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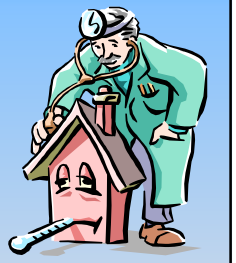
Indoor Air Quality (IAQ), Productivity, Health, and Legal Liability *OR* - HVAC Implications Since COVID-19

Jim Newman, CEM, LEED AP, ASHRAE OPMP & BEAP - June 2020

Content

- IAQ - What's It All About?
- How It Affects Health, Productivity
- What Can Be Done About It?
- Water Issues
- Proper Cleaning and Disinfection – HVAC/Other Surfaces
- What's the Legal Liability?



Poor IAQ

Can Have Many Origins – Some Indoor, Some Outdoor

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350 Building IAQ Study by NIOSH – Problem Buildings

- 50% - Ventilation Problems
- 28% - Specific Indoor Contaminant
- 11% - Specific Outdoor Contaminant
- 11% - ???

Solving IAQ problems in commercial office buildings is not always easy.

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Liability/Litigation

Who is Blamed for Poor IAQ?

- Building Owners
- Architects & Engineers
- Building Contractors & Suppliers
- Building Management, Maintenance Personnel
- Real Estate Brokers
- Landlords & Tenants
- Employers

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What Happens to HVAC Systems as Time Passes?

Green

↓

Gray

IAQ Problems

- Humidity – too high/too low
- Mold or mildew growth due to condensation
  - Interior surfaces of walls near thermal bridges
  - Carpeting on cold floors
  - Locations where humidity promotes condensation
- Not enough outdoor/indoor air – or unhealthy OA
- Water intrusion – outdoor/indoor

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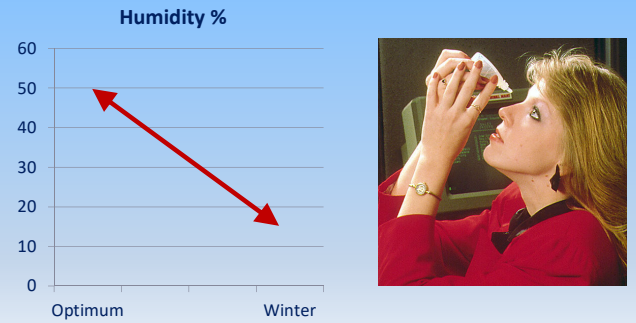
How to Know if There Are IAQ Problems

Communicate with the people in your building.

IAQ Problem: Winter Humidity

As Low As 15% In Many Buildings!



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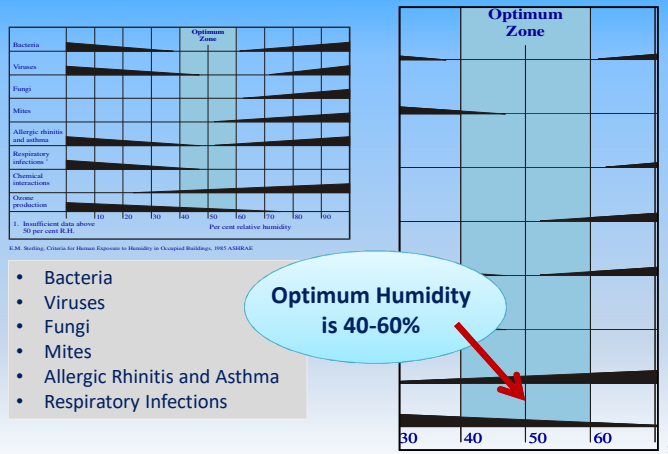
Optimum Relative Humidity for Health



- Bacteria
- Viruses
- Fungi
- Mites
- Allergic Rhinitis and Asthma
- Respiratory Infections

Optimum Humidity is 40-60%

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IAQ Problems: Mold and Mildew

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IAQ Problems: HVAC *System*

- A source of biological contaminants
- Surface Contamination by molds, bacteria, viruses
- Interior ductwork
- Odors

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IAQ Problems: HVAC *Unit*

- Drain Pans
- Improper Damper Operation
- Surface Contamination
- Coils
- Air Filters

