Schnackel University

Schnackel engineers

ENHANCED HVAC INFECTION CONTROL: RESTAURANTS

WHITE PAPER OCTOBER 2020

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 restaurants.

Our primary objective will be to answer the question:

> *What should I do to my restaurant to improve the safety and comfort of its patrons and employees?*

We will review the common systems types found in restaurants 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.

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 ANSI/ASHRAE 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 Restaurant HVAC System Types

Restaurants may be served by a wide variety of system types including, but not limited to, the following:

- Commercial packaged roof top units
- Terminal units: Fan coil, WSHP, VRF, split-systems
- Central air handlers (rare)

The central air handling systems (commercial packaged roof top and central air handler types) handle the introduction of fresh outside air in the equipment itself, through various forms of dampers and intake hoods.

The terminal unit systems usually get fresh outside air via wall louvers or via gravity intake vents on the roof.

Nearly all of the system types associated with restaurants 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.

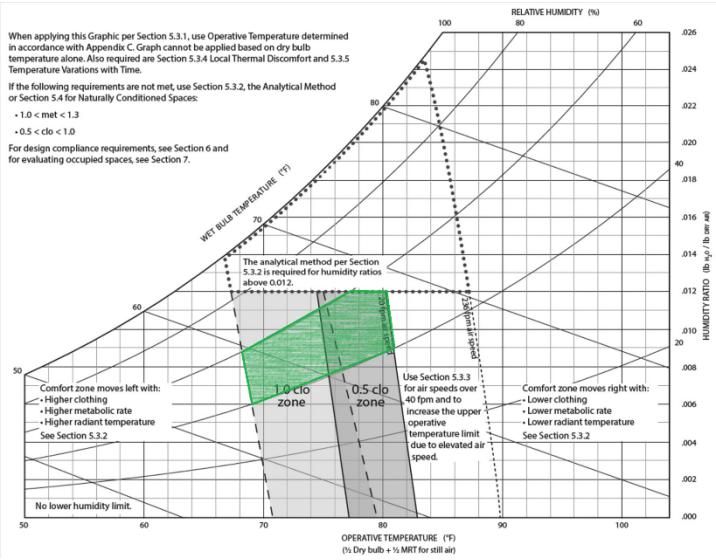
Temperature Control

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. Different individuals have different expectations with respect to temperature and humidity in order to determine if a space is considered "comfortable". In addition, the perceived comfort level is impacted by a multitude of factors including the metabolic rate of the activities in the space, the air temperature, the radiant temperature, the relative humidity, the clothing insulation levels of the occupants and the average airspeed in the occupied zone, not to mention basic personal preferences.

According to ANSI/ASHRAE Standard 55, an acceptable level of occupant comfort means that less than 10% of the occupants polled would rate their experience in the space as "thermally dissatisfied". ASHRAE calls this metric the *predicted percentage of dissatisfied or PPD*. Basically, you

will never please everyone, so as long as you please at least 90% of the occupants, it is considered satisfactory performance per the ASHRAE Standard.

Instead of indicating a specific temperature range for each occupancy, ASHRAE 55 recommends that spaces be maintained within a band of coincident temperature and humidity levels, taking into account the velocity of air movement in the occupied zone, as indicated by the relatively large grey shaded area on the graph below.



ASHRAE 55: Acceptable Range of Operative Temperature and Humidity for Spaces

The green shaded area superimposes the recommended anti-viral humidity range of 40%-60% RH on the ASHRAE 55 comfort zone chart to achieve a PPD of <10% in a highly effective, anti-viral indoor environment. As is evident from the graph, there is a fairly narrow range of coincident temperatures and humidity levels that are considered acceptable for both human comfort and for infection control. Any modifications to the HVAC systems should be carefully coordinated to ensure that the end result lands within the green bounded area of human comfort and effective infection control.

Qualified service technicians should verify that the temperature and humidity sensors in all areas are calibrated and operating properly, prior to embarking on an upgrade program to improve infection control.

Ventilation Systems

ANSI/ASHRAE Standard 62.1-2019 requires a minimum of 7.5 cfm per person plus 0.18 cfm per square foot of floor area of outdoor air for restaurant dining rooms. Based upon a dining area occupant density of 70 people per 1000 ft2 and a 10'-0" ceiling height, this translates into approximately 4.3 air changes per hour of outdoor air. Because of the high people density, this air change rate is 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. See our white paper on Dilution Ventilation for further details.

