Schnackel University

Schnackel engineers

ENHANCED HVAC INFECTION CONTROL:

WAREHOUSES & INDUSTRIAL FACILITIES

WHITE PAPER JANUARY 2021

Introduction

Continuing our look into occupancy specific building types this paper examines the unique characteristics and challenges of mitigating the spread of airborne diseases in warehouses and industrial facilities.

Our primary objective will be to answer the question:

What should I do to my facility to improve the safety and comfort of its occupants?

We will review the common systems types found in these facilities and make recommendations for improving the infection control potential of these systems. We will also examine how well these systems can be adapted to meet the latest infection control standards and recommendations. This white paper focuses only on the large volume storage and production areas of these facilities. Please refer to our Offices White Paper for our recommendations for the administrative areas of these facilities.

Agency Recommendations

The latest recommendations from the ASHRAE Epidemic Task Force for Commercial Buildings (updated 08/17/2020) include the following improvements related to any building's HVAC system:

- Maintain temperatures in accordance with ANSI/ASHRAE Standard 55-2017.
- Maintain relative humidity between 40% and 60%.
- Verify minimum ventilation requirements per Standard 62.1 are maintained. Increase ventilation rate as allowed per installed equipment and still maintain comfort levels.
- Operate systems at maximum outside air mode for two hours before and two hours after occupied times.
- Increase filter rating to MERV-13 if equipment can handle the additional pressure loss.

(https://www.ashrae.org/technical-resources/resources)

The Centers for Disease Control and Prevention's Resuming Business TOOLKIT includes the following general recommendations for all ventilation systems:

- Increase ventilation rates or percentage of outdoor air.
- Disable demand-controlled ventilation (DCV).
- Improve filtration to MERV-13.

(https://www.cdc.gov/coronavirus/2019-ncov/community/resuming-business-toolkit.html)

Typical Warehouse/Industrial System Types

Warehouses and industrial facilities may be served by a wide variety of system types including, but not limited to, the following:

- Commercial Packaged Roof Top Units
- Central Air Handlers
- Heating & Ventilating Units
- Unit Heater and Exhaust Systems

HVAC system types associated with these facilities offer many options for improving indoor air quality and reducing the risk of the spread of contaminants and pathogens. The key is selecting the right combination of measures to achieve the optimum result for each system, within the budget constraints of the project, while maintaining acceptable comfort levels for the occupants.

Temperature Control

ANSI/ASHRAE Standard 55-2017 does not directly specify temperature requirements for various occupancies. This is due to the fact that occupant comfort is a very subjective matter. In addition, warehouses and industrial facilities have very wide ranging requirements with respect to what is considered acceptable temperatures. Any modifications

to the HVAC systems should be carefully coordinated to ensure that the end result still lands within the established acceptable range of temperatures to ensure human comfort, proper facility operation and effective infection control

Ventilation Systems

ANSI/ASHRAE Standard 62.1-2019 requires a minimum of 0.06 cfm per square foot of floor area of outdoor air for warehouses. Assuming a 40'-0" ceiling height, this translates into less than 0.1 air changes per hour of outdoor air.

While this rate meets minimum code requirements, it is not considered sufficient for the purpose of an effective dilution ventilation strategy for viral control. Most recent studies and the current CDC guidelines recommend a *minimum* of 2 to 4 air changes per hour of *outdoor* air to achieve a reasonable level of infectious agent dilution.

Air changes per hour	Minutes required for removal efficiency	
	99%	99.9%
2	138	207
4	69	104
6	46	69
12	23	35
15	18	28
20	14	21
50	6	8
400	<1	1

Time required for infectious agent removal based on the number of air changes per hour (adapted from CDC guideline [28])

Infectious Agent Dilution Ventilation Performance

Depending on the HVAC system installed and the outdoor temperature/humidity conditions, typical warehouse systems are unlikely to be able to achieve an increase to 2 to 4 air change rate without requiring major renovations and/or additions to the existing HVAC systems. Plus, the energy consumption impacts of doing so make these air change rates impractical for most of these occupancies. Therefore, the goal should be to achieve the maximum outdoor air ventilation rate possible at any given time without overloading the HVAC's system ability to properly condition the air and retain reasonable energy efficiency. Generally speaking, achieving true dilution ventilation of these large volume spaces is simply impractical, except in the smallest of these facilities with low ceiling heights.

Demand Controlled Ventilation Systems

Some warehouses and industrial facilities. may be equipped with Demand Controlled Ventilation systems or DCV, which vary the amount of outdoor air introduced based on the measured CO_2 levels in the space (or return air stream). These systems are design to adjust the outdoor air intake system to reflect the actual occupancy of the building at any given time, rather than simply bringing in a fixed amount of outdoor air to meet minimum code requirements. DCV systems were introduced primarily as an energy conservation measure to ensure that the central HVAC system was not bringing in any more outdoor air than was necessary to maintain acceptable indoor air quality levels, generally defined to be indicated by <1,000 ppm total CO_2 concentration or <600 ppm above the outdoor ambient CO_2 concentration level. (Outdoor air typically contains between 350 and 450 ppm CO_2.)

While the CDC has recommended *disabling* DCV systems, it is Schnackel Engineers' recommendation that they be maintained to help ensure that the maximum amount of outdoor air is being introduced during periods of higher occupancy. However, in lieu of a typical pre-COVID-19 set point of 1,000 to 1,200 ppm total CO_2, these systems should be lowered to a 600 ppm maximum set point to effectively double the amount of fresh air delivery to the space when the building is heavily occupied. As a general rule of thumb, a doubling of the ventilation rate will cut the concentration of contaminants in the air by approximately

50%. The system can then scale back the fresh air delivery somewhat during periods of lower occupancy or high outdoor ambient conditions, without requiring any manual intervention in the control of the system, albeit to higher levels of ventilation that were previously recommended.

