AINSWORTH

BUILDING SYSTEMS

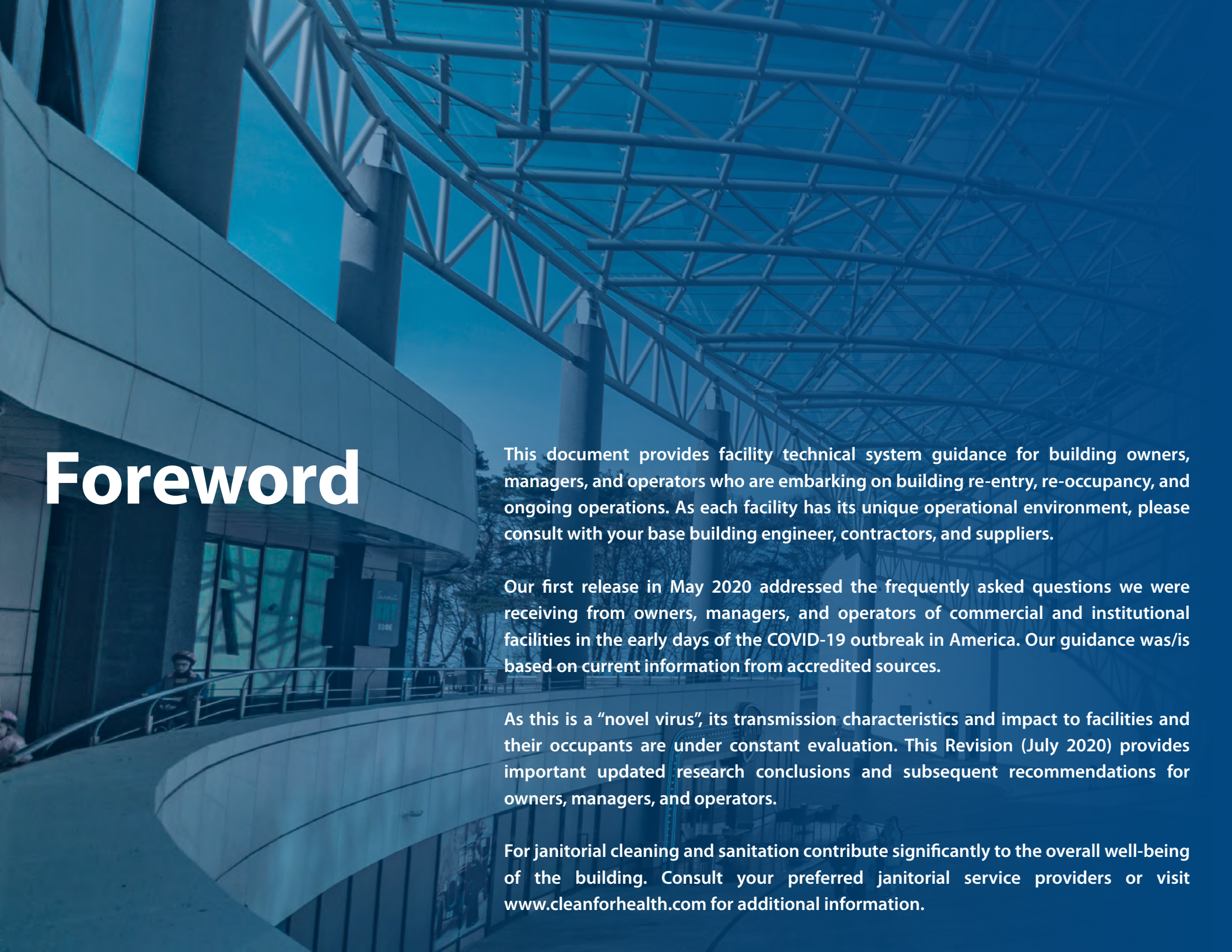
# Workplace Re-Occupancy Planning

OUR LATEST PERSPECTIVE ON THE COVID-19 PANDEMIC

Steve Horwood | Howard Lu

MSCA CONNECT

1ST REVISION//JULY 2020



# Foreword

This document provides facility technical system guidance for building owners, managers, and operators who are embarking on building re-entry, re-occupancy, and ongoing operations. As each facility has its unique operational environment, please consult with your base building engineer, contractors, and suppliers.

Our first release in May 2020 addressed the frequently asked questions we were receiving from owners, managers, and operators of commercial and institutional facilities in the early days of the COVID-19 outbreak in America. Our guidance was/is based on current information from accredited sources.

As this is a "novel virus", its transmission characteristics and impact to facilities and their occupants are under constant evaluation. This Revision (July 2020) provides important updated research conclusions and subsequent recommendations for owners, managers, and operators.

For janitorial cleaning and sanitation contribute significantly to the overall well-being of the building. Consult your preferred janitorial service providers or visit www.cleanforhealth.com for additional information.

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# Executive Summary

By March 15th, 2020, consequences of the COVID-19 pandemic with respect to commercial building occupancy levels impacted most North American communities. Government policies stipulated business operations closures & restrictions as a means of "flattening the curve" to community transmission. Also, businesses have implemented additional measures on their own accord.