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 restaurant systems may already be able to achieve a higher air change rate than the recommended 2 to 4 minimum range. The goal is 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. If properly balanced to meet the minimum code values stated above, many restaurant

HVAC systems are already providing a good level of dilution ventilation for infection control. However, without a proper technical assessment, the performance is unknown.

During periods of economizer operation (mild weather conditions), outdoor air rates rise to as high as 100% of the supply air quantity, providing excellent air change rates (>10 AC/hr), better indoor air quality and lower energy costs. Any system that is not already equipped with an air side economizer, should be analyzed to determine if it can be retrofitted for both energy conservation and viral control improvement reasons.

Most commercial kitchens are already extremely well ventilated due to the large amounts of air exhausted by the grease hoods and vapor hoods throughout the kitchen and dish wash areas. These areas are often experiencing upwards of 10 air changes per hour due to the large quantity of exhaust required for the cooking equipment.

There are some smaller kitchen formats that do not involve grease laden vapors, which may not have as much ventilation as is necessary to keep the concentration of infectious particles in the ambient kitchen air low enough. In these cases (sandwich shops, coffee shops, etc.) the same principles discussed above for dining rooms would apply to the kitchens also. An evaluation of each kitchen facility should be performed to determine the baseline air exchange rate provided by the existing exhaust systems to ensure adequate ventilation to keep the staff safe and to maintain outstanding food safety.

All HVAC systems, regardless of type, should be checked to ensure that the ventilation rates currently delivered to the occupied spaces are as high 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 improving filtration performance 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.

Central air handling units and commercial package 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. Sometimes 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.

Terminal Unit systems can be more challenging when it comes to filtration. Since terminal units are relatively small in size and therefore have smaller fans and motors, most will not be capable of handling an upgrade to a MERV-13 rating. However, the filters should still be upgraded the highest MERV rating that each unit can safely handle. Even an upgrade to MERV-8 or MERV-10 can provide a meaningful reduction in the concentration of airborne infectious particles, particularly the larger droplets that are associated with SARS-CoV-2 spread.

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. Cooking, food and diner respiration

all provide some level of humidity improvement in the winter, however these factors alone are unlikely to achieve the recommended minimum 40% RH necessary to reduce the spread of viruses and other pathogens in colder climates.

Most restaurants systems have a reasonable capacity to dehumidify the air in the building using the air conditioning system, however very few restaurants are equipped with any type of supplemental humidification equipment to keep viral spread low during the winter months.

Humidification Mode

Commercial package roof top units and central air handling units should be fitted with central "clean-steam" humidification systems and in-duct steam distributors for each unit serving the dining areas, where the typical sources of moisture are not able to maintain adequate humidity levels in the winter. Evaporative type humidifiers should be avoided unless they are coupled with UV light sterilization systems to ensure no mold or bacterial growth can occur.

Restaurants served by terminal units will need to be evaluated on a case-by-case basis. Individual humidifiers featuring in-duct steam distribution might work in some instances. However, in most cases a different approach is warranted. "Clean-steam" humidifiers with wall-mounted distributors are a viable option where in duct units are not possible.

Humidification of the kitchen and back of house areas is probably not necessary due to the large amount of humidity generated by the cooking, food preparation and ware washing activities taking place in these areas.

Dehumidification Mode

Most restaurant HVAC systems are able to operate efficiently under part-load conditions and maintain humidity levels within the target range during the summer months. In rare cases, 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 to remain below 60% RH in the summer, reheat coils can be added to the existing equipment to allow for drying of the air during light loading conditions without over-cooling the space. This should be a relatively rare condition in most restaurant settings.

Additional Prevention Measures

In addition to the recommendations discussed above, there are several other options available to provide additional layers 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-Duct UV disinfection systems can be installed to disinfect the air as it passes through the HVAC unit and to keep the coils and drain pans free of any type of pathogen, including viruses, bacteria and mold.
- 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.

Summary

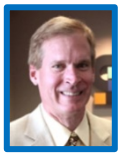
Well-designed restaurants are already very well ventilated and have a reasonably good ability to control humidity. Increasing filtration levels and verifying that all systems are operating at their peak performance levels may be all that is necessary to bring your restaurant into good standing with respect to infection control. Older restaurants will likely require some updates, however those updates are probably warranted regardless of the consideration of their infection control performance.

Schnackel Engineers can assist you with a thorough evaluation of your building 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 restaurants, 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 restaurants, 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