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Protection Against *Legionella* & Elements of Cooling Tower Management

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NYSDOH Wadsworth Center, Albany, NY

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Outline of Objectives

- Summary review of the new regulation on cooling towers and “Protection from Legionella.”
- Discuss why *Legionella* becomes a problem & the role of biofilm;
- Present an overview of cooling towers;
- Present an overview of some industry guidance on cooling tower microbiological control.

Public Health Law Section 4

Emergency Regulation

Addresses *Legionella* risk from:

1. Cooling towers and
2. In Article 28 facilities (i.e., Hospitals and Nursing Homes)

Emergency Regulation: PROTECTION AGAINST LEGIONELLA

Components:

1. Cooling Towers

- Registration;
  - Culture sample collection, cleaning, and disinfection;
    - Inspection and certification;
      - Maintenance program and plan;
        - Recordkeeping;
          - Discontinued use;
            - Enforcement;
              - Electronic registration and reporting.

2. Healthcare facilities

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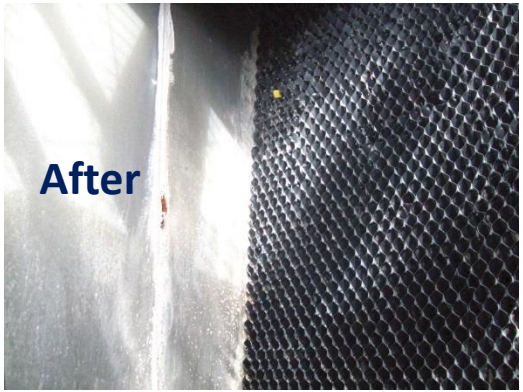
Regulation: Electronic Reporting

- Initially within 30 days, and thereafter within 10 days after any action, owner must electronically report (unless the electronic system is not available):
- Registration information: building address, owner information, intended uses, etc. & . . .
  - Dates of sampling, sampling results, remedial actions;
  - Dates of last cleaning/disinfection;
  - Dates of shutdowns for more than 5 days;
  - Date of last certification and its due date;
  - Date of last inspection and its due date;
  - Date of discontinued use.

Regulation: Culture sample collection and testing

- Owners were to collect samples and obtain *culture testing* within 30 days, unless testing was performed in the prior 30 days;
- Thereafter, in the period up to *March 1, 2016* or until the development of a maintenance program or plan, whichever comes first, Testing must occur at intervals *not exceeding 90 days* while the tower is in use.

When to “Clean” & When to “Disinfect”



Pictures courtesy of Chem-Aqua

We’ll look at tower components soon.

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Regulation: Certification

- Owners must obtain annual certification from a qualified person as described in the regulation.
- Certification components:
  - Tower has been inspected, cleaned, disinfected in compliance with regulation;
  - Tower condition is appropriate for intended use;
  - Maintenance program and plan has been developed and implemented;
  - Functioning of conductivity control and dosing equipment.
- This requirement is *first effective November 1, 2016*, and annually *on November 1* thereafter.
- Certification must be reported to Department (website).

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Regulation: Maintenance Program and Plan

- By March 1, 2016 and thereafter prior to initial operation, owners must have a maintenance program and plan developed in accordance with ASHRAE 188-2015
- Program and plan also must include provisions for:
  - Routine sample collection and culture testing of bacteriological samples
  - Emergency sample testing collection and culture testing for *Legionella*:
    - Power failure sufficient to allow for the growth of bacteria;
    - Loss of biocide treatment or failure of conductivity control sufficient to allow for the growth of bacteria;
    - Failure of conductivity control to maintain proper cycles of concentration;
    - Determination by the commissioner that cases are associated with the tower.
  - Immediate action in response to culture testing results

Regulation: Enforcement

- Officers, employees, or agents of the Department or local health department are authorized to enter properties to conduct compliance inspections.
- The Department or local health department may determine that failure to comply with the provisions of the regulation constitutes a nuisance.
- Violation of any provision of the regulation is subject to civil and criminal penalties; each day a violation occurs constitutes a separate and distinct violation.