Prior to and during ongoing re-occupancy of your building, we recommend you create a strategic plan that includes the following:

1. **Measures, programs, and training to make occupants feel safer**
2. **Clear communication with occupants and key stakeholders**
3. **The supply chain for critical items, such as filters, PPE, is confirmed**
4. **Ongoing communication with your essential building system contractors as re-occupancy evolves.**
5. **Access to building operation data (cleaning, HVAC, BAS, Life-services, etc) is available and being validated and acted upon**
6. **Check with legal regarding "force majeure" relief in the contractual obligations.**

> ***In an unprecedented time like this, it is important every member on your building restart team (building operations, engineers, HVAC/BAS contractors) are aligned and supportive of the goal.***

**Steve Horwood,**
Ainsworth

As most occupants transitioned to work-from-home arrangements, building technical systems experienced a decline in their operational requirements. Additionally, these workspace changes have occurred during a seasonal climatic "shoulder period" – typically Spring and Fall when outside temperature swings between 15°C (59°F) to 21°C (70°F) daily. The combination of reduced equipment loads as a result of low occupancy levels, combined with moderating outdoor temperatures suggests that many technical systems listed below have seen little use:

**Mechanical/Electrical/BAS Systems**
**Chilled/condenser water: open/closed loops (cooling towers)**
**All Ventilation and (booster) pumping systems**
**Water, Sanitary Systems, Traps, Sumps**
**Fire Life Safety Systems**
**Elevating Devices**

Operational resiliency and health and safety shall be paramount as you prepare your facility for re-entry and recovering occupancy levels. Building owners, managers, operators, and base building contractors should agree on what activities constitute the most appropriate facility re-start. Facility use, design, age, types of systems, any known issues, and level of ongoing maintenance since March 1st, 2020 will be key considerations.

**Ainsworth** urges owners or managers to collaborate and implement a simple re-start plan for each technical area based on the initial occupancy re-entry level. As building occupancy increases, ongoing discussion is needed to ensure technical systems are responding accordingly to the operational (health, comfort, energy, resilience) requirement.

The physical condition and operation of equipment and services supporting the building should be assessed. We suggest that each of your base building contractors conduct what is considered their more robust level of preventative and predictive maintenance routines as preparation for re-entry. All tasks do not necessarily contribute to COVID-19 mitigation measures but should provide the peace of mind and confidence that your key systems can respond and perform well.

Building owners, managers, and operators ask COVID-19 related questions related to their HVAC system. These questions must be addressed with information and facts from accredited sources such as ASHRAE, WHO, and CDC as examples.

To provide a practical and easy-to-follow guideline, this document addresses COVID-19 Frequent Asked Questions (FAQ) about your building re-entry planning.

# Frequently Asked Questions (FAQs)

## Is COVID-19 airborne?

The technical name for the virus caused the COVID-19 disease is SARS-CoV-2, both terms will be used interchangeably throughout the document.

The COVID-19 virus is transmitted in droplet form by infected person's sneezing and coughing. These droplets vary in size, where smaller ones can stay suspended in the air for up to 3 hours [1]. However, no current scientific evidence is suggesting that COVID-19 is technically classified as an aerosol transmitted disease. [2]

Official sources from CDC, US EPA, and WHO state that the COVID-19 disease spreads preliminary through small droplets expelled when an infected person coughs, sneezes, speaks, or sings. These droplets sink to the ground quickly due to their size, however, can potentially infect a healthy person if he/she breathe-in these droplets while still in the air. As of July 10th, 2020, while droplets are still believed to be the primary route of transmission, there have been growing numbers of researches suggested aerosol path is possible. To quote from a recent update from US EPA [2],

"…There is growing evidence that this virus can remain airborne for longer times and further distances than originally thought. In addition to close contact with infected people and contaminated surfaces, there is a possibility that the spread of COVID-19 may also occur via airborne particles in indoor environments…."

WHO also included "Airborne Transmission" in its Scientific Brief on July 9th, 2020 and commented [3],

"…WHO…has been actively discussing and evaluating whether SARS-CoV-2 may also spread through aerosols in the absence of aerosol-generating procedures…".

*(cont. on page 7)*

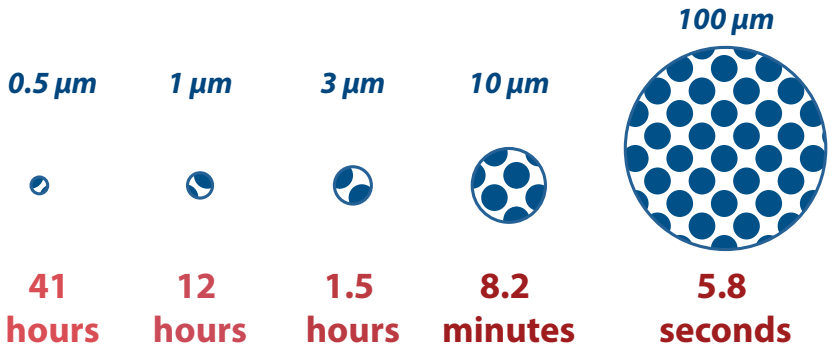
As of July 2020, we do not have any facts on what is the required dose of viable SARSCoV- 2 virus to infect a healthy person, and further studies are required. This is why building owners and managers need to advise everyone to practice social distancing and frequent hand washing as well as avoid touching faces, and through the "do-no-harm" principle, consider best practices measures against aerosol transmission.

## Can the COVID-19 virus circulate within and spread through my HVAC system?

Based on current studies, the COVID-19 virus is being transmitted in droplets where most are too heavy to be circulating within your HVAC return air system [3]. However, Short-range transmission is possible via fomite (touch an infected area then touch eyes/nose) or direct (coughing/sneezing directly into other's eyes/nose) or local air.

Accredited bodies such as **ASHRAE** suggested that building owners and operators to make changes their HVAC system to increase ventilation rate and filtration efficiency [4]. These measures will provide the building owners, managers, and occupants with increased peace of mind.

### *Time to settle 5 feet by unit density spheres*




**Aerodynamic diameter definition:**
diameter of a unit density sphere that settles at the same velocity as the particle in question.

> **"Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, & airconditioning systems, can reduce airborne exposures."**
>
> **ASHRAE Statement on Airborne transmission of SARS-CoV-2**

### PARTICLE SETTLING IN STILL AIR

Studies show typical droplet size is between 5 to 10 um [4], which can stay suspended in the air. Under certain unique conditions, these particles may circulate back to the return air system. With proper filters, the system will capture most of these droplets, which is why it is important to keep your HVAC system running.