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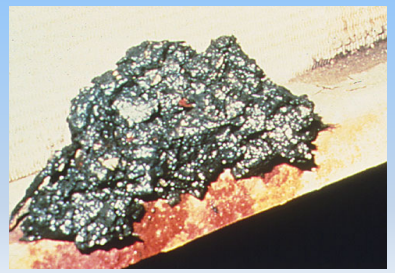
Dried-Up "Goop"
(Engineering Term)

From Drain Pan in Air Handling Unit



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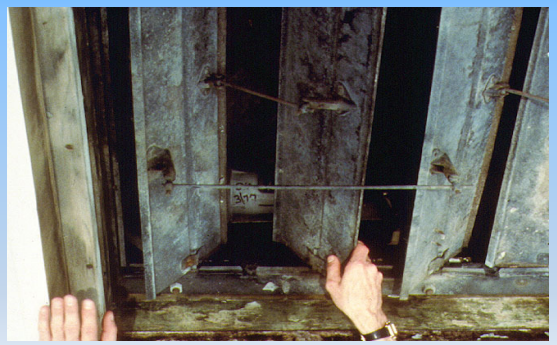
Poorly Maintained Dampers



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Poor (or No) Filter Maintenance

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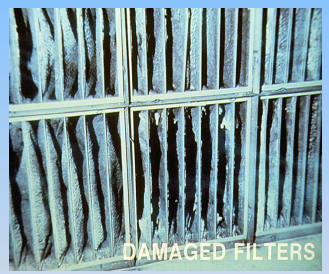
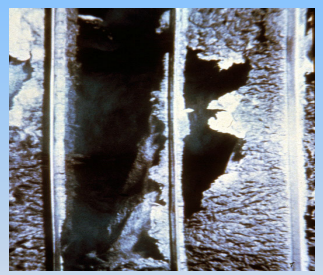
Poor Filter Maintenance Goes To Worse – This Is What Happens





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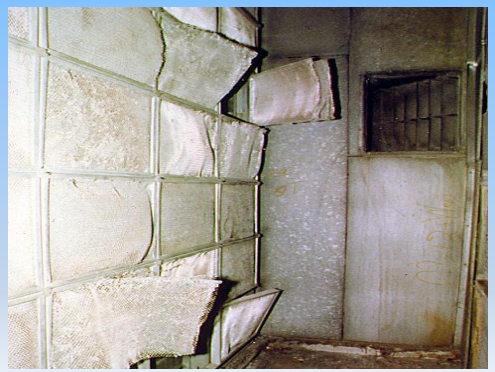
These Are Permanent, Cleanable Filters



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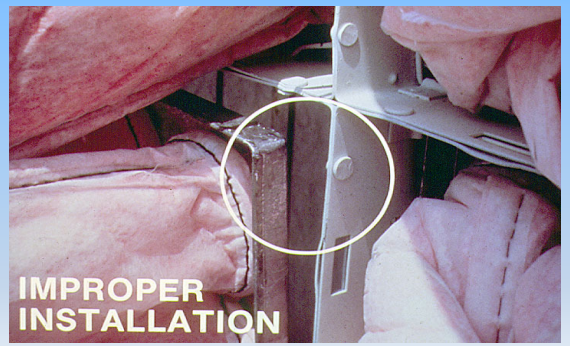
Improper Filter Installation or Replacement



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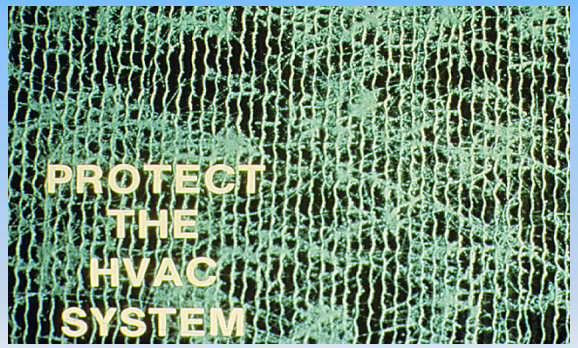
IAQ Problems – HVAC Filters



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Potential IAQ Problems: Outdoor

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Potential IAQ Problems: Outdoor

Energy Recovery Makeup Air Unit to Hospital O.R.

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IAQ Problems: What Else?

- Mold spores on final filters
- Legionella from cooling towers
- Biofilm on heat transfer surfaces
- Bacteria
- Viruses

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What Is Biofilm?