Regulation: Health Care Facilities

- All general hospitals and residential health care facilities, as defined in Article 28 of the Public Health Law, shall, as the department may determine appropriate:
  - Adopt a *Legionella* sampling plan for its facilities' potable water distribution system;
  - report the results of such sampling;
  - take necessary responsive actions.
- The department shall determine if any requirements more stringent than noted are warranted.

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Health Advisory & Updated Guidance

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ANDREW M. CUOMO
Governor

HOWARD A. ZUCKER, M.D., J.D.
Commissioner

SALLY DRESLIN, M.S., R.N.
Executive Deputy Commissioner

DATE: **August 10, 2015**

TO: All Article 28 Hospitals and Nursing Homes

FROM: Office of the Commissioner

Health Advisory:
Prevention and Control of Legionellosis (Legionnaires' disease) in Healthcare Facilities

Please distribute immediately to: Administration, Medical Director, Infection Prevention, Infectious Disease Service, Pulmonologists, Hospitalists, Nursing Administration, and Engineering and Facilities Maintenance

The New York State Department of Health (NYSDOH) and the New York City Department of Health and Mental Hygiene (NYCDOHMH) are currently investigating a cluster of cases of Legionnaires' disease in the Bronx. From 7/8/2015 through 8/7/2015, 100 persons have been infected and there have been 10 deaths associated with this outbreak. Given the distribution of cases in the community and preliminary laboratory data, it is believed that cooling towers in the

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Attachment #3

Attachment 3

NEW YORK STATE DEPARTMENT OF HEALTH PREVENTION AND CONTROL OF LEGIONNAIRES' DISEASE ENVIRONMENTAL GUIDANCE AND ENGINEERING MEASURES

Environmental Assessment

The New York State Department of Health (NYSDOH) recommends that facilities proactively perform an environmental assessment of their water systems. This assessment involves reviewing facility characteristics, hot and cold water supplies, cooling and air handling systems and any chemical treatment systems. The purpose of the assessment is to discover any vulnerabilities that would allow for amplification of *Legionella* spp. and to structure a response in advance of any environmental sampling for *Legionella*. Factors to be considered include, but are not limited to:

- Facility Characteristics
  - Types of care
  - Age of buildings
  - Floor space and numbers of beds/population capacity
- Source of water supply and treatment
  - Hot and cold water temperature profiles
  - Free chlorine residuals
  - Presence and location of thermostatic mixing valves
  - Presence and service of water softener systems
  - Supplemental (long-term) water treatments for microbial contamination
  - Other water quality parameters (pH, TOC, etc.)

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Cooling Towers & Management

Why Do *Legionella* spp. Cause Problems?

Why do *Legionella* spp. Become a Problem?

Lack of Biocide Residual

- In potable water, there is loss of chlorine residual from the plant to the point of delivery. Potable water is used as “make-up” water for cooling towers.
- Chlorine isn’t very effective against *Legionella* at low doses normally encountered in the distribution system (2 to 6 ppm needed for effective control).
- There is additional loss of residual upon delivery to the user (building or apparatus including cooling towers).
- There may be improper application of biocides to cooling towers.

Why do *Legionella spp.* Become a Problem?

Thermal modification

Heat added -- but not enough to be lethal.

- Domestic hot water loops cooling down too much.
- Potable cold water loops warming up too much.
- Ornamental displays running at ‘tepid’ temperatures (about 68 F and higher).
- Cooling Towers, by their function of exchanging heat, contain warm water and scrub nutrients out from the ambient air.

You are familiar with the Modes of Transmission

- Airborne (aerosol)
  - Most cases can be traced to human-made aquatic environments where the water temperature is higher than ambient temperature
- Other, in particular aspiration.
  - Improper “gag” reflex resulting the inhalation of water droplets/sputum.
- Not person-to-person

A Complication to Control *--in buildings and cooling towers*

Primer on Biofilm

What Is a Biofilm? - 1

- A biofilm is a consortium of bacteria, and other participating or incidental life-forms (such as amoebae);
- It is usually composed of a matrix involving polymers and by-products from microorganisms and from the environment;
- It may be thick or thin, complex or simple, sparsely or heavily populated.