As of July 10, 2020, there have been studies discovering traces of SARS-CoV-2 virus RNA throughout the HVAC system in a health care facility with active COVID-19 patients. During these studies, multiple samples were taken from the return air grill of the patient's room to the return air damper before the air entering the mixing chamber, and approximately 25% of the samples taken contains the presence of SARS-CoV-2. [6]

For other buildings, there is still no clear evidence of SARSCoV-2 transmission that is associated with HVAC system air circulation. There is, however, epidemiological evidence that poorly ventilated indoor conditions may have contributed to the transmission of SARS-CoV-2. It is critical for every building owner and manager to focus their effort on maintaining adequate dilution ventilation with outside air and particulate filtration. [7]

## How else can my HVAC system contribute to the spread of the COVID-19 virus?

Supply air is provided through air grills and diffusers that are located throughout the occupied space. Depending on the diffuser design and the characteristics of the airflow, the velocity will vary. A higher velocity of air movement can propel contaminated droplets a further distance resulting in these droplets staying in the air for a longer period.

Occupants practice recommended social distancing may still be subject to droplet exposure under the above-mentioned circumstances. An indication that this situation may exist in your facility is the periodic occupant complaints about drafty air.

An incident report that reflects this condition is documented by the CDC and can be view via the link below for your reference.

https://wwwnc.cdc.gov/eid/article/26/7/20-0764_article

This is one of the incidents that has been widely reported.

Let's look at a typical lunchroom setting. As illustrated in **figure 1,** the air is supplied from one side of the room where the length of the arrow indicates the speed of the airflow. Person #2 is infected with COVID-19 and in this situation, he may spread the virus to person #3, #4, and #5, who are sitting within the recommended social distancing guidelines of 2 meters. The slow supply airflow has minimum impact on propelling the infectious drops beyond the social distancing guideline.

Now, let's look at the same lunchroom with a much stronger supply airflow as illustrated in **figure 2.** The infectious droplets from person #2 may be propelled and travel further to the adjacent tables and potentially infect person #1, #11, #6, #7

This demonstrates the importance of noat only implementing system-wide ventilation and increase filtration measures but understanding how local airflow design can contribute to short-range transmission.

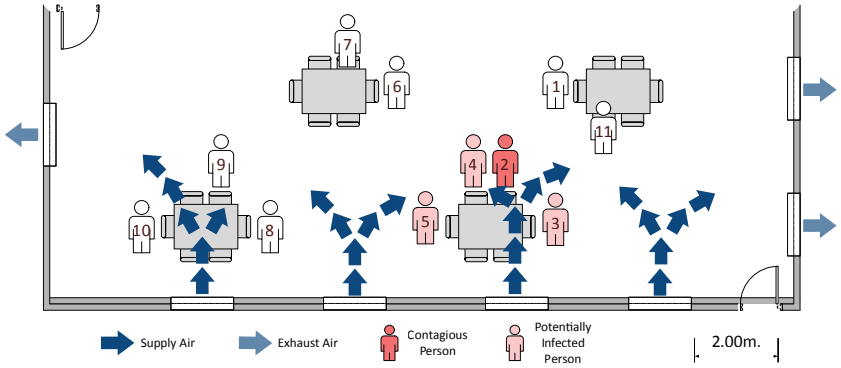



Figure 1

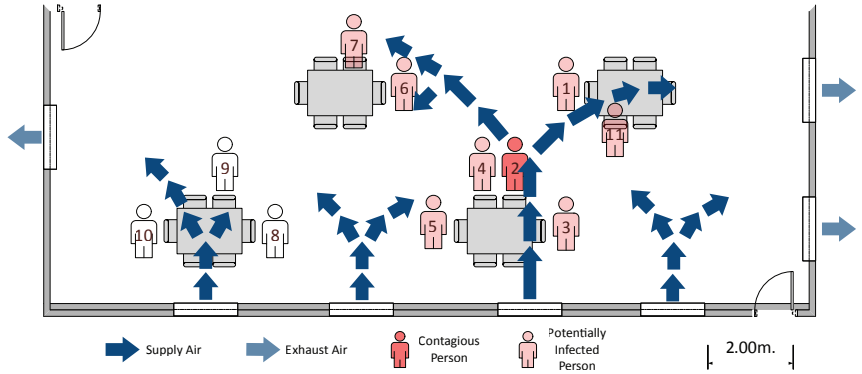



Figure 2

As of July 10, 2020, multiple studies are demonstrating the importance of ventilation. Inappropriate ventilation continues to be a major factor in various superspreader events, such as the Chinese restaurant discussed earlier or the choir practice incident in Seattle where the lack of dilution ventilation was observed.

We strongly encourage building owners and managers to thoroughly inspect all components on their HVAC system to ensure adequate dilution ventilation and particulate filtration. For example, during one of our service inspection, we witnessed dirty coils that disrupt airflow and severely reduce the system air exchange. We recommend all building owners and operators that now is the time to repair and retrofit any outstanding HVAC deficiencies.

Although no cases are suggesting so, some energy wheels may potentially cross-contami-nation between the intake and exhaust air stream. There are many types of energy recov-ery system and some present higher risks than others. We recommend building owners and managers to review and follow the guidance, Practical Guidance for Epidemic Operation of Energy Recovery Ventilation systems [8] by ASHRAE.

