HVAC and Air Filtration:
Best Practices to Minimize Infectious Disease

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Today's Webcast starts at 1:00 p.m. Eastern.

Thank you for joining us.

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Jim Newman is Owner/Managing Partner of Newman Consulting Group headquartered in Farmington Hills, MI. He is a Certified Energy Manager (CEM), a Certified Sustainable Development Professional (CSDP), a LEED Accredited Professional, an ASHRAE Distinguished Lecturer (DL), an Operations and Performance Management Professional (OPMP), a Building Energy Assessment Professional (BEAP) and a Fellow of the Engineering Society of Detroit (FESD).

An active member of many technical societies, he has received many awards. In 2010 Jim was named a Green Leader by the Detroit Free Press, and a Green Initiatives Champion by Corp! Magazine. In 2012 and 2013, he received the Distinguished Service Award from ASHRAE. He's been recognized as a Legend in Energy by the Association of Energy Engineers (2012), a Sustainability Champion by EcoWorks (2015), and received ESD's TechCentury Image Award in 2018. He is a certified trainer for ASHRAE Energy Standard 90.1, the basis for building codes in most states, and has trained hundreds of architects, engineers, code officials and contractors on the use of the Standard.

He received a BSME from Tufts University, Boston, MA, and continued his education for an MBA degree at the University of Detroit and Wayne State University in Detroit, MI.

Learning Objectives

- Understand common Indoor Air Quality problems related to HVAC systems
- Review ASHRAE recommendations for infectious aerosols
- Learn about proper coil restoration
- Review the role in relative humidity regarding infectious disease spread

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To Ask Questions:

Please use the question and answer panel on the bottom of your screen.

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Presentation Handouts

All participants will receive an e-mail with a link to download a PDF copy of today's presentation slides.

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HVAC and Air Filtration:
Best Practices to Minimize Infectious Disease

Webinar: FacilitiesNet.com , 08/18/20

Content

- Background
- What do we think we know?
- What do we really know?
- Recommendations
- HVAC
  - Outside Air
  - Filtration
  - Humidity
  - Virus neutralization
- Concerns
- Old normal vs “new” normal

Liability/Litigation

Who is Blamed for Poor IAQ?

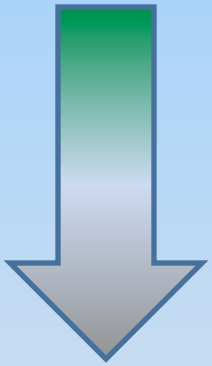
- Building Owners
- Architects & Engineers
- Employers
- Building Contractors & Suppliers
- Building Management, Maintenance Personnel
- Real Estate Brokers
- Landlords & Tenants

Poor IAQ

Can Have Many Origins – Some Indoor, Some Outdoor

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
- Bacteria/Viruses

IAQ Problems: HVAC *System*

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

IAQ Problems: HVAC *Unit*

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

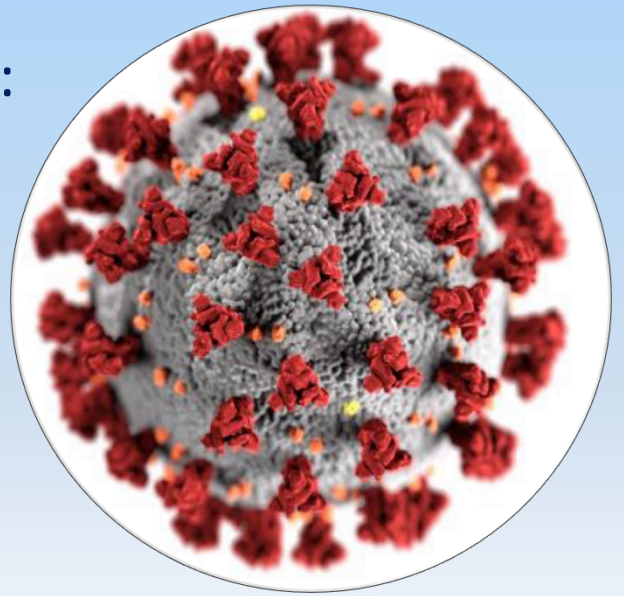
IAQ Problems – HVAC Filters

IAQ Problems: What Else?

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

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

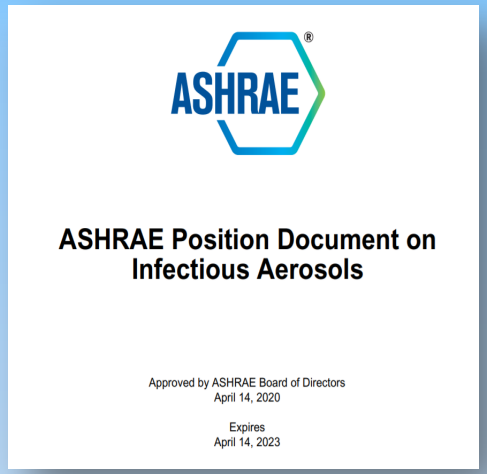
What are the facts? We're still learning! And the "facts" are constantly changing.

- "Social" Distancing – Really "Physical" Distancing
  - 6' not enough
  - Aerosols, droplets, etc. – Breathe, Speak, Sing, Yell, Cough, Sneeze: 4' - 34' !!
- Face Masks
  - Yes? Why, When, What kind
  - No? Why, When
- Symptomatic vs. Asymptomatic
  - 14 days?
  - 28 days, or longer?
- Vaccine
  - If / When? How successful?

