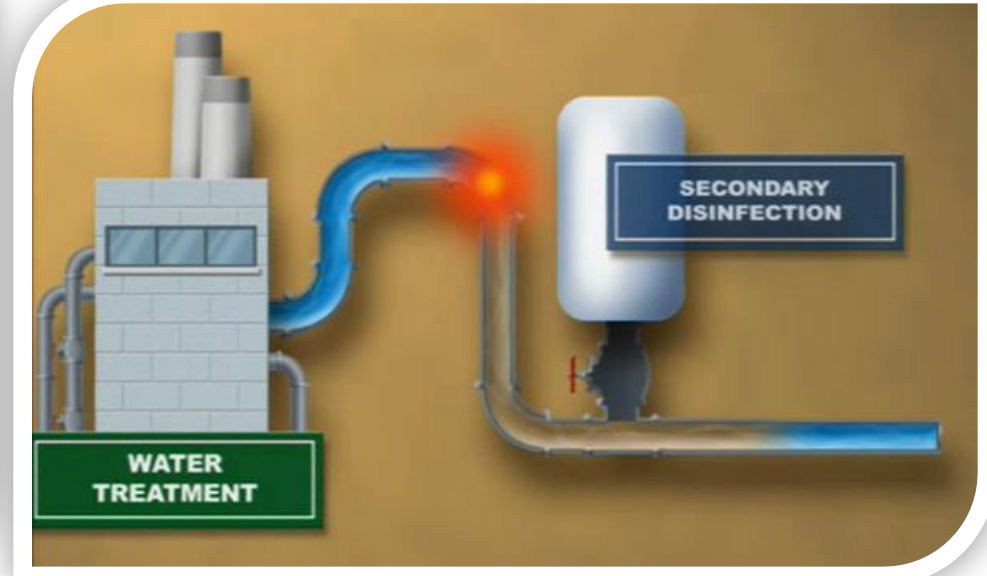
Domestic Water

# DISINFECTION

# Secondary Disinfection



- ▲ Water distribution is complex
- ▲ Water main breaks happen
- ▲ Large complex systems are more prone to *Legionella* growth than smaller systems



- ▲ Facility owners are responsible for water safety once the water enters the facility
- ▲ Secondary disinfection coupled with managing stagnant water conditions and water temperature is one of the most effective approaches for reducing risk

# Secondary Disinfection Methods

- ▲ Super Heat and Flush
- ▲ Hyperchlorination
- ▲ Continuous Chlorination
- ▲ Chloramine
- ▲ Copper-Silver Ionization
- ▲ Ozone
- ▲ Ultraviolet Radiation



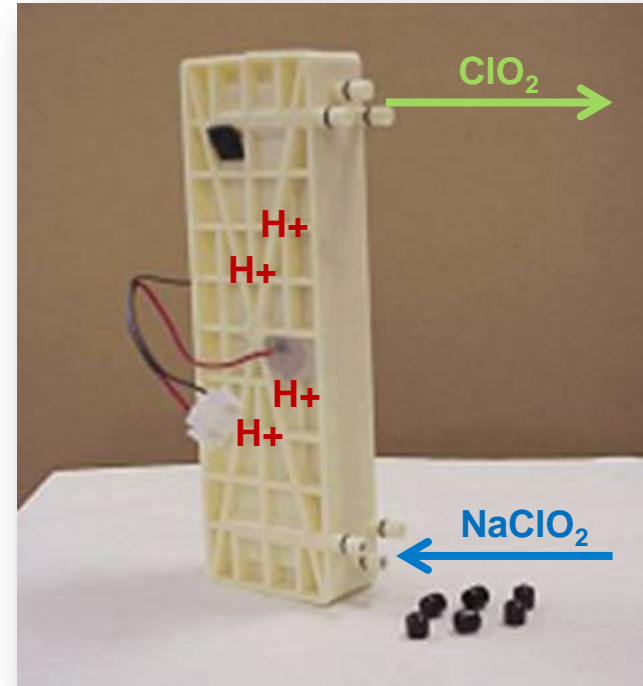
# Envirox Electro Chemical Chlorine Dioxide System