- Aggregates of predominantly bacterial cells attached to and growing on a surface (Costerton J.W. and Stewart, P.S., 2001 Battling Biofilms. Sci. Am., 285:74-81.)
- Bacteria excrete slimy, sticky substance that allows them to adhere to surfaces
- Extracellular polymeric substance (EPS) increases resistance to antimicrobial agents, heat/cold, cleaners

From, Jeff Seippel, BIOMIK

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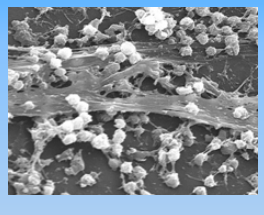
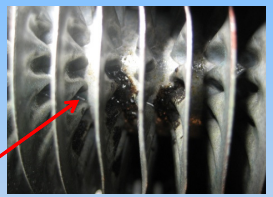
Biofilm Effects

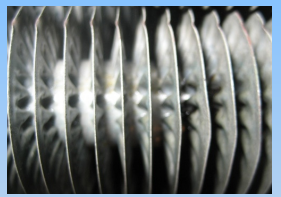


- Bacteria - in/on coils and fins
- Lowers HVAC system efficiency
- Irritating odors – health issues

Biofilm Cleaning Challenge



Close-up of coil after conventional cleaning (note: black tar like substance is biofilm)



Close-up of coil after cleaning using engineered EFM after conventional cleaning

Solution to Bio-Film

Step 1: Proper Cleaning

- Use environmentally-friendly surfactants
  - Enzymes
  - Environmentally Friendly Microorganisms (EFM)
  - Break down biofilm and release trapped dirt
- Clean at the microscopic level

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Solution to Bio-Film (cont.)

Step 2: After Cleaning

- Restore and maintain a healthy balance of EFM
  - Automatic delivery tied into the HVAC system controls
- Return HVAC systems to “like new” condition
- Continuously deactivate bacteria and viruses
  - Bi-polar ionization
  - UV-C

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The *Real* Result

- Improve heat transfer of coil and system
  - Coil functions more efficiently
  - Chiller (or compressor) functions more efficiently
  - Can reduce chilled water flow
  - Can increase chilled water temperature
  - Can reduce fan speed (energy varies as power cubed)

Conserve energy and save money

Other Environmental Stressors

Poor IEQ (Indoor Environmental Quality)

- Lighting – Glare
- Noise – Too much or not enough
- Vibration
- Ergonomic Stress
- Psycho-social Factors

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What To Do With an IAQ Problem – Real or Perceived

- Respond Immediately!!
  - If you don't, 1 goes to 2, 2 goes to 4, etc., until you have "Mass Psychogenic Illness"
  - Remember, "Perception Is Reality" to the person with the perception
- Identify Problem (if there is one)
- Make Necessary Corrections as Needed

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When Should Owner Seek Outside Assistance for IAQ Mitigation?

- Cannot identify the problem
- Mitigation efforts have been unsuccessful
- Air sampling is required
- Mistakes or delays could be serious
- Management feels that an independent investigation is more credible

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Summary: Why Be Concerned About Good IAQ?

- Overall Health of Employees and Tenants
- Reduced Absenteeism
- Increased Productivity
- Increased Profitability (cost of employee vs. operating costs)
- Minimized Litigation Risk
- ***Saves Money & Makes Money***

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How to Maintain Sustainability? Proper Operation & Maintenance

- Best designs and construction – doomed to failure without proper and ongoing maintenance
- Commissioning and re-commissioning
- Retro-commissioning to return to original design concepts and operation
- On-going Commissioning
- BE AWARE!

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Owner Defensive Strategies (1)

- Avoid Potentially Offensive Building and Maintenance Materials
- Fully Commission Mechanical Systems Prior to Occupancy
- Understand Liability Insurance Coverage and Operate Within its Limits
- Document Everything

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Owner Defensive Strategies (2)

- Operate with Adequate Ventilation
- Operate Cooling & Heating Systems Conservatively
  - Toward the center of the Thermal Comfort Zone, see ASHRAE Standard 55
- Clean and Maintain Equipment ***Properly***
- Operate Systems As Designed

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Owner Defensive Strategies (3)