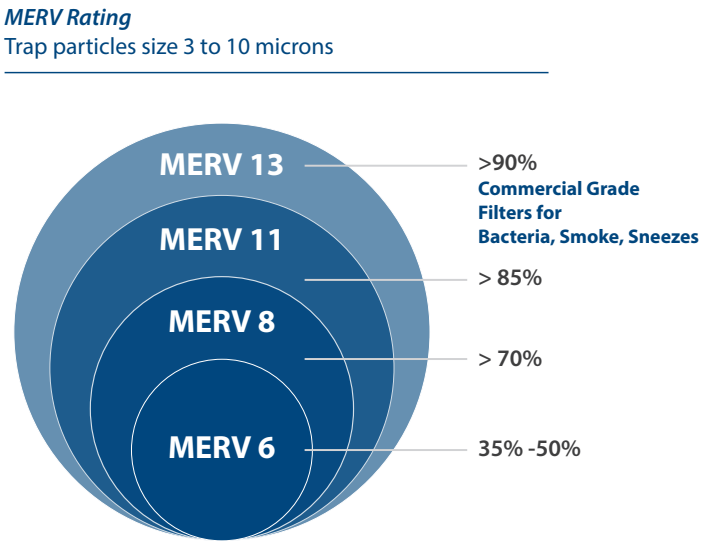
## How should I ventilate my system if we have confirmed cases in our building?

You should modify your system operation to maximize dilution ventilation, such as running the fan continuously for as long as possible and bringing in outdoor air as much as possible. Consider the outdoor air condition (temperature, humidity, and pollution contents) to adjust your ventilation strategy. The best strategy is the combination of increasing ventilation rate and improving filtration efficiency.

*However, you should take the following into consideration:*

- **The capacity of the HVAC system**
- **Impact of outdoor condition to occupant comfort (i.e. on hot and humid days)**
- **Impact on energy consumption**

We recommend you work with your building operation, engineers and HVAC/BAS contractors to modify your system operation. We recommend you make only one or two changes at a time & continue to monitor the impact on building operation and occupant's health and comfort.




## What kind of filter should I be using in my HVAC system?

Based on ASHRAE, the minimum standard of filters for a commercial application is MERV-6, a MERV-8 if your facility is a High-Performance Green Building. For urban buildings where there is PM2.5 in the atmosphere air, the minimum standard is **MERV-11. [4]** Although there is no scientific evidence that the COVID-19 virus is spread through the air in the HVAC system, for additional peace of mind and to mitigate potential future liability, we recommend you to follow a "do-no-harm" principle and use higher-grade filters with MERV-13 rating or above. **Please refer to the MERV Filter Rating chart in Appendix A. [9].**

For quick reference, in Appendix C, we have included ASHRAE's step-by-step guide for increasing MERV rating to assist you while working with your local contractor in accessing the appropriate filter to be used for your system. As of July 10, 2020, there were multiple reports that certain medical procedures (such as tooth drilling) will generate aerosol. We recommend buildings subject to such activities to upgrade filter to MERV-13 or higher.

## What is a HEPA filter and should I be using HEPA filter in my HVAC system?

HEPA is a type of pleated mechanical air filter. It is an acronym for "high-efficiency particulate air". This type of air filter can theoretically remove at least 99.97% of dust, pollen, mold, bacteria, and any airborne particles with a size of 0.3 microns (µm).

The SARS-CoV-2 virus that caused the global COVID-19 pandemic in 2020 has an average size of 0.06 microns to 0.15 micron in diameter. Accordingly, to current evidence by WHO [4], the COVID-19 virus is primarily transmitted through respiratory droplets at a size larger than 5-10 µm in diameter which is much larger than the naked virus itself. [4]

A previous study published in 2013 [10] suggested for recirculation of air through HEPA filters has a marginal benefit and MERV-13 filters can approach the performance of HEPA filters with time. Unless the building is a health care facility with a high risk of COVID cases, we willrecommend using MERV-13 filters.

## So, can my system use a higher rated filter? What should I be looking out for?

As you plan to increase the rating of your filters, not all systems are designed the same. You may run into issues in inadequate airflow, low system pressure, etc. It is recommended that you work with your local contractor reviewing the step-by-step guide in **Appendix B.**

## Q&A Is there an ideal temperature and humidity range that I should try to maintain for occupants to feel comfortable and safe?

Base on various studies [6], coronaviruses thrive in cooler and dryer conditions and the level of space relative humidity (RH) can have tremendous impacts on the air transmission of infectious disease. Researches show that known respiratory illnesses like influenza, the suggested RH range for minimizing airborne transmission is between 40 %rh to 60 %rh. Controlling RH is suggested in the **ASHRAE document [6]** as one of the airborne infection control strategies.

The Canadian seasonal climate can present a challenge for building operator to maintain the minimum recommended RH level of 40 %rh. It is particularly acute when the cold and dry arctic air settles over our communities. Unfortunately, we observed that many facilities overlook and neglect to maintain their (de)humidification systems properly and just left the systems dormant.

We recommend you work with your local contractor to:

> **Ensure (de)humidification system is working properly**
> **Review current system capability for temperature & humidity control**
> **Modification system where possible**

As of July 10, 2020, there has been evidence showing the direct correlation between environmental conditions (temperature and humidity) to the decay of SARS-CoV-2. An airborne decay calculator published by the UnitedStates Homeland Security demonstrated this correlation.

**https://www.dhs.gov/science-and-technology/sars-calculator#**

We recommend you to increase space temperature setpoint to the highest possible and ensure the humidity is properly controlled between 40%rh to 60%rh.

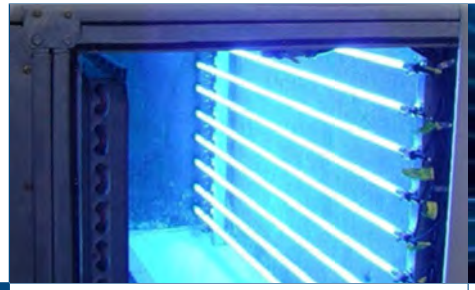
## Is there an easy HVAC reference document I can use with my team?