**Envirox SRE1000 ClO<sub>2</sub>**  
Output: Up to 1.1 lbs/day  
(480 gm/day)



**Envirox ClO<sub>2</sub> Dosing Package with Pallet**  
Delivers ClO<sub>2</sub> solutions into pressurized lines



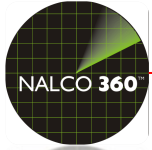
**Electro Chemical Cassette**  
Three Chamber Resin Catalyst Bed

- ▲ Envirox is NSF61 Approved
- ▲ 25% Sodium Chlorite (HYG-25)
  - NSF60 Approved
  - EPA Registered as a pesticide

- ▲ Safe delivery, 540 ppm ClO<sub>2</sub> solution
- ▲ Self-contained unit
- ▲ No mixing of acid
- ▲ Health & Safety optimized

# Continuous Monitoring for Validation

Web Dashboard



Nalco Global Gateway



Chlorine Dioxide  
Sensor/Controller

ClO<sub>2</sub> Signal

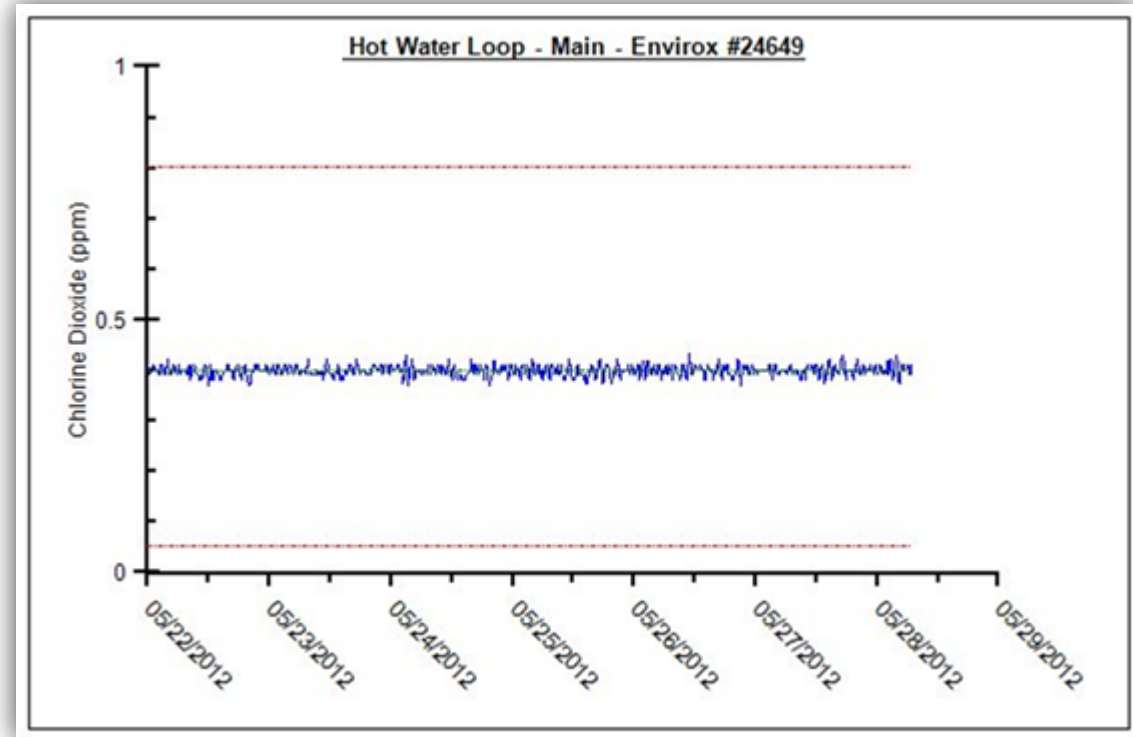
System Alarms



Nalco 360™ 3DT  
Starter for Envirox



Envirox System



- ✓ 24/7 Documentation of ClO<sub>2</sub> residual
- ✓ Weekly Reports
- ✓ Email Alarm Notifications:
  - Low ClO<sub>2</sub>
  - High ClO<sub>2</sub>
  - Generator Alarm
  - Dosing Tank High Alarm
- ✓ Maximum System Up Time
- ✓ Minimum System Down Time
- ✓ Optimum Chemical Usage

