Schnackel University

Schnackel engineers

ENHANCED HVAC INFECTION CONTROL:

HEALTH CLUBS

WHITE PAPER OCTOBER 2020

Introduction

Continuing our look into occupancy specific building types, this paper examines the unique challenges of mitigating the spread of airborne diseases in health clubs.

Our primary objective will be to answer the question:

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

We will review the common systems types found in health clubs and fitness centers 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 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 Health Club HVAC System Types

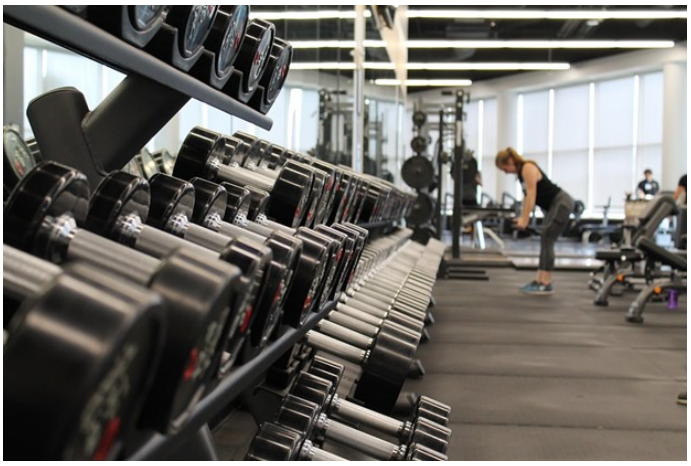
Health Club Facilities may be served by a wide variety of system types including, but not limited to, the following:

- Commercial packaged roof top units.
- Commercial split-systems.
- Central air handlers.
- Fan coil units or water source heat pump terminal units.

The central air handling systems (indoor modular, indoor self-contained and outdoor packaged types) handle the introduction of fresh outside air in the equipment itself, through various forms of dampers and intake hoods.

The smaller commercial split systems and fan coil/WHSP units usually obtain fresh outside air via wall louvers or gravity intake vents on the roof.

Nearly all of the system types associated with health club 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 type, 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. According to 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.

In health clubs, temperatures in the 70°F to 75°F maximum are necessary to be considered "comfortable" by the patrons, unless there is a specific objective in mind like Bikram Yoga or other unusually warm environment.

Qualified service technicians should verify that temperature and humidity sensors are present in all areas and that they 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 20 cfm per person plus 0.06 cfm per square foot of floor area of outdoor air for health clubs. The occupant density for health clubs is divided into two classes: 40 people per 1,000 ft^2 for aerobics rooms and 10 people per 1,000 ft^2 for weight rooms and other general exercise areas. Assuming a 10'-0" ceiling height, this translates into approximately 5 air changes per hour of outdoor air for aerobics rooms and 3 air changes per hour for weight rooms. If the ceiling heights are higher, the air exchange rate will be proportionally lower.

Because of the relatively high rate of outdoor air per person, the baseline air change rates may be 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 the table below and 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

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

Some health club 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, and even installed if they are not already present, to help ensure that the maximum amount of outdoor air is being introduced during periods of high 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.

High ventilation rate purge cycles up to two hours before club opening are also recommended to ensure that the air in the club is as clean as possible when patrons begin to arrive. Purge cycles prior to opening will often coincide with moderate outdoor air conditions, resulting in large volumes of clean fresh air being introduced without too much impact on indoor space conditions. Purge cycles must be carefully applied, however, to ensure that coil temperatures and room temperatures/humidity levels remain in check during extreme weather conditions, particularly in the winter months.

Most health club systems of the central fan types (rooftops and central air handlers) are equipped with outdoor air economizers. During periods of economizer operation (mild weather conditions), outdoor air rates rise to as high 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.

It is critically important that all HVAC systems, regardless of type, be checked to ensure that the ventilation rates 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 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.

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.

Fan coil unit and water source heat pump type 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-11 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. Elevated people activity levels in health clubs 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 health club facilities, regardless of type, have the ability to dehumidify the air in the club using the air conditioning systems, however very few health club facilities are equipped with any type of humidification equipment to keep viral spread low during the winter months. This is perhaps the most valuable enhancement you can make to keep your clubs safe during the colder winter months.

Humidification Mode

Central air handling units and commercial package roof top units should be fitted with central "clean-steam" humidification systems with in-duct steam distributors for each unit. Evaporative type humidifiers should be avoided unless they are coupled with UV light sterilization systems to ensure no mold or bacterial growth can occur.

Health clubs served by commercial split systems, fan coil units and water source heat pumps will need to be evaluated on a case-by-case basis. Individual humidifiers featuring in-duct steam distribution should work in most instances. However, in some cases a different approach is warranted. "Clean-steam" humidifiers with wall-mounted distributors are a viable option where in duct units are not possible and, properly applied, they provide just as effective a result as the in duct system.

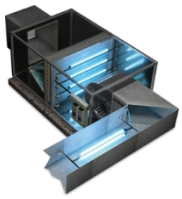
Dehumidification Mode

Most health club HVAC systems are able to operate efficiently under part-load conditions and maintain humidity levels within the target range during the summer months. In addition, 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. This should be a relatively rare condition in most health club facilities.

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. These systems are strongly recommended for all health club facilities, not only due to the current COVID-19 pandemic, but also for general cleanliness and sterilization of the air and equipment in a health club setting. Fresher, cleaner, disinfected air is always a welcome feature of any health and fitness club.



- In large areas with high ceilings Upper Room GUV can be installed for additional 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 and are preferred to the in-duct solutions wherever ceiling heights permit its use.

- Portable UV disinfection units can also be considered for off-hours, unoccupied sterilization of the equipment and room surfaces. However, staff must be thoroughly trained in the use of these powerful systems to avoid any possibility of human exposure to the damaging rays of the UV sterilization equipment.

Summary

Health clubs are well suited to provide a high level of infection control capability due to the strict code requirements surrounding outdoor air ventilation rates. However, many older clubs may not be in compliance with these newer standards and regulations.

Even in modern clubs, many of the HVAC systems may have been compromised since they were originally constructed, either intentionally to save energy or through normal wear and tear. Therefore, they should be verified to ensure they are performing in accordance with their original design specifications.

One improvement that all health and fitness clubs should definitely consider is the addition of humidification equipment to ensure that winter humidity levels stay above at least 30%, or preferably above 40% at all times.

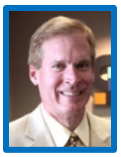
It is critically important that any existing club is thoroughly evaluated by a qualified professional to ensure that the existing systems are adequate to promote a safe and healthy environment for exercise. Due to the high respiratory and metabolic rate of the patrons of these clubs, it is important to make sure the systems are performing to their peak capabilities and are meeting basic infection control requirements and standards.

Schnackel Engineers can assist you with a thorough evaluation of your facility to ensure you are doing everything possible to prevent the spread of disease 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