ASHRAE Position Paper

Summary / Highlights

- Change building operations, including HVAC systems, to reduce airborne exposures
- Increase Ventilation and Filtration
- Maintain humidity between 40 – 60% RH
- Use higher MERV rated filters
- Run Systems Longer
- Use UVGI, in any form (duct, in-room, portable)
- Bi-polar Ionization not mentioned (no 3rd party information)



Requirements - HVAC

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

- Biofilm

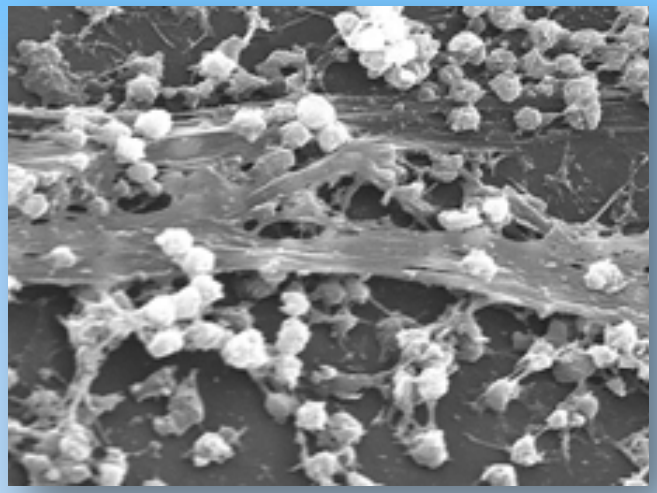
Requirements – HVAC (cont.)

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

What Is Biofilm?

- Aggregates of predominantly bacterial cells attach to and grow 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.

Biofilm Effects



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

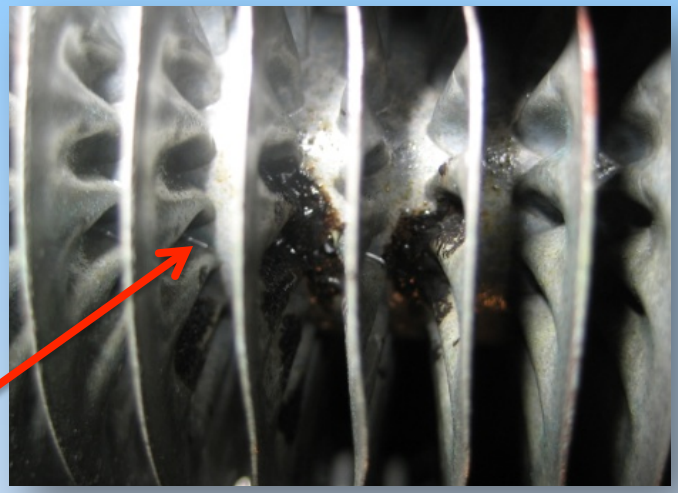
Solution to Bio-Film

Step 1: *Proper* Cleaning

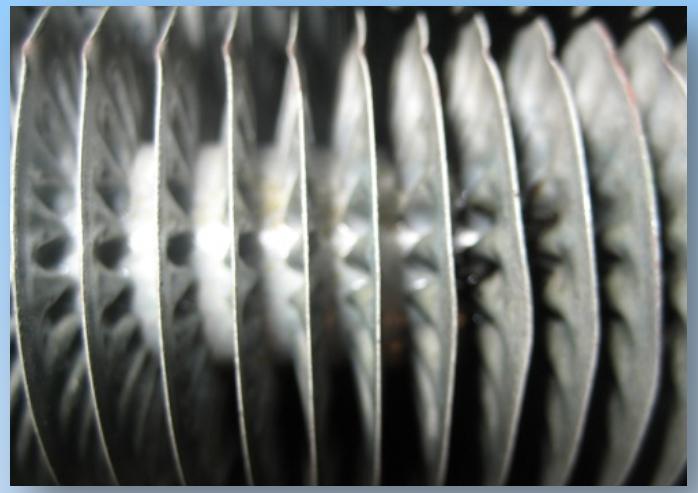
- Use environmentally-friendly surfactants
  - Enzymes
  - Environmentally Friendly Microorganisms (EFM)
  - Break down biofilm and release trapped dirt
- Clean at the microscopic level

Step 2: *Proper* Disinfecting

Biofilm Challenge

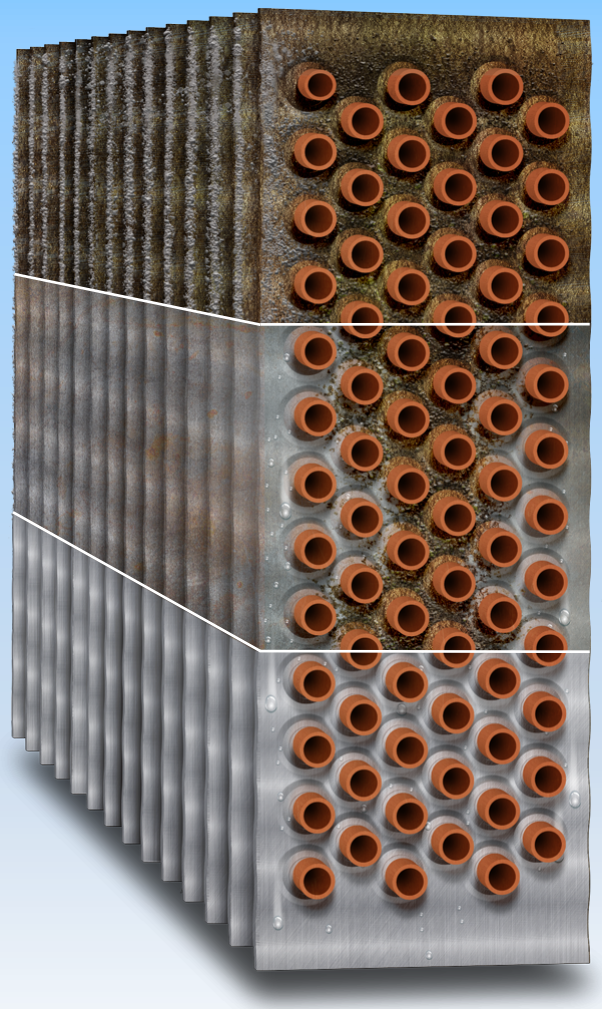


Close-up of coil after *conventional* cleaning (note: black tar like substance is biofilm)