What is a Biofilm? - 2

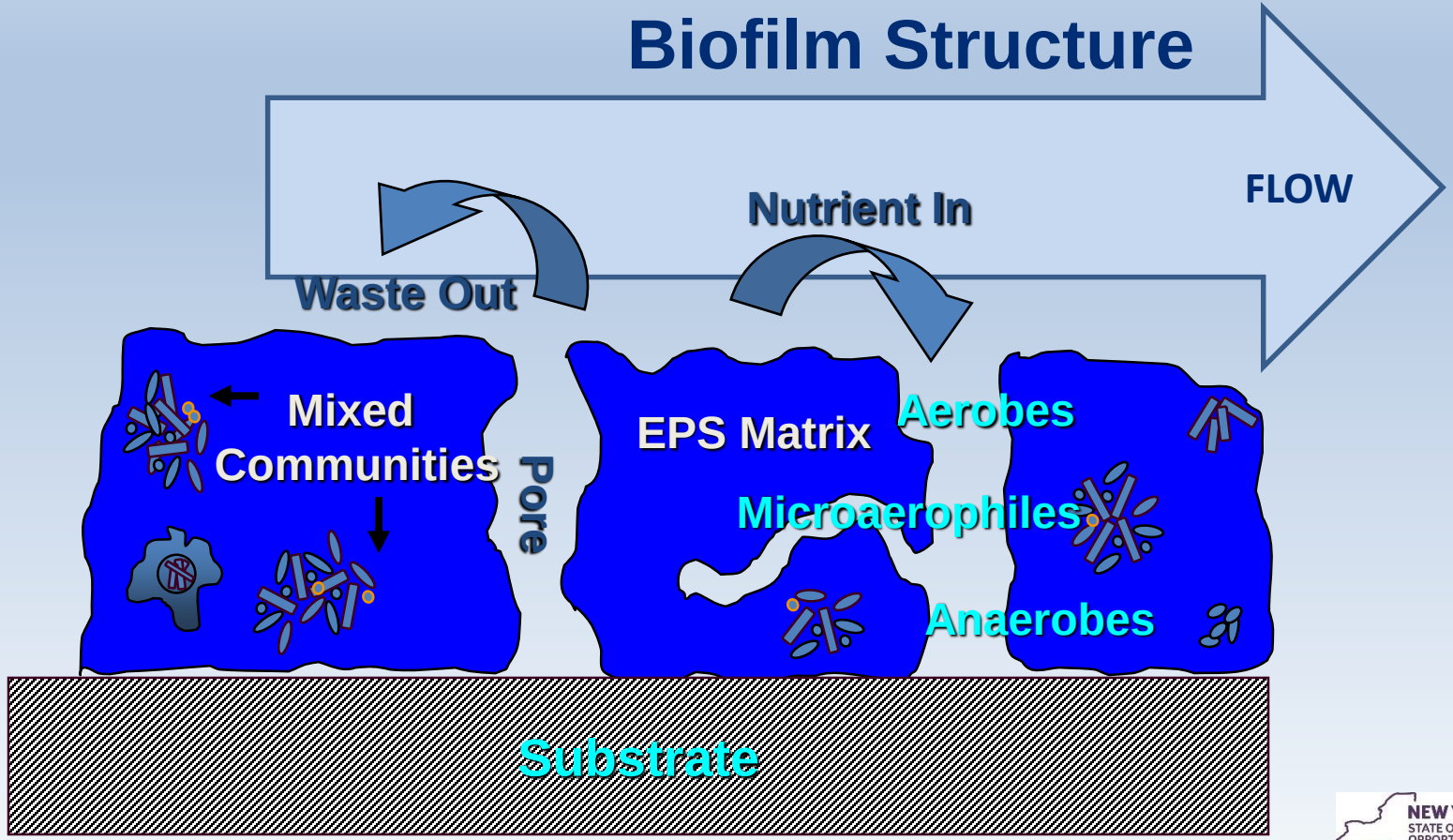
- The organisms, particularly bacteria, do not organize themselves in orderly fashion;
- Often patches of cells interspersed among an exopolysaccharide or SLIME;
- Nutrients, water, waste, and other chemicals are transacted in and through the slime.

Why do Biofilms Develop?