Yes, we have put together a summary in a one-pager format for you to circulate. **Please refer to Appendix C.**

## I have heard that Ultraviolet Germicidal Irradiation (UVGI) Lamps can be beneficial, is it true?

Our previous questions address various efficiencies of air *filtrations*. The use of UV lights is intended for air *purification.* It is proven scientifically that UVGI lamps kill airborne pathogens that cause allergies and sickness. As it has no dust removal capability, it should be used in conjunction with a good air filtration program. [4]

UV are typically applied in three different ways. Firstly, directly into air stream flowing through ductworks. Secondly, it can be applied to ventilation system surfaces such as inside of the ductwork or coils. And lastly, it can be applied in occupied spaces disinfecting surfaces and air. Depending on existing site conditions, you may deploy any combination of these three options:



| Disinfection | Induct Air | Induct Surface | Space |
|---|---|---|---|
| Installation | In ventilation system/ ductwork, targeting air | In ventilation system next to high-pathogen surfaces, targeting surface | Any space as required, can target both air and surface |
| Consideration | Airflow can limit the effectiveness of UV. | For cooling coils, drain pans, etc. | • Use schedule to accommodate occupancy<br>• Use portable unit if retrofit option is not feasible |

Any UV spectrum can kill or inactivate micro-organisms, but UV-C provides the greatest effect. UV-C does penetrate the outer surfaces of eyes/skin and proper PPE is required to avoid direct exposure. It is important to plan for these health & safety concerns when planning on retrofitting UVGI lamps.

As of July, 2020, there are various studies demonstrating the effectiveness of UVGI on reducing the half-life decay time for SARS-CoV-2. The link shows a surface decay calculator of SARS-CoV-2: **https://www.dhs.gov/science-and-technology/sars-airborne-calculator**

We recommend that building owners and managers work with their service provider to explore the potential of adding room surface UVGI for spaces serving vulnerable occupants. For in-duct surface UVGI application, building owners and managers should know that there is no guarantee tha-tin-duct UVGI will remove all fouling and manual cleaning is still be required.

## What about my plumbing system? What should I pay attention to?

Continue with your existing water risk management plan, and pay extra attention to the following area as your building may be partially occupied before the restart:

- Make sure all plumbing P and U traps are wet and filled with water
- Ensure any fixtures that will not be used by properly shut down and drained.
- Work with your food outlet tenants to confirm if their system was properly shut down and planning for the start-up.
- Inspect and verify the operation of your sumps
- Ensure your domestic water system is running and keep your domestic hot water circulating and operating at a water temperature at about 60 °C.
- If you are uncertain about the performance integrity of your facility or your food services plumbing system, we recommend the following tasks:

### Snake all sewer lines using different cleanouts

Hydro jet (not snake) the main sanitary lines, as determined by the blueprints and confirmed by you and your team.

Camera the lines and provide a full visual report.

### Snake sewer lines connecting to external grease trap

Hydro jet (not snake) the inlet and outlets of the grease traps, as determined by the blueprints and confirmed by you and your team.

Hydro jet (not snake) the main grease line of the grease traps, as determined by the blueprints and confirmed by you and your team.

### Camera the lines and provide a full visual report.

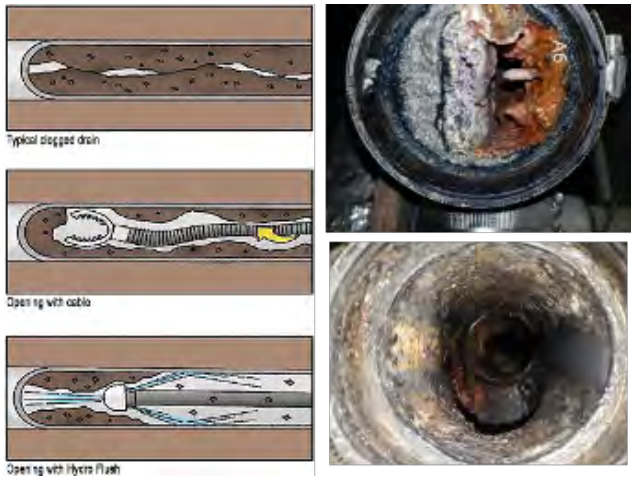
Secure clean-out covers & replace damaged covers

Perform visual inspection with reporting, of all clean-out covers for proper reinstallation, damage, and/or are a trip hazard or are leaking sewer fumes into the building.

Perform visual inspection with reporting, of all sewer traps for cracks due to seals became dry and cracking and are leaking sewer fumes into the building.

Perform visual inspection with eporting, of all accessible floor drains to ensure they are clear from debris and not missing any grates or baskets.

Perform visual inspection with reporting, of the building and basement including mechanical room for any visual issues like leaks, water damage as well as sewer fumes. accessible floor drains to ensure they are clear from debris and not missing any grates or baskets.



As of July 10, 2020, studies from previous SARS-CoV-1 epidemic shown virus could be transmitted through plumbing traps. Although there is no evidence suggesting the same mode of transmission for SARS-CoV-2, we recommend building owners and manager to keep plumbing traps full of water to mitigate such potential risk. [5]

## There is a lot of information about HVAC, how about my electrical system?

You should continue with your existing electrical maintenance program. Your electrical system has been under lighter than the usual load due to the shutdown and cooler weather.

Your electrical system provides power to all essential building systems and now is a good time to review some of your outstanding repair recommendations from previous inspection or IR scan to make sure the system is operating properly and safely.

In many cases, such as HVAC equipment, your electrical load will not increase immediately after the restart but will increase (plug load, AC load, etc) as occupancy slowly return to normal.