Close-up of coil after *proper* cleaning

Coil Restoration



Before

Poorly maintained cooling coils - major source of biofilm growth - contribute to poor IAQ

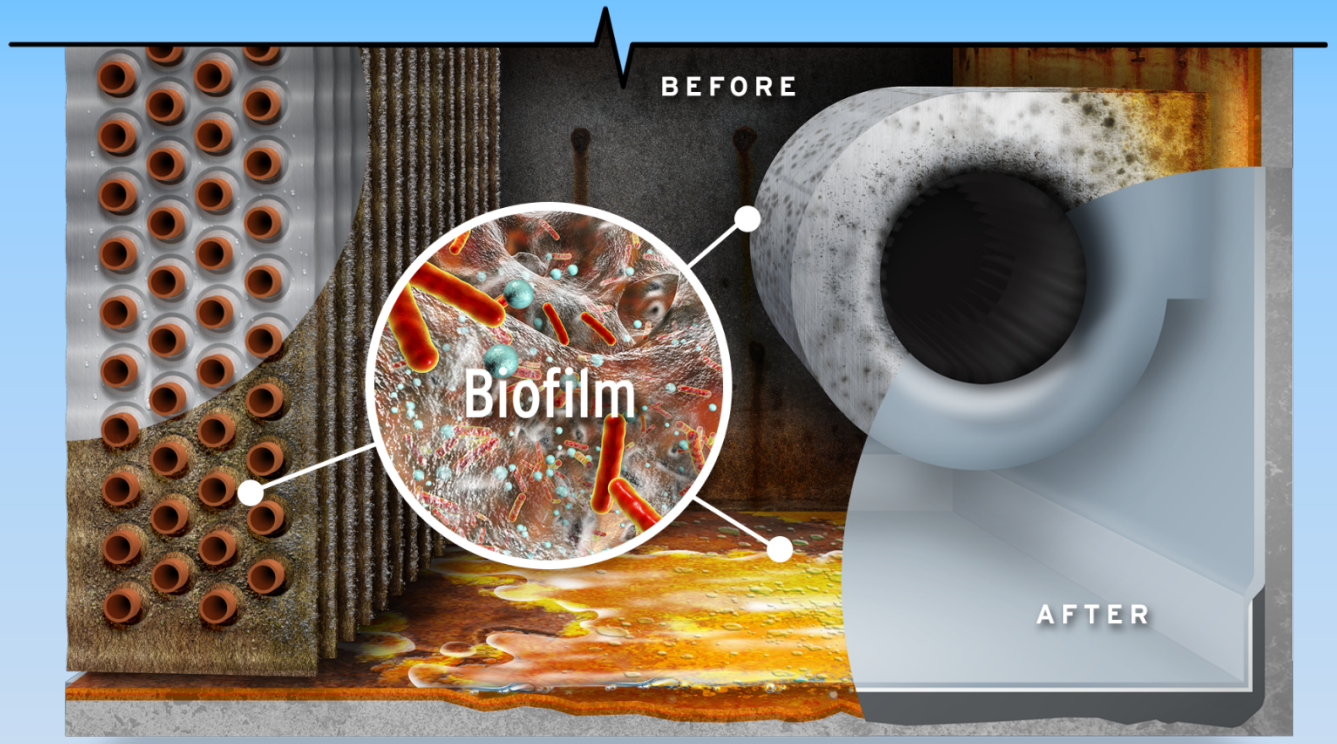
After Typical Coil Cleaning

Typical coil cleaning methods - fail to address center of coil - provide only marginal improvements in IAQ

After Proper Coil Restoration

Proper Coil Restoration - cleans at microscopic level throughout the coil - improves IAQ and coil performance

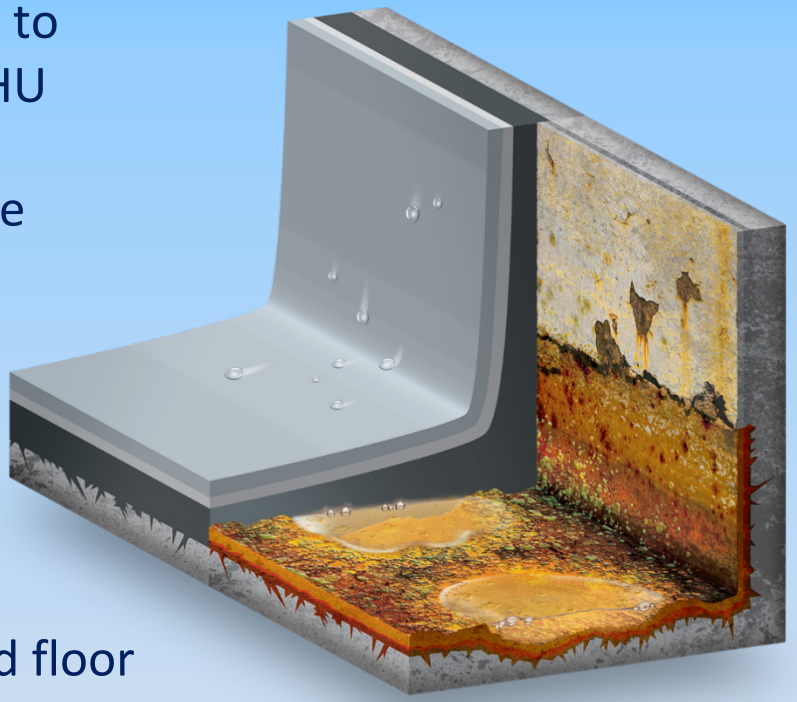
Biofilms in Air Handlers (AHU)