Three main reasons why biofilms develop:

- Protection from the environment.
  - Environmental stressors or disinfectants
- Nutrient exchange and/or metabolic cooperation.
- Exchange of genetic information.

Biofilm Structure



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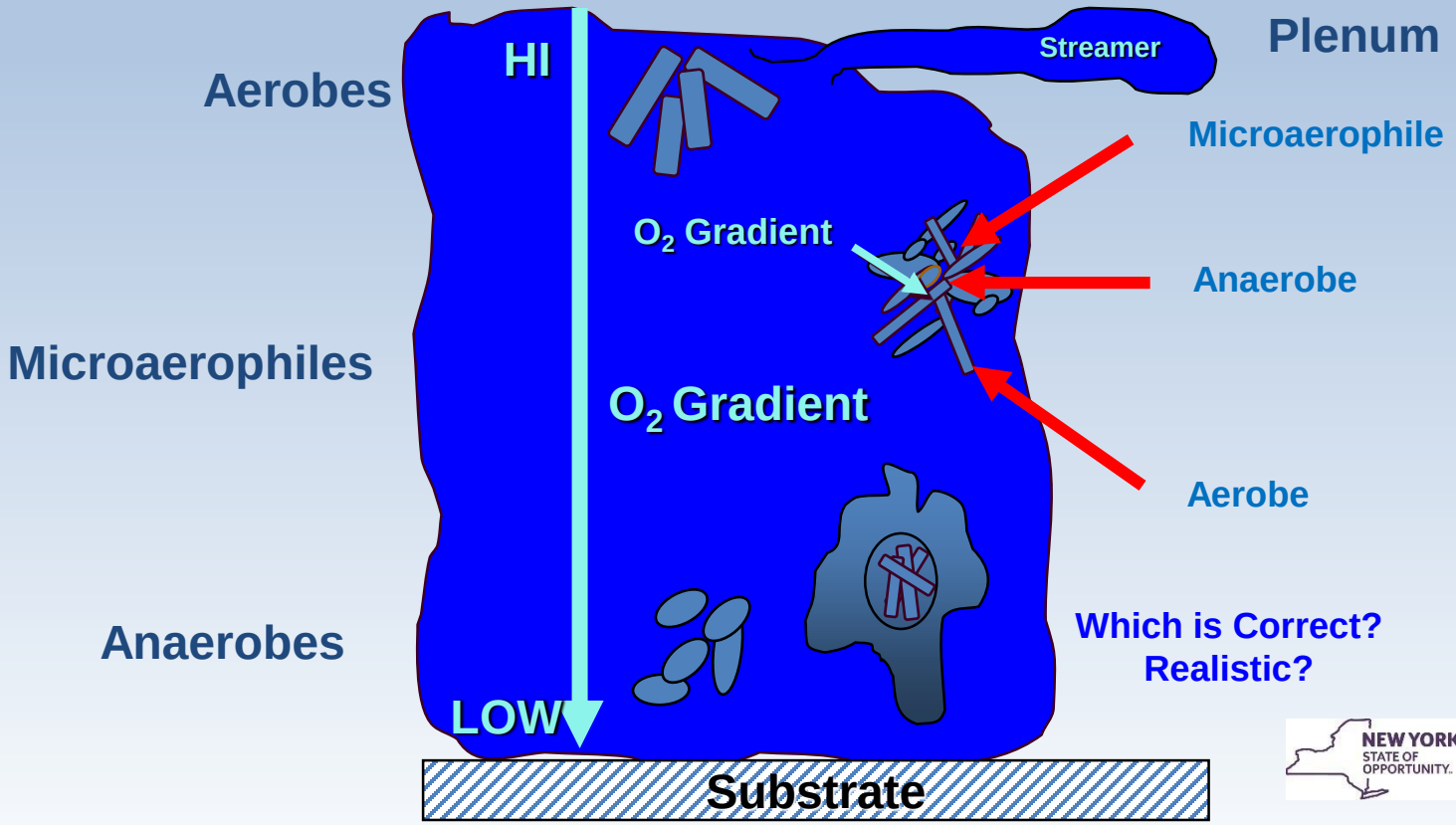
One More Refinement