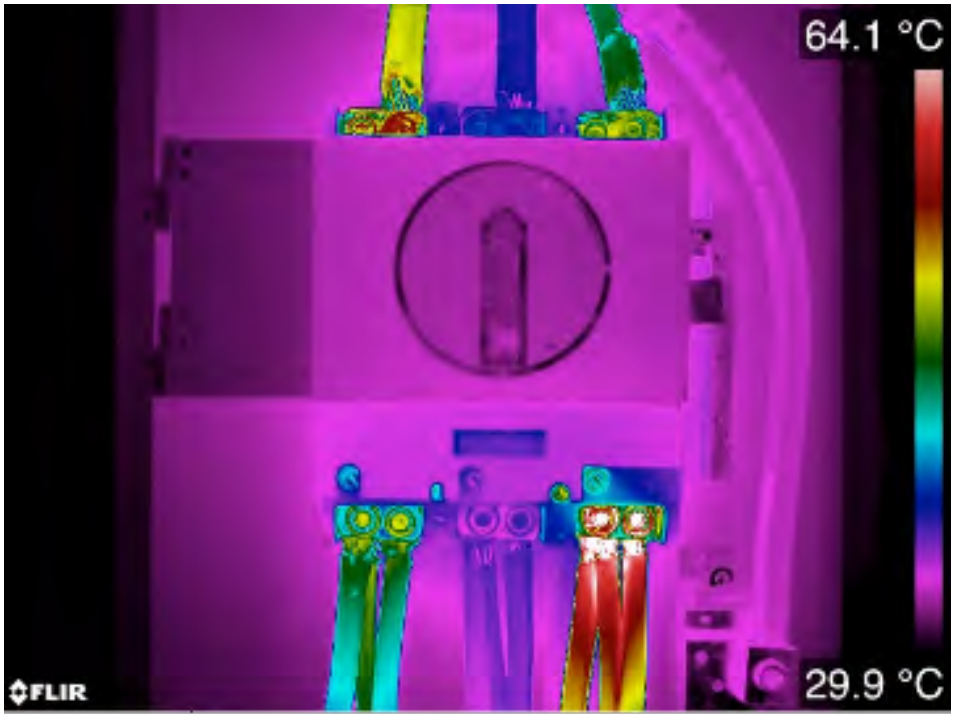
***"Stagger the restart of your heavy power-consuming systems to even out any spike in your electrical demand."***

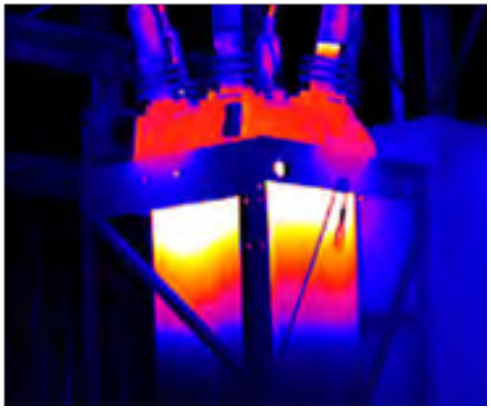
If you have any concern about the performance integrity of your electrical system, consider performing an IR scan to ensure its safety. We recommend you perform an IR scan for your electrical system after all systems operating and building in full operation or 60 days after initial re-occupancy. As an IR scan is one of the most cost-effective predictive measures available, consider increasing the frequency to satisfy risk mitigation.

If your HVAC systems have been off, stagger the start of the units to decrease the initial electrical demand. And make sure that you:

- Ensure that all disconnect switches are in its normal operating position
- Check fuses in all disconnects
- Confirm that all disconnects and starters are in the normal seasonal operation position.

We have prepared an easy-to-follow checklist that focuses on the following building electrical systems for you to use when working with your building operation and contractors. Please refer to **Appendix E.**



## How can I prepare my Building Automation System (BAS) for a building restart?

As we continue to change our building operations to adopt the new normal, building owners who invested in a BAS are starting from a position of strength. We recommend you take the following extra steps in preparation of building restart, in addition t`o your normal BAS maintenance routine:

- Verify and confirm proper control operation of all major equipment such as valves, dampers, pumps, fans, humidifiers, etc. Treat it as re-commissioning if required, consult with your BAS contractor.
- Review your system interface and master alarm list to identify faulty sensors, replace or calibrate as necessary. Pay extra attention to humidity sensors as they are often overlooked.
- Exercise system alarm testing to ensure proper operation of alarm annunciation and notification.
- Verify and confirm the communication integrity of your BAS
- Ensure all trending and archiving are working properly.
- Evaluate data and trending storage capacity, upgrade if necessary
- In addition to your regular system backup strategy, engage your BAS contractor to perform a complete system backup including all controllers and historical trending data.

## How can I leverage my current BAS to assist with ongoing building re-occupancy?

As a novel virus, we continue to study and understand more about the COVID-19 virus every day. In our "new normal", every building operation will be required ongoing adjustments to accommodate the changes in re-occupancy demands. Buildings without BAS can be at a disadvantage as all corrective measures recommended requires building owners possibly sacrifice energy consumption for occupant safety. BAS allows you to leverage the data to continuously optimize to achieve your goals.

Recommended Indoor Air Quality Index

| $CO_2$ | PM | RH | $O_3$ |
|---|---|---|---|
| ~700 ppm | 0.3 µm | 40-60 % | 0.07 ppm max |

Collecting relevant data via your BAS is vital for understanding how your building systems are coping with the demand. When you are collecting and analyzing data, it informs your decision making. We recommend you work with your local BAS contractor to explore the following:

- Where applicable as an outcome of the discussion with your team and BAS contractor, add additional sensors shall provide a broader perspective and deeper understanding. This can be either a new data point or simply additional sensors to increase resilience and accuracy. For example, consider adding additional RH sensors to learn about local RH condition across the floor space, or adding differential pressure sensors to measure the pressure drop across your upgraded filtration.
- Review and exam your temperature and humidity control to ensure the control loop configuration is optimized to accommodate any changes in the HVAC operation (i.e. increased outdoor air intake).
- Set your humidity setpoint to 50 %rh where possible to reduce the air transmission potential of viruses
- Consider prolonging the operating schedule of all ventilation fan to increase dilution ventilation and improve local ventilation
- If available, utilize your **Building Analytics platform** to measure the impact and effectiveness of the "new normal" building operation.
- Discuss with your local control contractor on creating an "epidemic mode" program that initiates pre-determined sets of operating sequences. This mode shall be implemented system-wide with appropriate security, so it is easily initiated by authorized personnel.