- Dark, damp environment within AHU - ideal location for microbial growth in form of biofilms
- Wet surfaces within air AHU: cooling coils, drain pans and floors - “amplification sites” for biofilm growth

Air Handling Unit - Refurbishment

- AHU Refurbishment - proven method to improve IAQ, extends useful life of AHU
- Properly pitched drain pans - eliminate standing water, prevent formation of biofilms
- Smooth, hygienic surfaces (free of voids) - easily cleaned, prevent accumulation of water and debris
- Elimination of rust from drain pan and floor surfaces - reduces bacterial growth



- Antimicrobial coatings on air handler floors, walls, ceilings, and fiberglass insulation - reduce microbial growth

Comparing IAQ Systems – Rev. 08/14/20

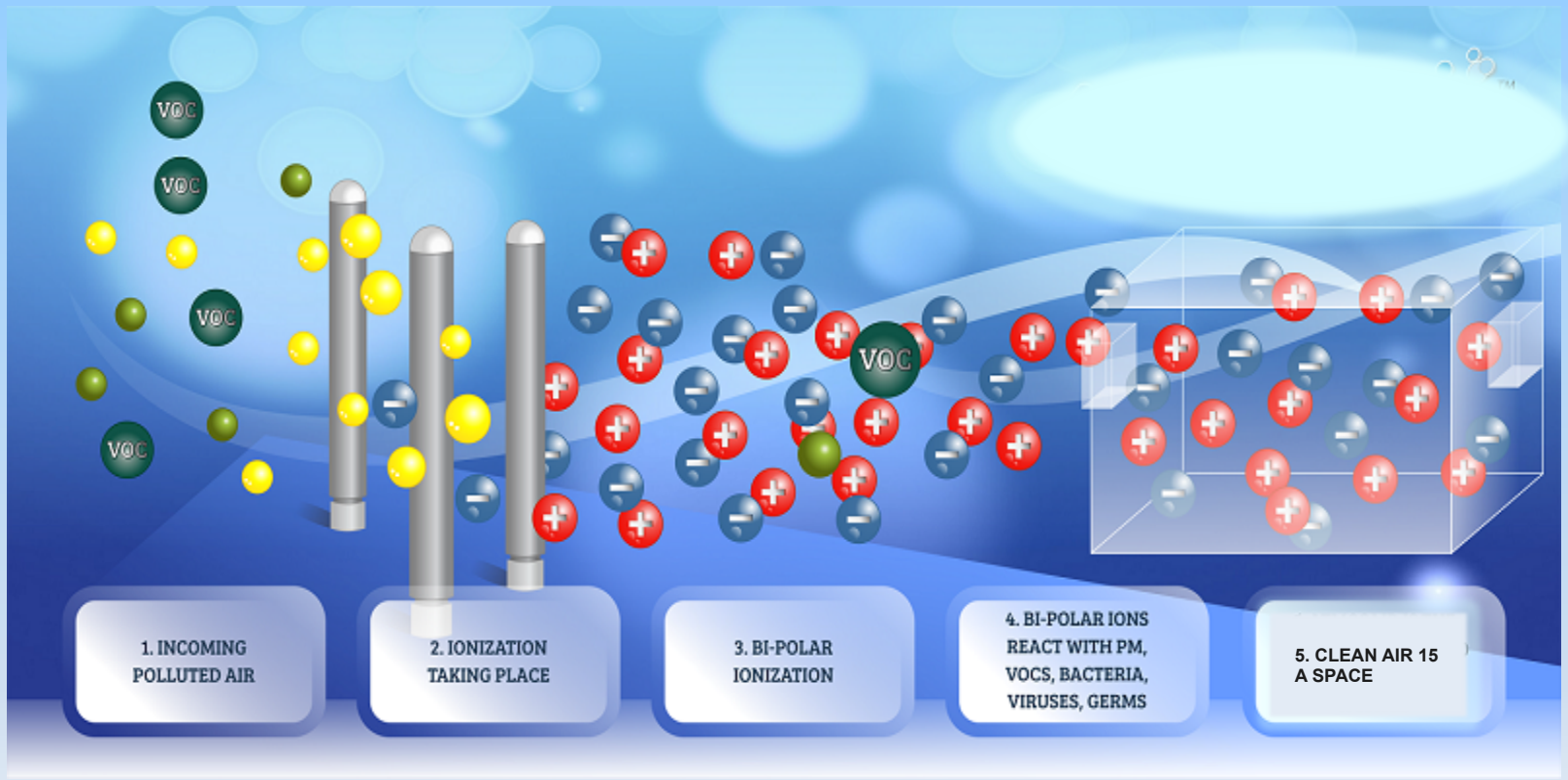
	Bi-Polar Ionization	Needlepoint Ionization	PCO	UV	Media Filtration	Chemical Filter	Electronic Air Cleaner	Scent Generator
Reduces Contaminants "in the Space"	Yes	No	Yes	Yes[1]	No	No	No	No
Reduces Odors	Yes	Yes	Yes[3]	No	No	Yes	No	Yes
Reduces VOCs	Yes	Yes	Yes[3]	No	No	Yes	No	No
Reduces Particles	Yes	Yes[3]	No	No	Yes	Yes	Yes	No
Effective on Bacteria and Germs	Yes	Yes	Yes	Yes	No	No	No	No
Effective on Viruses	Yes	Yes	Yes	Yes	No	No	No	No
Produces Ozone	No[3]	No[3]	No[3]	No[2]	No	No	Yes	No
Low Pressure Drop	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Maintenance Requirements	Every two years	When needles wear out	Yearly[3]	Yearly	Quarterly	Monthly	Monthly	Monthly
Requires Re-engineering of HVAC system	No	No	Maybe	No	Maybe	Yes	Yes	No
Reduces Energy Costs	Yes	Yes	Yes	Yes	No	No	Yes	No
Contaminants Must Travel Through Filtration System	No	No	No	Yes	Yes	Yes	Yes	N/A
Produces Chemicals or Byproducts	No	No	Yes	No	No	Yes	No	Yes
Tested Contaminant Re-ductions in Occupied Space	Yes[3]	No[3]	No[3]	Yes[3]	No	No	No	N/A