- Periodically Check For:
  - Sensor stress: Auditory, Visual, Olfactory
  - Psychologically Stressful Conditions
  - Ask "Would I want to work/live there?"
- Periodically Check Occupant Satisfaction
- Re-Commission Systems Every Year To Ensure Proper Operation

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Basic Conclusions

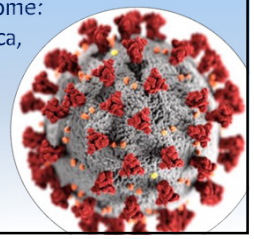
- IAQ - a large issue – **not** a simple issue
- IAQ - a part of IEQ
- HVAC - a large part of IAQ issues
- Proper Cleaning and Disinfection – HVAC/Other Surfaces
- Owners need assistance to avoid liability

Coronavirus & COVID-19

- Definition/Background
- Concerns
- HVAC
- Relative Humidity
- Filtration

What Is COVID-19

- **The Disease:** COronaVIrus Disease, 2019 (COVID-19)
- **The Virus:** Severe Acute Respiratory Syndrome COronaVirus 2 (SARS-CoV-2)
- **Related to:**
  SARS – China, 2003, Korea, Africa
  MERS – Middle East Respiratory Syndrome: Jordan, Saudi Arabia in 2012, then Africa, Asia, Europe, Korea in 2015
- Risks:
  - Person-to-person transmission
  - Airborne spread
  - Contaminates surfaces



How COVID-19 Spreads

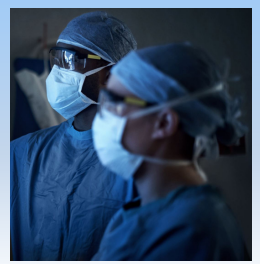
- Directly through aerosols
  - Infected people breathing, coughing, sneezing
  - Touching an infected person's hand or face

- Indirect Contact
  - Touching surfaces like doorknobs, elevator buttons, railings, handles, etc. then touching your eyes, nose or mouth

COVID-19 Concerns

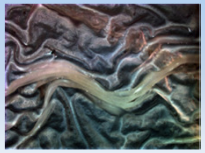
What are the facts? We're still learning!

- "Social" Distancing – Really "Physical" Distancing
  - 6' not enough
  - Aerosols, droplets, etc. – Breathe, Speak, Sing, Yell, Cough, Sneeze: 4'-20'
- Face Masks
  - Yes? Why, When
  - No? Why, When
- Symptomatic vs. Asymptomatic
  - 14 days?
  - 28 days?
- Vaccine
  - When?



Requirements - HVAC

- Flush with Outside Air
  - 100%? Or less?
- Humidification
  - 40-60% Relative Humidity (RH)



- Biofilm

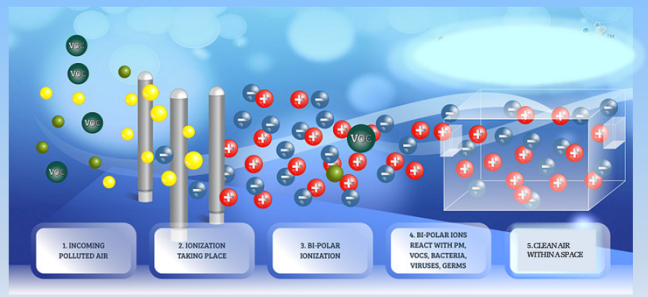
Requirements – HVAC (cont.)

- Filtration
  - MERV 13,14 Filters (Minimum Efficiency Reporting Value)
  - HEPA filters (High Efficiency Particulate Air)
  - Electrostatic filters
  - Carbon filters
  - Ultraviolet
    - UV-C
    - GUV (Germicidal Ultraviolet)
  - Ionization
    - Needle Point
    - PCO (Photo Catalytic Oxidation)
    - Bi-Polar (BPI)