As you continue to tweak your HVAC system to increase ventilation rate and improve filter effectiveness, BAS, if available, shall be leveraged to optimize your outcome. Please refer to **Appendix F for a reference breakdown of how BAS can be part of the modified HVAC strategy.**

## How can I further leverage my BAS to maximize overall facility performance during this time and beyond?

As the world recovers from the initial shock of the pandemic, we all need to find a balance between what worked previously and what needs to change to be successful in the new normal. As this shift in practices and perspectives continue to evolve, no one knows what the future may bring us. This is why we need, more than ever before, relevant and accurate data to help us make informed decisions. We want to share with you below, a 4-steps approach to transform your operation and position for success.

### a) Action Driven Data Collection

Having a BAS lays out a solid foundation for you to measure your building performance and collect data for analytics. As you plan on expanding your BAS, we recommend you verify your planning against this five-step approach (figure 5) to ensure that the data you collect always contributes to outcomes with appropriate actions.


### b) Make Informed Decisions with Analytics

Every BAS can collect an enormous amount of data; however, raw data is just individual facts. Only by organizing each independent measurement and then analyzing the structured data set, we can turn data from information to knowledge. A well-deployed building analytical software can help you to gain deep insight into your building operation. We recommend you work with your local BAS provider to discuss the potential of leveraging data analytics to enhance your building operation.

### c) Measure what you want

With or without a BAS, you measure key performance index (KPI) on your building operation regularly, and you believe that these measurements are closely correlated to the final performance outcome. However, too often, we got hung up on what we measure (leading indicators) and forgot to verify the outcome (lagging indicators). The table below shows a few typical KPI we measure versus what we are trying to achieve:

| What is Measured | What is *Really* the Goal |
|---|---|
| Frequency of service on ventilation system (i.e. monthly, quarterly, etc) | Proper IAQ that contributes to the health & well-being of the occupants |
| Frequency of interior surface cleaning (High Touch vs. Low Touch) | Low count of pathogens on surfaces that contributes to the health of the occupants |
| Confirmation of HVAC seasonal service is completed | An energy-efficient operation, minimal risk of failure and optimal longevity of the equipment |
| Frequency of emergency power generator testing | A reliable emergency power source and a well-function life safety system |

Although there is merit to measuring leading indicators, we shall not forget about the lagging indicators which are essentially our end goals. This discrepancy often creates blind spots as we pursue the performance outcome we desire.

We recommend that you review your existing KPI and expand to include any missing indicators by asking yourself the question – what is it you really want? With the goals in mind, you can then work backward to identify any infrastructure requirements such as new analytical algorithms and/or additional data measurement and collection.

### d) Plan Holistically

By creating your goals and leveraging your BAS capabilities, you now have building operation wisdom and insights that informs decision making and validate results. Discuss among your team how you can combine both the hard (HVAC/BAS/Life-Safety, etc) and soft (Cleaning, Leasing, Tenant Relations, etc) performance goals to achieve a integrated building ecosystem dashboard.

# Conclusion

***It's not just about being safe, but also about feeling safe in the new normal.***

When the pandemic struck, there was little time for us to plan our responses. Many communities are now slowly recovering from the initial shock caused by this novel virus and trying to define the new normal. Let's not overlook the human aspect of our recovery planning.

This paradigm shift is not a one-time event and will continue to evolve. We hope this document not only provides some value for your workplace re-entry planning but also a different perspective to help you position your business for future success.

We shall provide a revision to this document as our communities continue our journey in this pandemic.

# References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# Appendix A – MERV Rating Chart

| MERV Rating | Trap particles size 0.03 to 1 microns | Trap particles size 1 to 3 microns | Trap particles size 3 to 10 microns | Typical Application | Notes/ASHRAE Standards |
|---|---|---|---|---|---|
| MERV 1 - 4 | N/A | N/A | < 20% | Fiberglass/Aluminum Mesh filter for Pollen, Dust Mites, Spray Paint, Carpet Fibres | |
| MERV 5 | N/A | N/A | 20% - 35% | Cheap Disposable Filters for Mold Spores, Cooling Dusts, Hair Spray, Furniture Polish | |
| MERV 6 | N/A | N/A | 35% - 50% | | Minimum ASHRAE Standard for Commercial Application (62.1) |
| MERV 7 | N/A | N/A | 50% - 70% | | |
| MERV 8 | N/A | N/A | > 70% | | Minimum ASHRAE Standard for High Performance Green Building Standard (189.1) |
| MERV 9 | N/A | < 50% | > 85% | Better Box Filters for Lead Dust, Flour, Auto Fumes, Welding Fumes | |
| MERV 10 | N/A | 50% - 65% | > 85% | | |
| MERV 11 | N/A | 65% - 80% | > 85% | | Minimum ASHRAE Standard when atmospheric particulate matter is less than 2.5 micrometers, a.k.a. PM2.5 (62.1) |
| MERV 12 | N/A | > 80% | > 90% | | |
| MERV 13 | < 75% | > 90% | > 90% | Commercial Grade Filters for Bacteria, Smoke, Sneezes | |
| MERV 14 | 75% - 85% | > 90% | > 90% | | Recommended by ASHRAE Epidemic Task Force |
| MERV 15 | 85% - 95% | > 90% | > 90% | | |
| MERV 16 | > 95% | > 95% | > 95% | | |
| MERV 17 | 99.97% | N/A | N/A | HEPA & ULPA for Viruses, Carbone Dust | HEPA = High-Efficiency Particulate Air |
| MERV 18 | 99.997% | N/A | N/A | | |
| MERV 19 | 99.9997% | N/A | N/A | | |
| MERV 20 | 99.99997% | N/A | N/A | | |