1 - When used in the space.

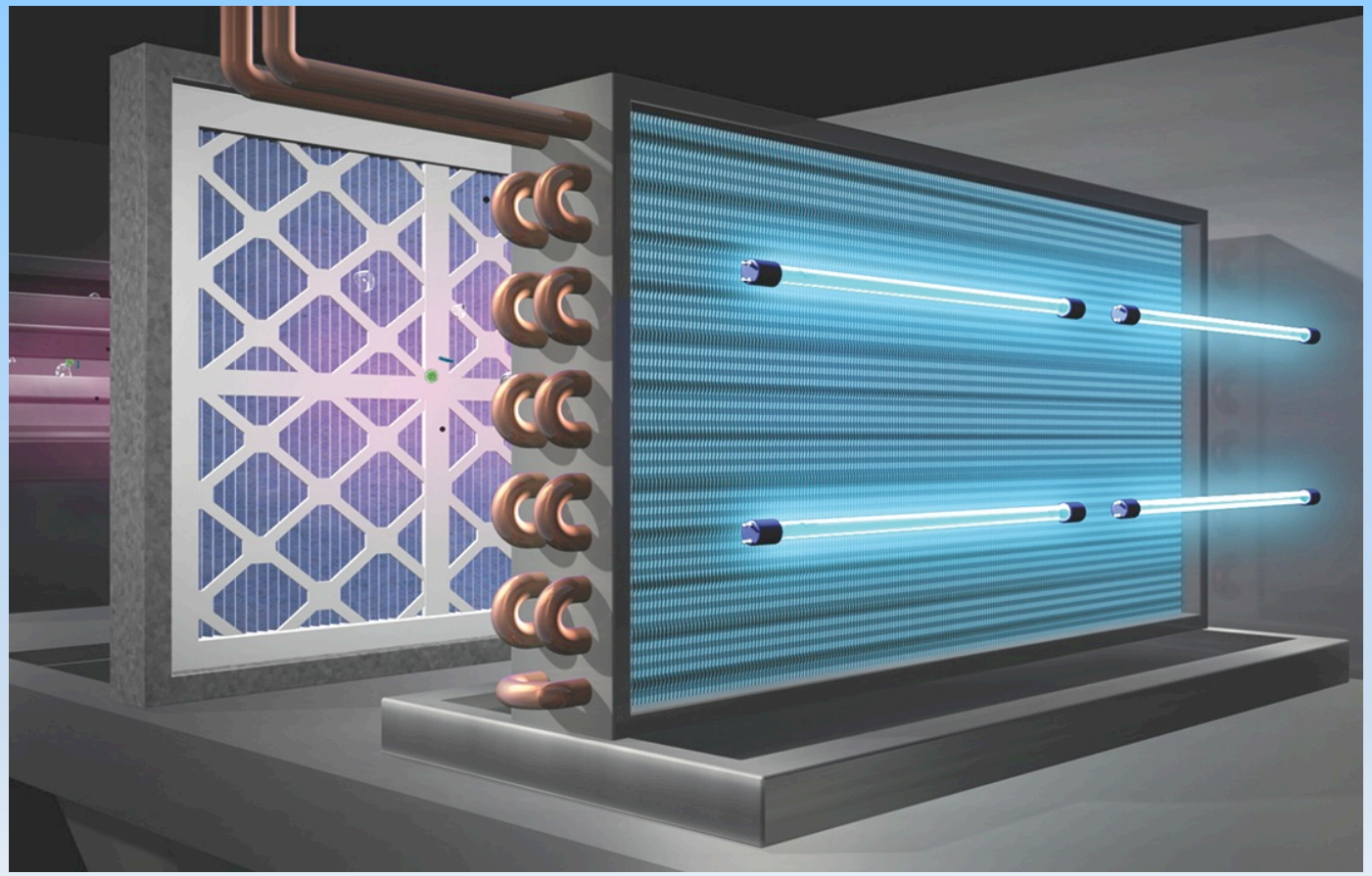
2 - UVV (Vacuum UV), UV-A and UV-B typically produce ozone. Properly designed UV-C does not.