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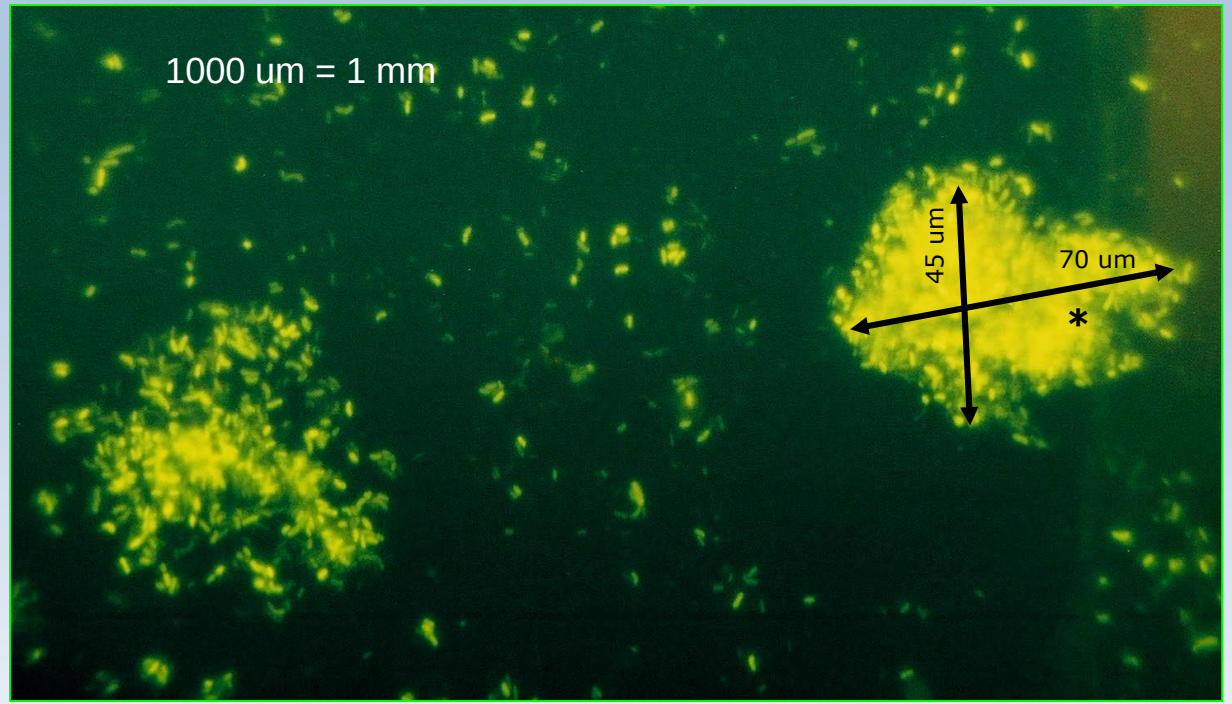
Biofouling



The rod-like bacteria are approximately 0.5 x 2.0 microns to 1.0 x 3.0 microns. The biofilm aggregates are approximately 45 x 70 microns.

***Roughly 1000 organisms in the area shown -- does not include volume considerations.**

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How a Cooling Tower Works

What do they look like?

The basics

What do CTs Look Like?

Pictures courtesy of Chem-Aqua

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What do CTs Look Like?

Pictures courtesy of Chem-Aqua

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What do CTs Look Like?