Comparing IAQ Systems

	Bi-Polar Ionization	Needlepoint Ionization	Media Filtration	UV	PCO	Carbon Filters	Electronic Air Cleaner	Scent Generators
Reduces Contaminants "in the Space" at their source	Yes	No	No	Yes*	Yes	No	No	No
Reduces Odors	Yes	No	No	Yes	No	Yes	No	Yes
Reduces VOCs	Yes	Yes	No	Yes	No	Yes	No	No
Reduces Particles	Yes	No	Yes	No	No	Yes	Yes	No
Effective on Bacteria and Germs	Yes	Yes	No	Yes	Yes	No	No	No
Effective on Viruses	Yes	Yes	No	Yes	Yes	No	No	No
Produces Ozone	No	No	No	No**	No	No	Yes	No
Low Pressure Drop	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Maintenance Requirements	Every 2 years	When needles wear out	Quarterly	Yearly	Yearly	Monthly	Monthly	Monthly
Requires Re-engineering of HVAC system	No	No	Maybe	No	Maybe	Yes	Yes	No
Reduces Energy Costs	Yes	Yes	No	Yes	Yes	No	Yes	No
Contaminants Must Travel Through Filtration System	No	No	Yes	Yes	No	Yes	Yes	N/A
Produces Chemicals or Byproducts	No	No	No	No	Yes	Yes	No	Yes
Tested Contaminant Re-ductions in Occupied Space	Yes	No	No	Yes`	No	No	No	N/A
	*When used in the space.							
	**UVV (Vacuum UV), UV-A and UV-B typically produce ozone. Properly designed UV-C does not.							

Bi-Polar Ionization (BPI)



Pathogen Transmission

Pathogen infectivity is high when RH < 40%

Greater aerosol transmission

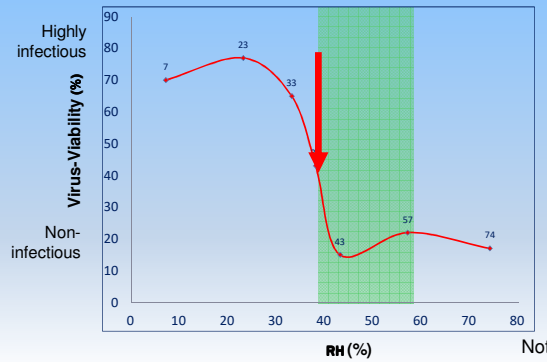
Evasion from surface cleaning through resuspension

Increased survival and virulence of pathogens

From Dr. Stephanie Taylor, M.D., M. Arch., CIC

Role of Relative Humidity

Influenza A virus is more infectious when RH is below 40% (Taylor)



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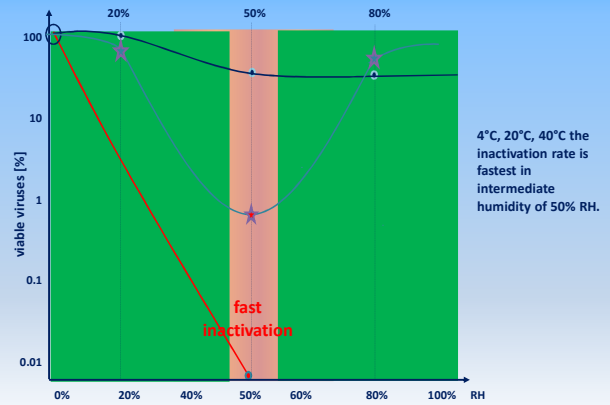
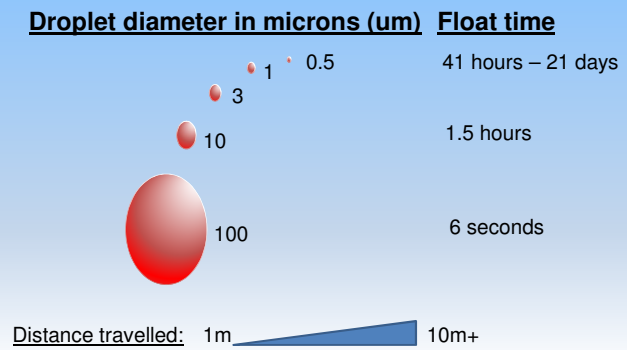
Pathogen Transmission

50% RH inactivated Coronavirus particles in air and on surfaces – true for all temps. (Taylor)



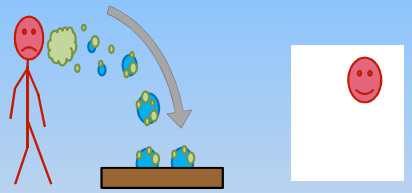
Infectious Droplets

Infectious droplets shrink, travel far and evade surface cleaning when the air is dry. (Taylor)



