



**Indoor Air Quality and
Air Cleaning Technologies
Trane
January 15, 2021**

Agenda

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Introductions



Kevin Glauber CEM – a project engineer with Trane who oversees detailed audits of facilities, engineering design, and work scopes for our clients. He provides a comprehensive approach, from LED lighting to retrofitting HVAC with bipolar ionization in order to meet the specific needs of our customers.







Don Borgmann, PE – a project engineer with Trane who develops energy savings metrics for Intelligent Services reports, providing technical assistance with ongoing review of building data for system troubleshooting, diagnostics, and energy savings. Don is also responsible for developing Indoor Air Quality Assessments for clients and developing solutions for air cleaning technologies in HVAC.



Jessica D'Anna –engineer with Trane who works with clients on alternative funding sources including utility incentives, guaranteed energy saving projects, and CARES funding. She acts as the customer's liaison to ensure project is meeting or exceeding expectations from initial concept through construction.

Indoor Air Quality Recommendations

The U.S. Centers of Disease Control and Prevention (CDC) and World Health Organization (WHO) both published recommendations for occupying workplaces in areas with a COVID-19 outbreak. In addition, two leading industry trade associations, ASHRAE and REHVA, published guidance for operating building HVAC systems under these circumstances.

	<i>ASHRAE Guideline</i>
 DILUTE	Proper ventilation ensures that plenty of fresh, outdoor air comes into the building to dilute the buildup of indoor contaminants. Adjusting building ventilation is one tool that can influence indoor air quality.
 EXHAUST	Getting exhaust air out efficiently is equally important – including recirculated air from kitchens, restrooms and combustion systems.
 CONTAIN	Maintaining indoor humidity levels within the ASHRAE recommended range maximizes the comfort of building occupants while avoiding the likelihood of harmful microbial growth in the building.
 CLEAN	Of increasing concern is the HVAC system's ability to reduce micro-organisms, such as mold, bacteria and viruses.

The Four Key Areas of IAQ

DILUTE & EXHAUST: Increase ventilation with outdoor air & maintain exhaust

- Disable demand-controlled ventilation (DCV)
- Raise minimum outdoor-air damper (or airflow) setpoints
- Operate air-handling units with 100 percent outdoor air (no recirculation), when conditions allow
- Keep ventilation systems operating for a longer period of time, even if at lower airflows
- Implement pre- and post-occupancy purge sequences to flush building with outdoor air
- Keep restroom exhaust operating continuously

CONTAIN: Control indoor humidity

- Install humidity sensors, update control sequences, and add equipment or components to maintain indoor RH between 40 and 60 percent
- Disable discharge-air temperature reset for multiple-zone VAV systems during humid weather
- Ensure hot-water heating system is enabled to provide reheat for humidity control, if necessary

CLEAN: Safely use air cleaning technology, as appropriate

- Upgrade filters to MERV-13 (or higher, if possible) and ensure effective air seals
- Add portable room air cleaners with HEPA or high-MERV filters
- Install ultraviolet (UV) lamps in ductwork, air-handling equipment, or upper region of the room
- Retrofit air-handling equipment with a suitable air cleaning device

Controls & Indoor Air Quality

- Web-based control system allows for monitoring of four key areas
 - Dilute / Exhaust – monitor correct operation of HVAC equipment and exhaust fans
 - Contain – additional humidity sensors & dehumidification sequences
 - Clean – check status of air cleaning technologies through control system
- Active monitoring 24/7 monitoring system
- Trends and Reporting Features
- Text message / email critical alarms







COVID-19 vs. Guidelines

- COVID19 is transmitted in three (3) forms:
 - Droplets: *greater than 5 microns*
 - Aerosol: *less than 5 microns*
 - Surface Contact
- “Aerosol” is inherently very difficult to address
- The primary source of aerosol is the air that people exhale.
- Virus concentration is a critical aspect of the risk

GUIDELINES
RISK REDUCTION METHODS

COVID TRANSMISSION FORMS

		Droplets (> 5µm)	Aerosol (< 5 µm)	Surface Contact
CDC	Masks and Social Distancing	Highly Effective		
ASHRAE	 DILUTE		Moderately Effective	
	 EXHAUST		Moderately Effective	
	 CONTAIN		Low Effectiveness	
	 CLEAN		Moderate to Highly Effective	Highly Effective

Neither the CDC or ASHRAE published or reviewed the contents of this chart. Each guideline could have some direct or indirect impact in other areas as well.