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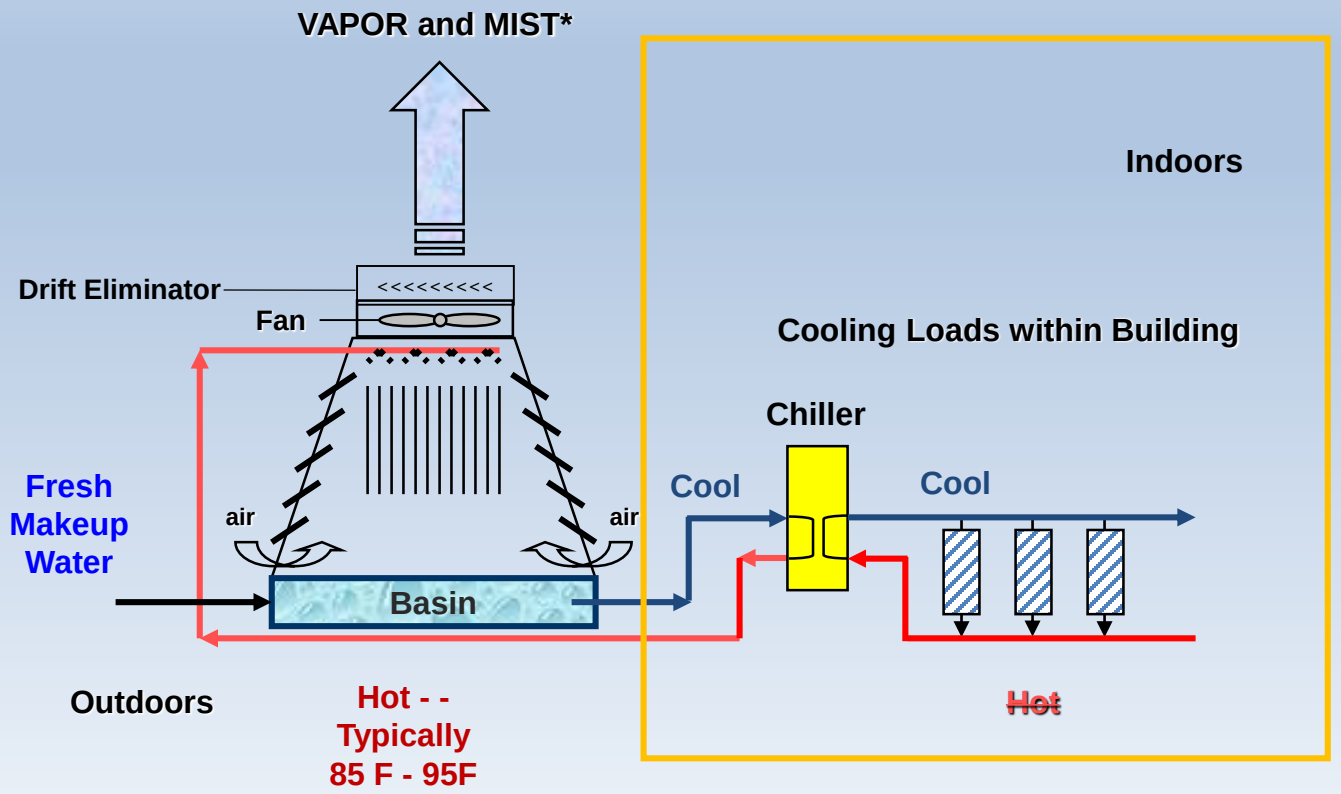

*Mist containing droplets less than 5 microns will leave the unit. The mist is what is referred to as "Drift."

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9535
HVAC
HVAC
HVAC

Drift Issues (approximate!)

- Cooling towers produce drift.
- This is reported as the ‘%’ of circulating water flow.
- A counter-flow cooling tower will produce drift at 0.005% of flow.
- A tower without drift eliminators will produce 0.3% to 1.0% drift.

Drift Issues (approximate!)

So if a 1,000 ton tower re-circulates at 3,000 gph. It will re-circulate 72,000 gpd.

- With a good drift eliminator it will produce: 72,000 gpd x 0.00005 = **36** gpd of drift.
- Without a drift eliminator or a damaged eliminator: 72,000 gpd x 0.01 = **720** gpd of drift. (!)

What is a Cooling tower “ton?”

- A ‘ton’ of air-conditioning is equivalent to removing 12,000 btu/hr.
  - A ‘ton’ is the amount of heat removed by an air conditioning system that would melt 1 ton of ice in 24 hours
- A cooling tower ‘ton’ is about 15,000 btu/hr.

Cooling Tower Guidance and Treatment

Besides the Regulation - -

Is there guidance ??

Guidance Sources

For health care facilities:

- Allegheny County (University of Pittsburgh);
- CDC
- State of Maryland;
- New York State (August 10, 2015 update);
- Veteran's Health Administration (VHA, 2008).