Ventilation System Maintenance

All HVAC systems, regardless of type, should be checked to ensure that the ventilation rates delivered to the occupied spaces are as high as possible without compromising comfort levels or causing undue loading on the system equipment. All dampers, motors, controls and accessories associated with the ventilation systems should be checked to ensure they are working properly, and meeting at least the minimum code requirements, if not higher.

Filtration

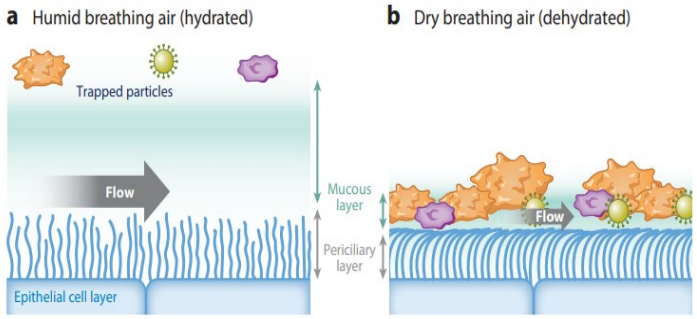
Our Filtration White Paper took an in-depth look at the available filtration technologies that can be applied to almost any HVAC system. Please refer to that white paper for more specific information about MERV ratings, filter efficiencies and the associated pressure drop considerations. The primary objective of increasing filtration with respect to infection control, is to install as high-efficiency of filters as is possible, subject to the static pressure limitations of the HVAC system. However, in warehouses and industrial facilities, systems are often designed using 100 percent exhaust ventilation, which eliminates the need for filtration of the return/exhaust air.

In facilities with recirculating air systems, those systems should be equipped with as high efficiency of filters as can be accommodated by the existing equipment.

Central air handling units and commercial packaged roof top units should be capable of overcoming the additional static pressure associated with the higher MERV ratings recommended for infection control. Whenever possible, install filters of a MERV-13 rating, or higher, to achieve maximum viral droplet capture. In some cases, increasing the MERV rating of the filters will require either no modifications to the HVAC equipment or minor changes to the belts, pulleys and possibly the supply fan motor, all of which can be accomplished at a relatively minor cost.

Humidity Control

As we learned in our Humidity Control White Paper, maintaining the optimum humidity level of 40%-60% RH may be the single most effective way to mitigate the spread of viruses in buildings. This is due to both the human body's adverse reaction to low humidity and the viruses' ability to thrive and spread under low and high humidity conditions.



Mucociliary Clearance Mechanism

Humidification Mode

Warehouses and industrial facilities should be immediately fitted with central "clean-steam" humidification systems with large, in-room steam distributors for each area. If central plant steam is available, it can be utilized in a steam-to-steam converter arrangement to ensure the moisture delivered to the space is free of any boiler water treatment chemicals. Never directly inject boiler plant steam into the air as treatment chemicals present potential health hazards. Evaporative type humidifiers should be avoided unless they are coupled with UV light sterilization systems to ensure no mold or bacterial growth can occur. Generally speaking, evaporative pad humidifiers will be relatively ineffective in large volume space due to their inability to release sufficient moisture to materially change the humidity in the space.

Dehumidification Mode

If a facility is provided with an air conditioning system, most of these systems are able to operate efficiently under part-load conditions and maintain humidity levels within the target range during the summer months. Some of these systems may already be equipped with a dehumidification cycle option, utilizing either hot refrigerant gas or electric reheat to prevent over-cooling. If additional dehumidification is necessary, reheat coils can be added to the existing equipment to allow for drying of the air during light loading conditions. Dehumidification is as important as humidification to prevent the growth of mold and the propagation of viruses and bacteria in any facility.

Germicidal Ultra Violet Sterilization

In addition to the recommendations discussed above, Germicidal UV Sterilization (GUV) is can be provided to provide an additional layer of infection control and prevention. Often a multi-layered approach is the best strategy to bring a building up to its maximum infection control potential. These measures can include the following:

- In large areas with high ceilings Upper Room GUV can be installed for added protection, killing the airborne viruses as they circulate within the rooms. These systems are extremely effective at killing airborne virus droplets and aerosols very near to their source. They can only be installed in areas where there is no possibility of human exposure to the UV radiation.

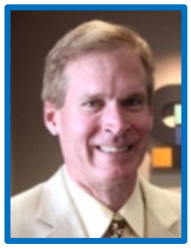
Summary

Schnackel Engineers can assist you with a thorough evaluation of your facility to ensure you are doing everything possible to prevent the spread of viruses within your facility. Please give us a call at 800-581-0963 or email us at info@schnackel.com for a consultation.

About Pedro:

Pedro Ferrer, P.E. has been involved in the design of mechanical systems for malls, mixed-use developments, corporate offices, national retail roll-outs, commercial and institutional buildings for over 26 years with Schnackel Engineers. Email Pedro at pferrer@schnackel.com

About Greg:



Gregory Schnackel, P.E., LEED AP has been involved in the design of mechanical, electrical, plumbing, fire protections and information technology systems for malls, mixed-use developments, corporate offices, national retail roll-outs, schools, hospitals, medical facilities, commercial and institutional buildings for over 40 years with Schnackel Engineers. Email Greg at gschnackel@schnackel.com

RESOURCES	
ASHRAE	https://www.ashrae.org/
Centers for Disease Control	https://www.cdc.gov/coronavirus/2019-nCoV/index.html
ASHRAE Journal	https://www.ashrae.org/technical-resources/ashrae-journal
Schnackel Engineers White Paper Series – Enhanced HVAC Infection Control.	http://www.schnackel.com/firm/white-papers/enhanced-hvac-infection-control-white-papers