Technologies for Microbiological Air Cleaning

PRODUCT	TECHNOLOGY	TESTED TO KILL VIRUSES	TREATS VOCS, ODORS, BACTERIA	TREATS ENTIRE BREATHING AREA	TREATS SURFACES	APPLICATIONS					Maintenance
						ROOM DIRECT	HEAT PUMPS	SMALL RTUS	LARGE RTUS (IPAK)	AHUS	
Genesis/TCAC	Filter, UV, PCO	YES	YES	NO	NO		X	X	X	X	Filter, UV lamps
UV - coil cleaning	UV	NO	NO	NO	NO		X	X	X	X	UV lamps
UV - air disinfection	UV	YES	NO	NO	NO		X	X	X	X	UV lamps
UV - Upper Air	UV	YES	NO	NO	NO	X					UV lamps
Phenomenal Aire	Bipolar ionization	YES	YES	YES	NO		X	X	X	X	clean device
Global Plasma	Bipolar ionization	YES	YES	YES	NO		X	X	X	X	clean device
RGF Enviromental	UV, PHI	YES	YES	YES	NO	X	X	X	X	X	UV, replace catalyst
Synexis	Dry Hydrogen Peroxide	YES	YES	YES	YES	X	X	X			Replace sail, monthly

PCO - Photo Catalytic Oxidation

PHI - Photohydoionization

ROOM DIRECT - CONSOLE UNIT PLACED IN ROOM

Technologies for Microbiological Air Cleaning

Technologies vary in their efficacy to reduce micro-biologicals

There are NO silver bullets

Best

● High Efficiency Particulate Filter (HEPA)

● Photo Catalytic Oxidation

Better

● Mechanical Particle Filtration (MERV 9-16)

● Ultraviolet Germicidal Irradiation (UVGI)

● Air Ionization

● Ozone Generating Cleaners

● H2O2 Photolysis
(Dry Hydrogen Peroxide)

Good

● Mechanical Particle Pre-Filter (MERV 1-8)

● Electrostatic Filters

Technologies for Air Cleaning

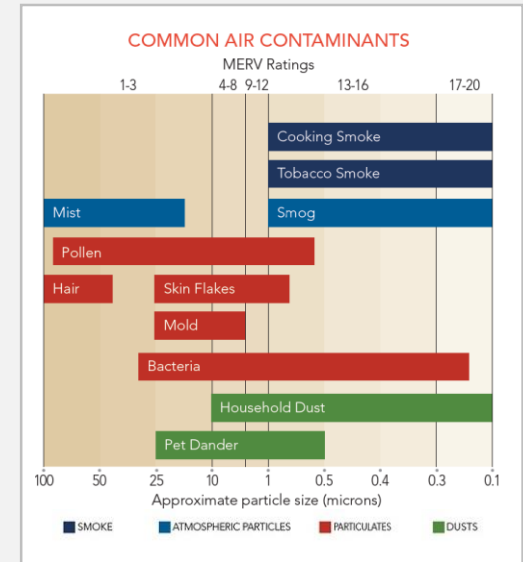
Good

Mechanical Particle Pre-Filter (MERV 1-8)

- Very low airside pressure drop but ineffective at capturing micro-biologicals unless they are attached to large particulate particles

Electrostatic Filters

- Enhanced particulate capture efficiency through electrostatic forces
- Airborne particles bearing negative electrostatic charge are attracted to a filter with positively charged fibers
- Low pressure drop and high capture effectiveness of particulates requires electricity for low power requirement
- More costly than filters but can replace existing filters or augment HEPA filtration



SOURCE: [Harvard study](#) correlated that a small increase in particulates in the air can be associated with an increase in COVID-19 death rate

Technologies for Air Cleaning

Better

- **Mechanical Particle Filtration (MERV 9-16)**
 - At higher MERV numbers, significant airside pressure drop but becomes more effective at capturing micro-biologicals (especially with adherence to particles)
- **Ultraviolet Germicidal Irradiation (UVGI)**
 - Use of UV lights to irradiate microorganisms
 - Amount of microorganism reduction dependent upon duration of exposure
- **Air Ionization**
 - High voltage is used to create ions which can:
 - React with airborne contaminants including micro-biologicals and VOCs
 - Create clustering of particles that are then caught in filters
 - May emit ozone – *this should be addressed with new technology*
- **Ozone Generating Cleaners**
 - Ozone created to attack micro-biologicals
 - Can be dangerous to people at high levels
- **H₂O₂ Photolysis**
 - Use of vaporized hydrogen peroxide to fill a space and disinfect the air and surfaces
 - Some uses may require spaces to be unoccupied during treatment
 - Scrubbers must have zero carryover to eliminate safety concerns