We won't be discussing these today

Guidance Sources

- For environmental issues (examples):
  - American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE 12-2000 and 188-2015)
  - Cooling Technology Institute (CTI)
  - Association of Water Technologies (AWT)
  - California Energy Commission (CEC) – **DRAFT** guidance document.
- For the workplace
  - OSHA (www.osha.gov/dts/osta/otm_iii/otm_iii_7.html)

ASHRAE 188-2015

- ASHRAE 188-2015 is a professional standard (for the industry).
- Related to ASHRAE 12-2000 which is a guidance document.
- ASHRAE 188 is complex and covers many building components but Section 7.2 covers cooling towers.

Cooling Tower - Guidance Comparison

In general all of the CT guidance documents approximately agree on the following:

1. General Background Guidance;
2. Start-up, Shut-down and Maintenance;
3. Record Keeping/Logs.

Biocide Selection - Oxidizers Mentioned

ASHRAE	CTI	CEC
Chlorine	**"Bleach"**	**Chlorine**
Chlorine dioxide	Chlorine dioxide	Bromine
Bromine	Chlorine gas	
Iodine		
Ozone		
<u>Stabilized</u>	<u>Stabilized</u>	<u>Stabilized</u>
Hydantoins	Hydantoins	Hydantoins
Isocyanurates	Isocyanurates	

Biocide Selection - Non-Oxidizers Mentioned

ASHRAE

Isothiazolins
Glutaraldehyde
DBNPA
Carbamates
Thiocyanates
"Quats"

And others

CTI

Use of non-oxidizing biocides is noted as 'critical'

CEC

Isothiazolin
Glutaraldehyde
DBNPA

Other Chemicals

ASHRAE	CTI	CEC
<u>Scale Control</u> • Phosphonates • Phosphates • Other polymers	Addressed in routine and emergency procedures	Biodispersants mentioned as an adjunct to biocide treatment
<u>Corrosion Control</u> • Phosphates • Azoles • Molybdenum • Zinc	Biodispersants (surfactants)and antifoams	
<u>Surfactants/ Penetrants</u>		

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Routine Biocide

ASHRAE

Alternate biocides weekly (oxidizing /non-oxidizing)

Concentrations specified for start-up (4-5 ppm) and emergency (10 ppm) operations.

CTI

Continuous Halogen

- 0.5 - 1.0 ppm chlorine or bromine (for high pH)

Intermittent

- At least 1.0 ppm for one hour each day.
- Use in combi-nation with non-oxidizing biocide.

CEC

Continuous Halogen

- 0.3 - 0.7 ppm chlorine
- 0.5 - 1.0 ppm Br-hydantoin as free chlorine

Microbial Testing

ASHRAE	CTI*	CEC
Culture is discussed as a means of verifying water treatment.	"evaluate microbial control"	"effective measure"
Focus is Lpn culture during problems.	Planktonic microbial counts: Target < 10^4 cfu/ml	Perform planktonic microbial counts: < or = 10^4 cfu/ml under control
	Sessile microbial counts: Target <10^5 cfu/cm^2	10^4 to 10^5 cfu/ml may be out of control
		>10^5 cfu/ml out of control

*Plate counts or dipslides

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1 - Legionella Testing – ASHRAE12-2000

- Culture is discussed as a means of verifying water treatment.
- Recovery of legionellae during an outbreak.
- Focus is *Legionella* culture.

2 - *Legionella* Testing – CTI

- Low risk
  - Low planktonic *Legionella.*
  - Low sessile counts.
  - No higher life forms (i.e. no protozoans).
- Possible higher risk
  - Low planktonic *Legionella.*
  - High sessile counts.
  - Potential for protozoan grazing and dangerous amplification of legionellae.
- Danger
  - Low planktonic *Legionella* and high number of protozoans.

3 - *Legionella* Testing –CEC

- *Legionella* testing is done whenever there is an 'upset'* condition.
  - Under control: <10 cfu/ml;
  - Needs disinfection: 10 – 100 cfu/ml
    - Must verify effectiveness with resampling within 2 weeks.
  - >100 cfu/ml: determine the cause of the upset; disinfection; retesting.