Role of Relative Humidity

With healthy RH of 40%–60%, infectious droplets settle out of the airborne environment. (Taylor)



- Disinfection benefits of proper air hydration:
  - Bedrails and other frequently touched surfaces cleaned more effectively
  - Hand hygiene is maintained
  - Settled infectious droplets are not re-suspended

Viruses vs Surfactants

- Both bacteria and viruses thrive in a biofilm environment. 90% of all pathogens live in biofilms.
- Biofilm is difficult to penetrate even with harsh chemicals and sanitizing methods.
- Microbes have different life spans on different surfaces.
- Sanitizers alone do not work. Proper cleaning is imperative.
- Biosurfactant and water will deactivate COVID 19.
- Testing to verify results is critical.

- Seippel

Viruses vs Surfactants

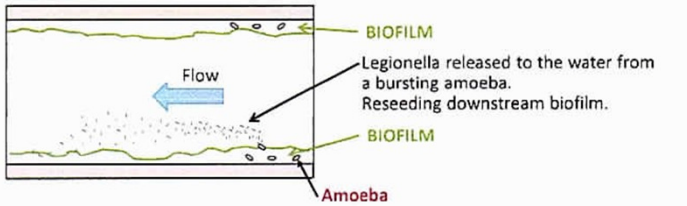
"Viruses are like tiny grease balls. Therefore, scrubbing with surfactant and water is the most effective solution for deactivating unprotected virus!"

- Seippel

Requirements - Water

- Flush and disinfect after long shutdown
  - Bacteria grows quickly in stagnant water
  - Chlorine loses its effectiveness
  - Must disinfect and flush **properly**
  - Rest Rooms
    - Sensor-operated faucets, toilets
    - Air Dryers or Paper Towels?

Sources of Contamination in Building Water Systems



1. Water Utility poor quality from Stagnation, Low Flows, Water Chemical Dissipation
2. Heat from equipment/adjacent pipes, spaces (Temperature)
3. Dead Legs/Stagnaton
4. Stagnant water/Unoccupied Buildings

From "Flushing Procedures for Building Re-Occupancy"
Ron George, CPD, Plumb-Tech Design & Consulting Services LLC, 734-755-1908

Resources

Pandemic Resources: NewmanConsultingGroup.us/web-sites

Government & Industry Resources:

- AIA Committee on the Environment - www.aia.org
- ASHRAE - www.ashrae.org
- Building Owners &Managers Association - www.boma.org
- CDC – Indoor Environmental Quality - www.cdc.gov/niosh
- EPA – Indoor Air Quality - www.epa.gov
- IAQA – Indoor Air Quality Association - www.iaqa.org
- US Green Building Council - www.usgbc.org
- World Green Building Council - www.wgbc.org

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"The greatest challenge we face today is failure to adapt to change"

Tim Wentz, ASHRAE President, 2016-17

For Further Information:
James L. (Jim) Newman
- JimN@NewmanConsultingGroup.us
- www.newmanconsultinggroup.us
- +1-248-626-4910

James L. Newman, CEM, CSDP, LEED AP BD+C, ASHRAE OPMP & BEAP

ASHRAE
- Co-Chair, IAQ Subcommittee for new Chapter on Climate Change in 2021 Handbook of Fundamentals
- Member, COVID-19 Committee (Local)
- Distinguished Lecturer since 2010
- Former Member, now Corresponding Member, Air-to-Air Energy Recovery Technical Committee (TC), Operations and Maintenance TC
- Past Vice-Chair, Industrial Air Conditioning TC
- Member, Energy Position Committee, 2008
- Past Board Member (Local)

BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)
- Immediate Past Chair, Sustainability for Savings Committee (Local)
- Trainer, High Performing Building Certification

ENGINEERING SOCIETY OF DETROIT (ESD)
- Past Chair, Council of Affiliated Organizations

U.S. GREEN BUILDING COUNCIL (USGBC)
- Founding Member, Detroit Regional Chapter
- Past Chair, Public Policy/Advocacy Committee (Local)
- Past Board Member (Local)

AMERICAN INSTITUTE OF ARCHITECTS (AIA)
- Member, Committee on the Environment (COTE)

URBAN LAND INSTITUTE (ULI)
- Member, Technology and Real Estate Council