3 - Depends on Manufacturer / Application

Bi-Polar Ionization (BPI)



Germicidal UltraViolet (GUV)



Pathogen Transmission

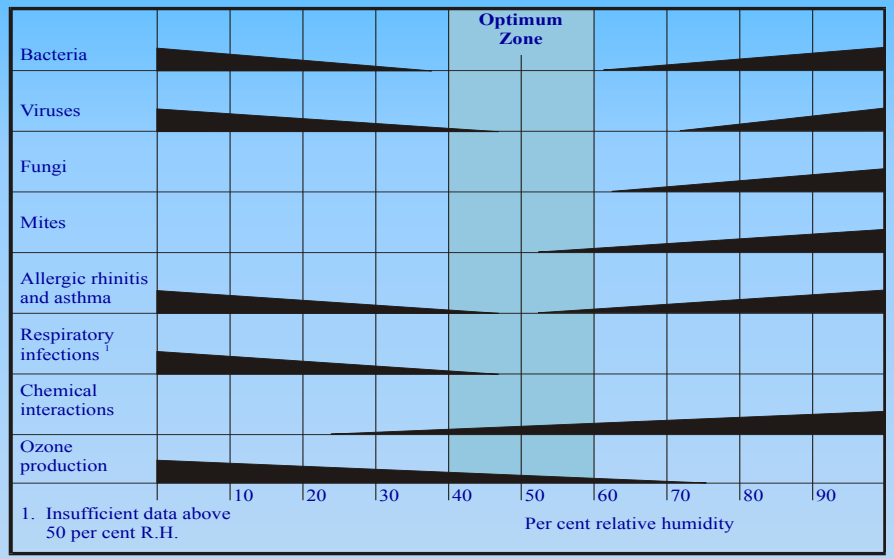
Pathogen infectivity is high when RH < 40%

Greater aerosol transmission

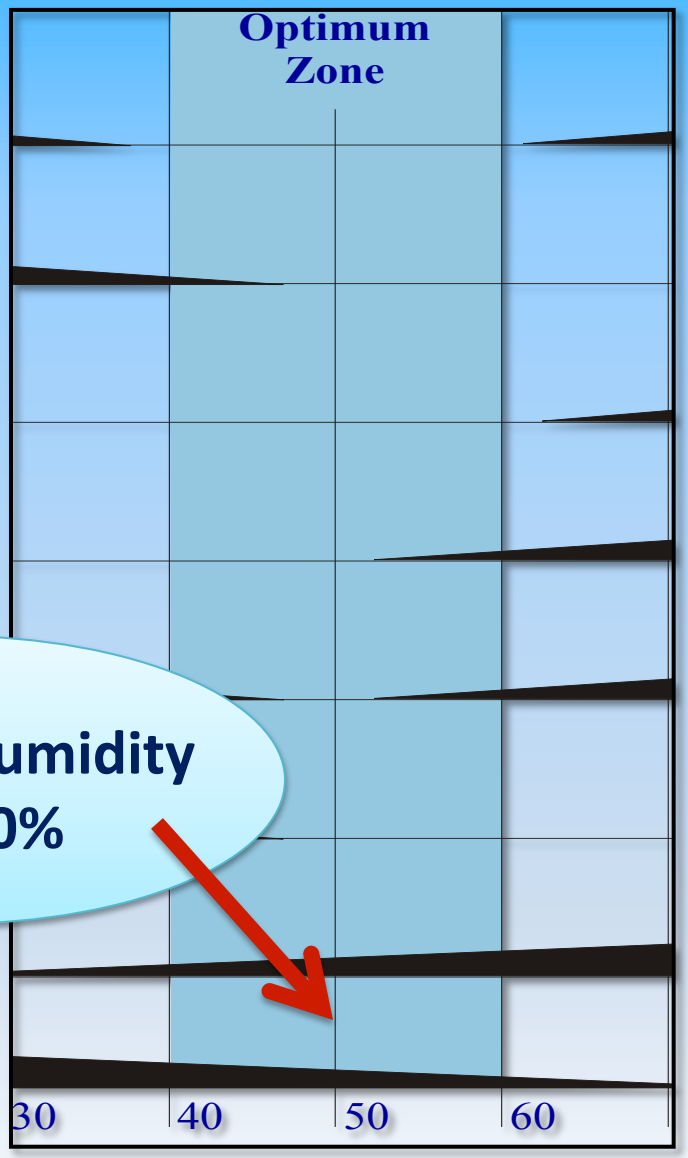
Evasion from surface cleaning through resuspension

Increased survival and virulence of pathogens

Optimum Relative Humidity for Health



E.M. Sterling, Criteria for Human Exposure to Humidity in Occupied Buildings, 1985 ASHRAE