Technologies for Air Cleaning

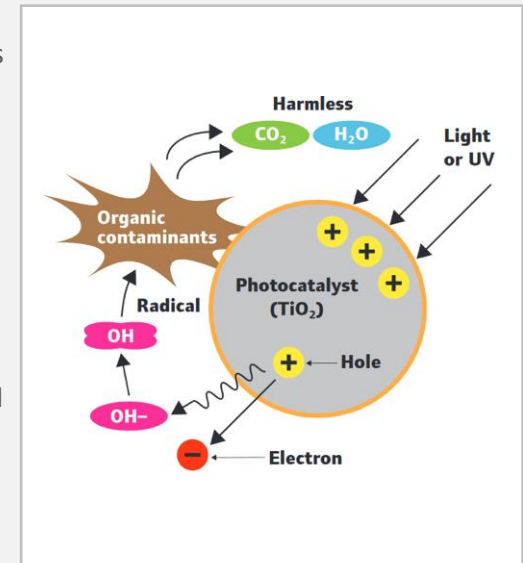
Best

High Efficiency Particulate (HEPA) Filter

- Filtration efficiency of 99.97% for particle diameters 0.3 μm
- Can filter out large micro-biologicals and those adhering to aerosols and small particulates
- High airside pressure drop and high maintenance costs than higher porosity filters
- Typically used in concert with pre-filter to remove large particles before HEPA filter
- Available for HVAC system and/or portable units

Photo Catalytic Oxidation

- UV lights are used on a titanium oxide catalyst to generate hydroxyl radicals
- The hydroxyl radicals attack/oxidize harmful pollutants including micro-biologicals and VOCs to produce harmless byproducts
- High cost
- Low airside pressure drop for higher efficiency



Financial Discussion - Options

- ✓ **Internal Capital Funds – what could you budget?**
- ✓ **Evaluate Comprehensive Operational Cost impacts for recommendations**
 - Energy Usage & Costs
 - Maintenance
 - Deep Cleaning / Surface Cleaning
 - Efficacy vs. Budgets
- ✓ **Trane in-house financing - Trane Integrated Funding Solution:**
 - Tax-exempt Lease Purchase Agreement – Balance Sheet / CAPEX Budget
 - Managed Services Agreement – “Off Balance Sheet” / OPEX Budget
 - Differed Payment Structure
- ✓ **Additional CARES Act Funding and Grants**
 - Schedule meeting with Dr. Paula Love to explore specific options and available grants

Appendix – ASHRAE Task Force

An infectious aerosol is a suspension in air of fine particles or droplets containing pathogens such as the SARS-CoV-2 virus that can cause infections when inhaled. They can be produced by breathing, talking, sneezing and other as well as by flushing toilets and by certain medical and dental procedures.

[ASHRAE's Core Recommendations for Reducing Airborne Infectious Aerosol Exposure](#) concisely summarize the main points found in the detailed guidance documents produced by the ASHRAE Epidemic Task Force. They are based on the concept that ventilation, filtration and air cleaners can be combined flexibly to achieve exposure reduction goals subject to constraints that may include comfort, energy use and costs.

“This guidance outlines a clear approach for lessening the risk of infectious aerosol exposure for building occupants that can be applied in a wide range of applications, from homes to offices to mobile environments such as vehicles and ships,” said William Bahnfleth, ASHRAE Epidemic Task Force chair. “ASHRAE’s Core Recommendations are based on an equivalent clean air supply approach that allows the effects of filters, air cleaners, and other removal mechanisms to be added together to achieve an exposure reduction target.”

Specific recommendations include the following:

Public Health Guidance

- Follow all regulatory and statutory requirements and recommendations.

Ventilation, Filtration, Air Cleaning

- Outdoor airflow rates guidance for ventilation as specified by applicable codes and standards.

- Recommendations on filters and air cleaners that achieve MERV 13 or better levels of performance.

- Air cleaners usage.

- Control options that provide desired exposure reduction while minimizing associated energy penalties.

Air Distribution

- Promote the mixing of space air.

HVAC System Operation

- Maintain temperature and humidity design set points.

- Maintain equivalent clean air supply required for design occupancy.

- Operate systems for a time required to achieve three air changes of equivalent clean air supply.

- Limit re-entry of contaminated air.

System Commissioning

- Verify that HVAC systems are functioning as designed.



www.trane.com/IAQ

Contact information:

Jessica D'Anna

Trane Commercial

Cell: 314-320-9324

Email: Jessica.danna@tranetechnologies.com

The transmission of Covid-19 may occur in a variety of ways and circumstances, many of the aspects of which are currently not known. HVAC systems, products, services and other offerings have not been tested for their effectiveness in reducing the spread of Covid-19, including through the air in closed environments