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CFM Company's Recommendations:
How to Minimize Airborne Transmission of COVID-19 Virus through HVAC Systems

Colorado's and Wyoming's economies are re-opening during a time where the novel coronavirus is still present, and the majority of our populations have not yet been exposed to the virus. Re-opening offices, schools, and other buildings under these circumstances presents a number of challenges to building owners and operators. This document is intended to guide the person that wants to maximize safety, but is not sure what interventions will be effective.

The guidance herein is focused on mechanical systems, CFM Company's area of expertise. A mechanical system has its original functions to serve, and it still needs to operate in accordance with local codes and the requirements of the building. There a number of are beneficial changes that can be made to a mechanical system that will serve to reduce airborne virus transmission.

We'll reference the ASHRAE Position Document on Infectious Aerosols, linked here . It's introductory statement states the following: "*Dilution and extraction ventilation, pressurization,airflow distribution and optimization, mechanical filtration, ultraviolet germicidal irradiation (UVGI), and humidity control are effective strategies for reducing the risk of dissemination of infectious aerosols in buildings and transportation environments*."

CFM Company's Recommendations are as follows:

- Humidify occupied rooms to 40% RH or higher
- Upgrade HVAC filters to capture ultra-fine particles
- UVGI is effective for deactivating virus, bacteria, and fungus. Sufficient dosage is required in order to inactivate the COVID-19 virus.
- Increase outside air percentage at AHU's and RTU's where possible for dilution

Humidify occupied rooms to 40% RH or higher.

This may be an unexpected first recommendation, but there is substantial scientific evidence that this strategy has merit. Consider that the largest market for humidification in our region is for hospitals. Specifically, the areas within a hospital where humidification is carefully controlled at 30% or higher are Intensive Care Units (30%+ RH) and burn units (40%+ RH), where patients are either very susceptible to infection or are the source of infection.

Humidifying to 40% or higher achieves a number of clear benefits:

1) Persistence and distribution: Virus is transmitted from an infected person to the air in the form of liquid droplets when they breathe, speak, cough, or sneeze. The droplets are dispersed in a variety of sizes. The largest ones (a few microns and larger) fall to the floor or other surfaces which can be cleaned. However, the smallest droplets at a size of 1 micron or smaller stay suspended in the air for hours. Given the size and persistence, those droplets can be recirculated through the air distribution system to non-infected people. If the air is dry, larger

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droplets quickly reduce size and can become suspended. At higher relative humidity levels, the larger droplets retain their size and are less able to be suspended and recirculated in the HVAC system.

2) Immune response: The human body is far more able to defend against viruses when healthy humidity levels are maintained. As an example, the influenza virus was found to have an infectivity percentage between 60 and 80% at relative humidities below 30%. At 40% and higher, the infectivty of influenza was reduced to 20% or lower. We estimate that the response to COVID-19 will be similar.
3) Viral activity: on surfaces and in the air, viral activity and the half-life of virus is reduced at higher relative humidities.

The ASHRAE Position Document on Infectious Aerosols states that the scientific literature generally reflects the most unfavorable survival for microorganisms when the RH is between 40% and 60% (Evidence Level B). Evidence Level B means that ASHRAE has recommended this mitigation, and that there is fair evidence to support the claims.

One of the reasons that this is CFM Company's first recommendation is that it can be applied with any mechanical system type. Humidification can be added to air handling units, duct systems, or distributed directly into rooms safely and without impacting fans, filters or heat transfer coils.

Pitfalls to avoid are uncontrolled humidity additions, potential condensation issues and improper installation. A proper engineering design and review will assist an owner in navigating possible unintended consequences of humidifying.

CFM Company represents DriSteem. They manufacture a comprehensive line of humidifiers and distribution systems and are recognized as a market leader in humidification, especially in critical environments such as hospitals and laboratories.

Reference page: DriSteem: Humidify to Reduce Virus Transmission

Upgrade HVAC Filters to Capture Ultra-Fine Particles

An HVAC system will have some filtration to either protect the equipment (lowest efficiency) or improve human health (higher efficiency). In most HVAC systems, the filtration system is NOT designed to capture particles that are one micron in size and smaller. As stated in the humidification section, particles of this size will remain suspended for long periods of time and are most able to bypass human defenses. Therefore, we are most interested in filtering these particles.