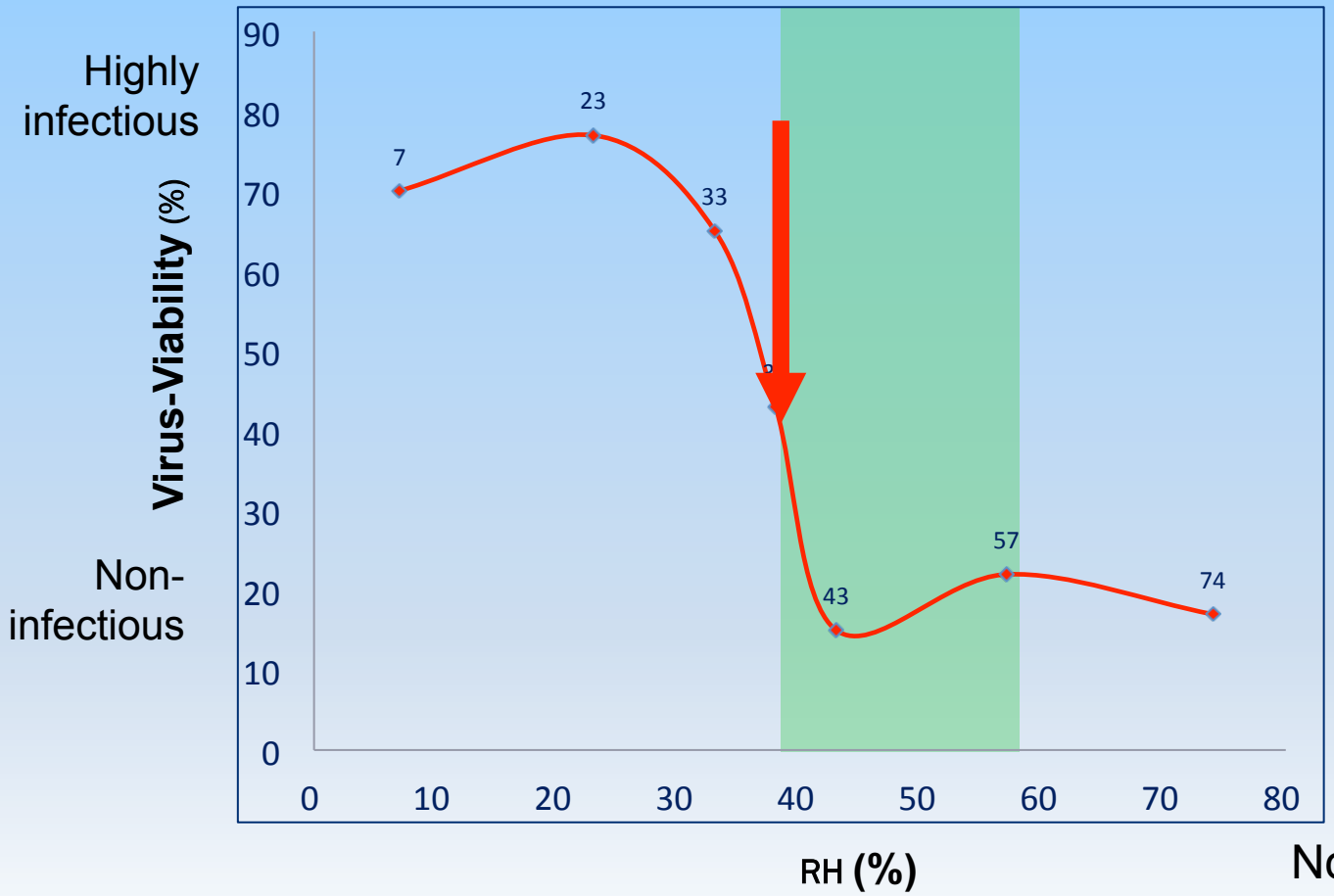


- Bacteria
- Viruses
- Fungi
- Mites
- Allergic Rhinitis and Asthma
- Respiratory Infections

Optimum Humidity is 40-60%

Role of Relative Humidity

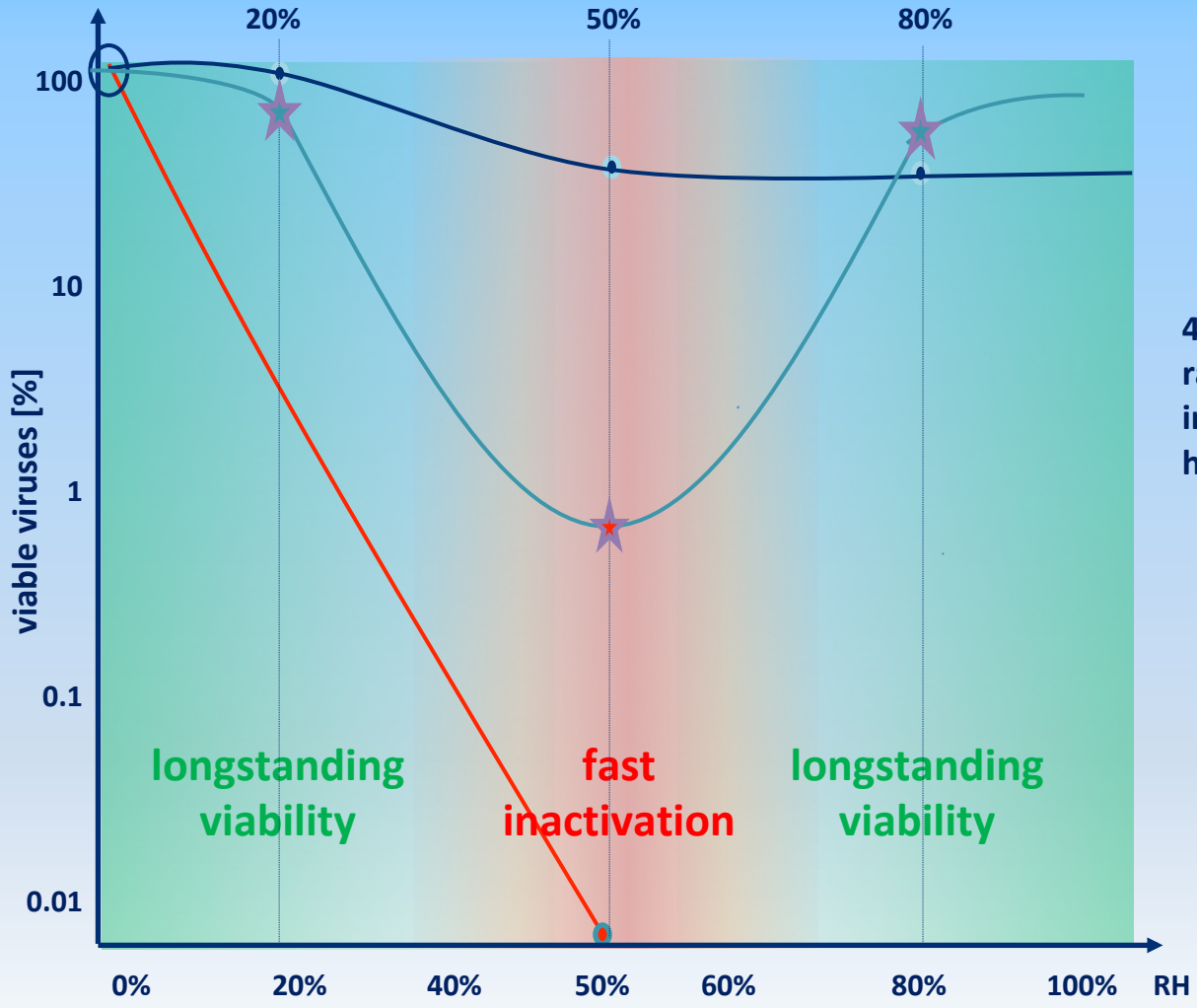
Influenza A virus is more infectious when RH is below 40% (Taylor)