# Summary of Disinfection Choices

**Envirox**

	Chlorine Dioxide	Chloramine	Chlorine	Copper-Silver	Ozone	UV-Light	Thermal Disinfect
Effective against legionellae	YES	YES	YES	YES	YES	YES	YES
Effective against most bacteria	YES	YES	YES	YES	YES	YES	NO
Effective against biofilm	YES	YES	YES	NO	YES	NO	NO
No Legionella resistance	YES	NO	NO	NO	YES	YES	YES
Protects whole system	YES	YES	YES	YES	YES	NO	NO
Not affected by pH	YES	NO	NO	NO	YES	YES	YES
Not affected by water hardness	YES	YES	YES	NO	YES	YES	YES
Easy to monitor	YES	YES	YES	NO	NO	NO	YES
Low corrosion rates	YES	YES / NO	NO	NO	NO	YES	YES
No Trihalometanes (THM's)	YES	NO	NO	YES	NO	YES	YES
Low disinfection by-products (DBP)	YES	YES	NO	YES	NO	YES	YES

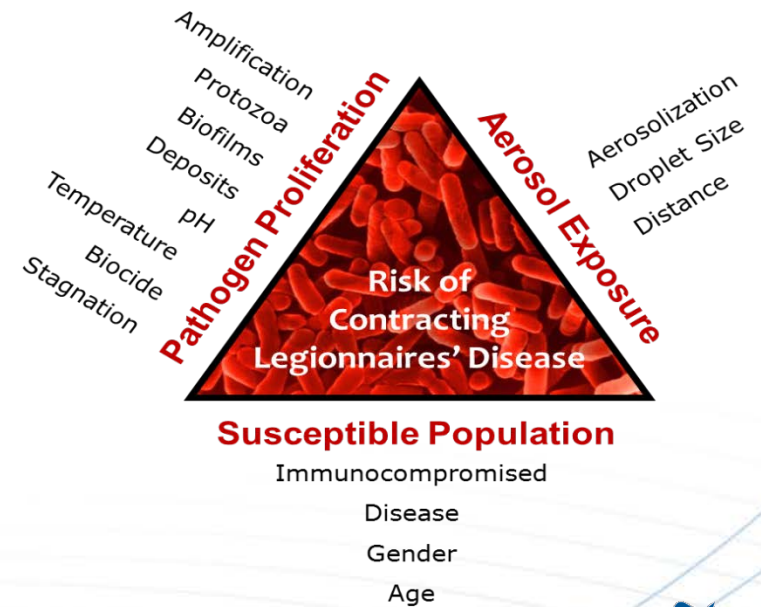
# Other Waterborne Pathogens of Concern

- ▲ Other common infections linked to domestic water systems
  - *Pseudomonas aeruginosa*,
  - *Stenotrophomonas maltophilia*
  - *Acinetobacter* species
  - *Aeromonas* species
  - *Non-Tuberculaosis Mycobacteriums* (NTM)
- ▲ Secondary disinfection with chlorine dioxide to control these pathogens is an emerging practice.





# OTHER “AT RISK” SYSTEMS



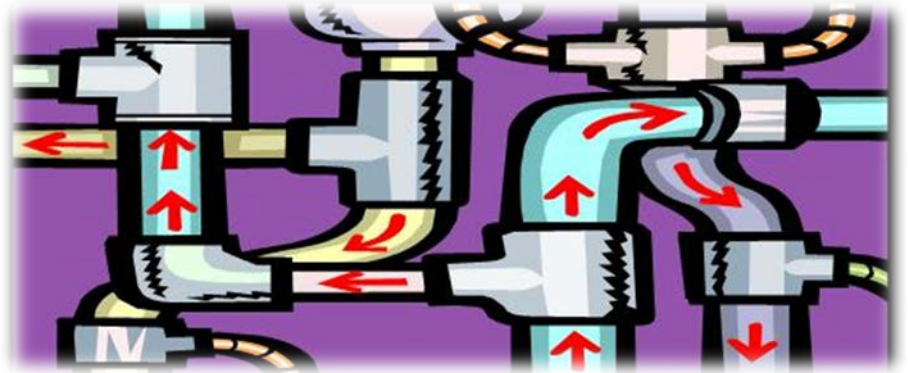
# Spa Pools, Bubblers, Hydrotherapy



Operated at 30-40°C (86-104°F)



Deliberate agitation of the water produces an aerosol above the water surface.