The ASHRAE 52.2-2012 test for filtration efficiency allows filters to be classified into a single-number rating system called a MERV rating, with higher numbers indicating greater filtration efficiency. Some quick numbers are indicated in the table below:

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	Minimum Removal Efficiency		
Particle Group Size	MERV8	MERV13	MERV15
E1 (3.0 – 10.0 micron)	70%	90%	95%
E2 (1.0 – 3.0 micron)	20%	85%	90%
E3 (0.3 – 1.0 micron)	N/A	50%	85%

ASHRAE offers a quick solution that will do some good: upgrade filters to at least MERV13. While this is technically correct (it will do some good), it probably won't provide a significant improvement in safety. It would be reasonable to assume that an infected person sheds virus with a particle load of many thousands in a few hours. Cutting that particle load in half may not provide a large enough benefit.

In order to upgrade a filtration systemto a higher MERV rating, filter racks in air handling units may need to be changed. It is recommended that a prefilter (typically MERV8) is installed upstream of a filter with a higher MERV rating. This allows the lower-efficency, lower cost filter to capture large particles and the higher-efficiency, higher cost filter to capture the fine particles.

The addition of a second stage of filtration may require that air handling fans be changed to overcome the additional static pressure losses of the filter. In some cases, the fans can simply be run at higher speed. In other cases, the fans and motors may need to be replaced in order to prevent motors from overloading or having reductions in airflow.

Dynamic Air Quality Solutions manufactures a polarized media air cleaning system called Dynamic V8 that cleans air at a MERV15+ efficiency (E3 effectiveness = 94%) and has a maximum pressure drop of around 1.4 inches of water when fully loaded (it can take many years to fully load a Dynamic V8). Upgrading an existing system to this filter would usually allow for existing fans to remain in place. The filter assembly needs approximately 30 inches of space in the direction of airflow to be installed inside of an air handling unit, or filter boxes can be manufactured to accommodate the Dynamic V8.

One last benefit to the Dynamic V8 is that it has extremely high dust loading capability. Compared to a filtration system that uses MERV8 and MERV15 filters, a Dynamic V8 system would not require a media change until the MERV8 filters were changed fourteen times and the MERV15 filters were changed three times. This would result in significant labor cost and disposal savings.

For passive filtration, CFM Company represents AAF Flanders. For polarized media air cleaners, CFM Company represents Dynamic Air Quality Solutions.

Reference: Dyanamic Air Quality Solutions COVID-19 Statement
Reference: Dynamic V8 Dynamic Sterile Sweep

Reference: AAF COVID-19 Passive Filter Recommendations

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UVGI is effective for deactivating virus, bacteria, and fungus. Sufficient dosage is required to inactivate the COVID-19 virus.

The application of UVC light has grown wide acceptance over recent years, especially in health care applications. One of the more common applications of UVC has been in air handling units, applied downstream of the cooling coil, where it can irradiate the coil. A cooling coil can be a major source of growth of biological contaminants such as bacteria and fungi.

Since virus does not grow on a surface like fungi and bacteria do, its treatment needs to be formulated to provide a sufficient dose in the case of a "fly-by" application. UVC dosing to inactivate virus is well-documented, and it requires an expression of emitted intensity x time in order to be effective.

The ASHRAE position document lists the addition of UVC systems to both health care and non-healthcare facilities as a beneficial measure.

CFM Company represents Steril-Aire for UVC light systems for air handling units, and their in-room and hand-held emitters. Our sales teams are able to properly size a UVC system for your review.

Reference: Steril-Aire Position on COVID-19

Increase outside air percentage at AHU's and RTU's where possible for dilution.

Increasing outside air for an AHU or RTU system will reduce the amount of air returned to the air handler and decrease the number of virus-carrying particles returned to the supply air. Systems that have air economizer already accomplish this when outdoor air conditions are suitable for economizer operation (typically 55 degress F or lower).

Operating at high outside air percentage will likely require increases in cooling and/or heating capacity when outside air conditions are hotter than 55F or colder than 40F. Operational changes like this will require review by a qualified engineer to ensure feasibility and protection of assets. Many existing systems can support capacity upgrades. Costs and energy impacts can vary widely.

For increases in outside air that are not substantial (e.g. an increase from 15% outside air to 30% outside air), the benefit and risk mitigation would be fractional at best.

Understanding the Trade-Offs:

Some interventions will require differing levels of engineering assessment, design, cost of materials, and labor to install. We are committed to providing you with evidence-based solutions to assist you with these difficult decisions.