*High planktonic counts (as noted). High nutrient water with the presence of Sulfate-reducing bacteria.

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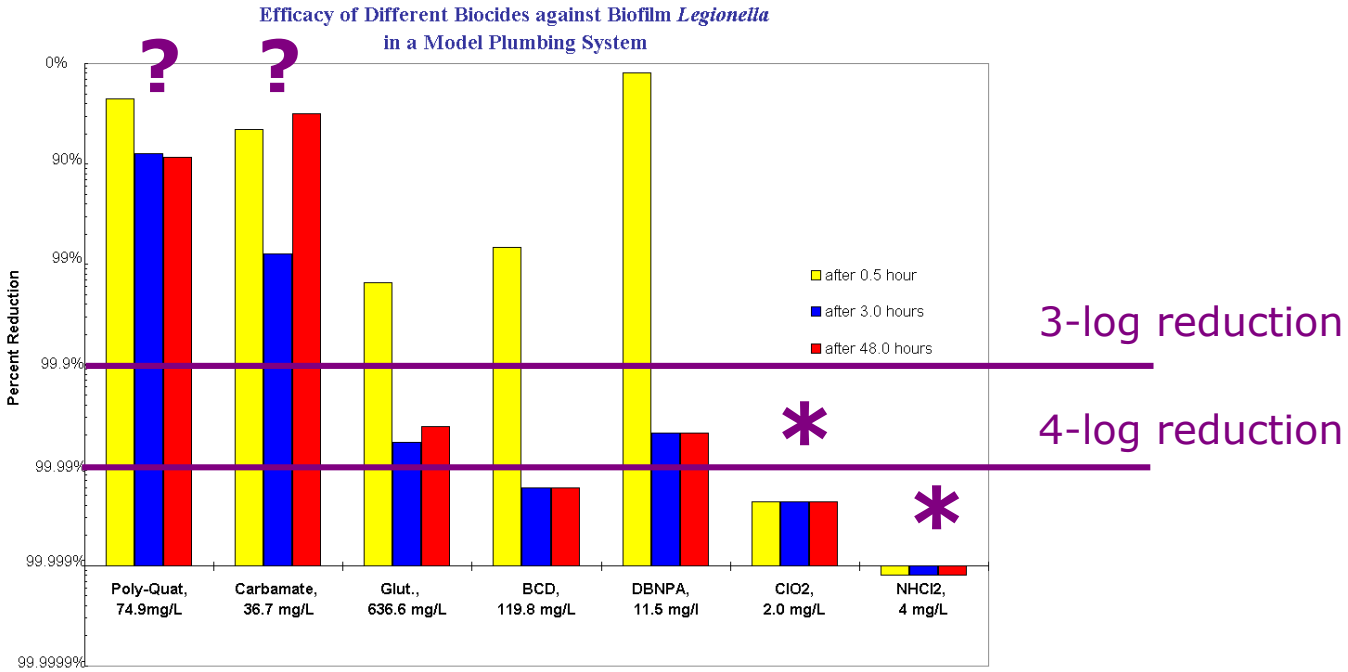
Cooling Tower Treatments



* 4.0 mg/L monochloramine and 2.0 mg/L chlorine dioxide were effective at killing 99.99% of biofilm associated *Legionella*. At the manufacturer's recommended maximum concentration, gluteraldhyde, BCD and DBNPA were effective in killing 99.99% *Legionella* in biofilm in 3.0 hours. 0% represents no reduction, 99.9% represents a 3-log reduction.

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http://www.legionella.org/biocides_research1.htm

Performance of Biocides in Controlling Legionella

Table 9. Summary of High-performance and Under-Performance Biocide Combinations.

High-Performance Biocide Combinations	Under-Performance Biocide Combinations
Quat + Bromine	Bromine alone
Quat + Hydroperoxide	Bromine + Glutaraldehyde
Quat + Isothiazoline	Bromine + DBNPA
Carbamate + Isothiazoline	Quat + Carbamate
THPS + Isothiazoline	
THPS + Bromine	
THPS + Carbamate	
THPS alone	

Miller, et al Assoc .Water Technologies 2008; THPS = Tetrakis (Hydroxymethyl) Phosphonium Sulfate

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