Bather loading and debris can get trapped in system piping.

# Pool Spa Best Practices

- ▲ Exchange 50% of the water each day
- ▲ Use sand filters and backwash each day
- ▲ Total volume turnover should take not more than 6-minutes
- ▲ Paper or polyester filters should not be used
- ▲ Treat continuously with an oxidizing biocide injected prior to the filter
- ▲ Where chlorinating biocides are used, target 3-5 mg/L (ppm) free chlorine
- ▲ Pumps and disinfection system should be run 24-hrs per day
- ▲ The residual disinfectant concentration and pH should be measured before use and every two hours during use.
- ▲ Pool waters should be tested microbiologically once a month.
  - The colony count at 37° C should be <100 CFU/mL , preferably <10 CFU/mL;
  - There should be <10 CFU/mL *Pseudomonas aeruginosa* per 100 ml;
  - There should be no coliforms or *Escherichia coli* in 100 ml



# Recreational Water

- ▲ Recreational water has rarely been implicated in an outbreak of legionellosis.
- ▲ Systems should be maintained to a high standard as defined by local health code requirements.
- ▲ Be aware that legionellae have been found in pool water filters; hence pool filter maintenance is essential.
- ▲ Be aware of potential of biofilm formation on semi-wetted surfaces and keep surfaces clean and disinfected.
- ▲ Be aware of rinse showers in the vicinity of the pool and ensure these showers are used frequently.





# Ornamental Fountains

- ▲ Avoid idle periods
- ▲ Avoid accumulation of sediments
- ▲ Watch out for heat sources (e.g., lights)
- ▲ Keep system treated to control biofilms
- ▲ Monitor system to ensure treatment is effective
- ▲ Clean and disinfect system 2x per year or more if necessary



# Other “At Risk” Systems

## ▲ Irrigation water

- Low risk when used daily
- Prevent stagnation
- Irrigate at off hours
- Drain when not used

## ▲ Emergency eye washes & showers

- Low risk since primary function is emergency use
- Flush weekly per ANSI standards
- Limit aerosols when flush tested

## ▲ Firewater protection

- Treatment is not feasible
- It is stagnant water
- Prevent aerosol exposure during maintenance practices

## ▲ Dental Water Lines

- Perform routine disinfection as required
- Do not let lines sit stagnant more than a week or less

## ▲ Ice Machines

- Clean and disinfect bins 2x/yr
- Change filters 2x/yr
- Use copper supply lines

# Nalco's Global Water Safety Capabilities

## Environmental Hygiene Services Resume

*Nalco's Environmental Hygiene Services Team has worked with customers on Water Safety planning for 15+ years*

30+ Certified HACCP managers

Over 1,000 HACCP plans written and implemented worldwide including over 250 in hospitals

Local service delivered that follows global practice standards

Demonstrated secondary disinfection expertise

Responsible for disinfecting 1 billion+ gallons of potable water annually

Nalco Legionella lab is a charter member of CDC-ELITE proficiency program

Six (6) Industrial Staff Microbiologists





# Nalco – Environmental Hygiene Services

*Complete comprehensive service capabilities*



## ▲ HACCP Plan Consulting

- Comprehensive services
- Reduced self-directed options
- Multiple site programs

## ▲ Cooling System Remediation

- Off-line clean & disinfect
- On-line clean & disinfect
- Acid cleaning methods

## ▲ Legionella Culturing

- CDC ELITE certified lab
- Comprehensive capabilities
- Includes assistance with interpretation

## ▲ Domestic Water Remediation

- Hyperchlorination of hot and cold water storage tanks
- Hyperchlorination of building water distribution systems
- Thermal disinfection of hot water systems
- Clean & disinfect ice machines
- Clean & disinfect decorative fountains

## ▲ Domestic Water Secondary Disinfection Programs

- Continuous water disinfection
- Continuous disinfectant monitoring and verification technology