Noti 2007

Pathogen Transmission

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

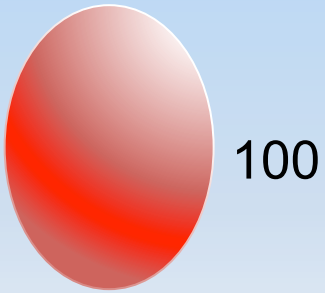


40-100F - inactivation rate is fastest in intermediate humidity of 50% RH.

Infectious Droplets

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

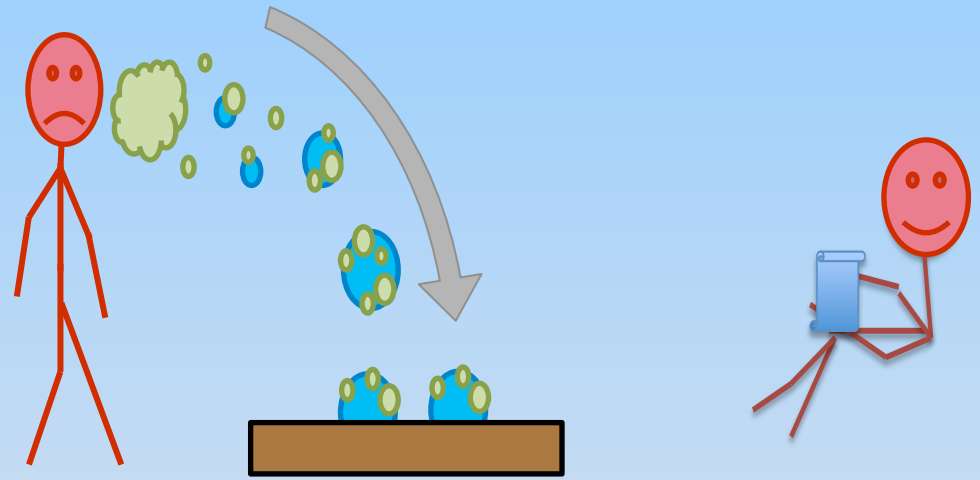
Droplet diameter in microns (um)	Float time
0.5, 1, 3	41 hours – 21 days
10	1.5 hours
100	6 seconds



Distance travelled: 1m  10m+

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

- 90% of all pathogens live in biofilms.
- Bacteria and viruses thrive in biofilm.
- 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.

Other Environmental Stressors

Poor IEQ (Indoor Environmental Quality)

- Lighting – Glare
- Noise – Too much or not enough
- Vibration
- Ergonomic Stress
- The “New” Normal - PSYCHO-SOCIAL FACTORS

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

Don’t Do This

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

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!

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

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

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

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***

Basic Conclusions

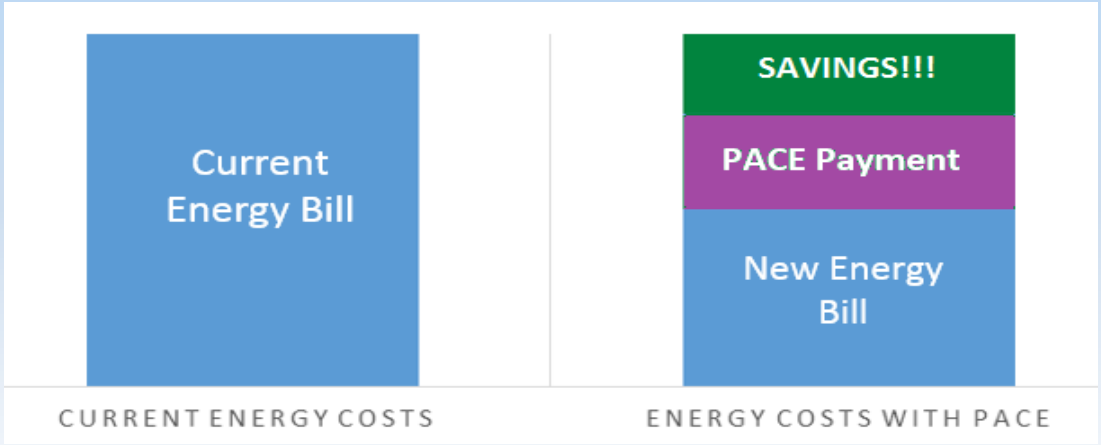
- IAQ - a large issue – **not** a simple issue
- IAQ - a part of IEQ
- HVAC – can be a large part of IAQ issues
- Proper Cleaning and Disinfection – HVAC/Other Surfaces
- Owners need assistance to avoid liability

Potential Financing

Property Assessed Clean Energy (PACE)

Financing through property tax special assessment – for energy-conserving projects

- 100% financing
- 20-25 year terms
- Positive cash flow for life of the project
- Routes loan via property taxes



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

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

Tim Wentz, ASHRAE President, 2016-17

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ASHRAE

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- Member, COVID-19 Task Force (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
- Fellow, 2021
- Past Board Member (Local)

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- Trainer, High Performing Building Certification

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- Fellow, 2010

U.S. GREEN BUILDING COUNCIL (USGBC)

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URBAN LAND INSTITUTE (ULI)

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