# Appendix B – ASHRAE's Step Guide for Increasing MERV & Worksheet

Resource: **https://www.ashrae.org/technical-resources/building-readiness#practical**

The following are practical steps an owner can take to evaluate the maximum MERV rating and HVAC system can accommodate while maintaining acceptable system performance:

1. Consider retaining the services of a qualified design professional, a certified commissioning provider (CxP) or a certified testing, adjusting and balancing (TAB) service provider especially for larger, more complex HVAC systems or for systems serving critical buildings or spaces within buildings.
2. If available, gather the documents described above under the System Evaluation section of this document. One of the most valuable documents to have on hand for analyzing filter upgrades would be the original TAB report if the building configuration, use and occupancy has not changed since the building was originally constructed. Consider having readings taken to confirm the values in the TAB report.
3. Determine the manufacturer, size and thickness and MERV rating of the existing filters. For example, 20 inches by 20 inches square, 1-inch thick, MERV 8. Obtain the filter's operating characteristics from the manufacturer or the manufacturer's website.
4. Inspect the filter frames inside the air handling equipment where the filters are installed to determine the filters fit tight within the frames and seals around the perimeter of the frame to minimize any air leakage around the filters (often called bypass air). For most filter frames, it would be wise to add silicone sealant on the upstream and downstream side of the frame as it meets with the AHU wall.
5. With the existing filters installed in the system, have the TAB agent perform and document a complete static pressure and temperature profile of the unit prior to any filter upgrades. This should be done per ASHRAE Standard 111-2008 (RA 2017) - Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation and Air-Conditioning Systems guidance. If the existing filters are dirty, have the TAB agent develop the profile with dirty filters installed, then change to clean filters of the same type as existing and develop a second profile. The profile should also document fan and motor RPM and power supply voltage and amp draw at each condition (old dirty filters, old filter type clean and new filter upgrade).
6. Obtain the airflow pressure drop of the proposed increased filter efficiency (MERV 13 or higher efficiency) and determine the appropriate "dirty filter" setpoint for the new filters. Have the TAB firm insert materials, such as cardboard pieces, to block the existing filters to achieve the upgraded filter dirty setpoint.
7. Have the TAB company develop the unit profile. The profile should also document fan and motor RPM and power supply voltage and amp draw.
8. The team should determine if this is an acceptable temporary operating point for the AHU.
    9. The TAB agent should be able to calculate the changes in airflow caused by the change in filters and determine the percentage reduction in airflow. If the unit's airflow does not drop by more than 5% from the original TAB report airflow, unit discharge temperatures do not drop too low, or the airflow is less than the recommended CFM per ton to potentially cause coil freezing or suction pressure issues in DX equipment, then the filter upgrade may not require any further adjustments to the unit.
    10. If airflow drops to low and causes problems, then have the TAB agent evaluate the fan drive to determine if the fan motor speed may be increased for direct drive fans using variable speed drives or that a sheave change can be made to belt driven fans to get the fan back to its pre-filter change airflow without overloading motor and drive maximum amp ratings.
    11. If the new filter MERV rated filter pressure drop is too great to allow the unit to operate within 95% of the pre-filter change airflow, consider dropping to a lower MERV filter and repeat the process.

12. Once the appropriate new filter MERV level is determined, obtain a set of filters that can be inserted into this unit's filter frame. Change out the existing filters to the new filters and have the TAB agent develop unit profiles with the new filters installed. The TAB agent should be able to calculate the changes in airflow caused by the change in filters and determine the percentage reduction in airflow. If the unit's airflow does not drop by more than 5% from the original TAB report airflow, unit discharge temperatures do not drop too low, or the airflow is less than the recommended CFM per ton to potentially cause coil freezing or suction pressure issues in DX equipment then the filter upgrade may not require any further adjustments to the unit.
13. If it is still desired to upgrade the system to a higher efficiency MERV filtration rate, consider retaining a licensed design professional to size and select new fans and motors and/or new air handler to perform to pre-filter change performance criteria with the new filter upgrade pressure drop increase. Have the engineer consider increased static pressure loads on the unitwith both clean and dirty filters.
14. If an increase in filter MERV level can be accommodated using the existing air handling equipment fans and motors, consider using portable HEPA filter units in high occupancy or high bioburden (such as the building entry) spaces.

| | | |
|---|---|---|
| **HVAC Contractor** | Name | |
| | Contact | |
| | Phone/Email | |
| **BAS Contractor** | Name | |
| | Contact | |
| | Phone/Email | |
| **Air Balancer** | Name | |
| | Contact | |
| | Phone/Email | |
| **Base Building Engineer** | Name | |
| | Contact | |
| | Phone/Email | |
| **Base Building Commissioning Agent** | Name | |
| | Contact | |
| | Phone/Email | |

## Available Documentations

| Electrical As-built | HVAC As-built | Manufacturer Manual | BAS Schematic | BAS Points list | Air Balancing Report |
|---|---|---|---|---|---|
| | | | | | |

## Notes

## Existing Filter

Make: | Model:

| Size | Thickness | MERV |
|---|---|---|
| | | |

| Dirty | | | Clean | | |
|---|---|---|---|---|---|
| **ΔP Setpoint** | **ΔP Actual** | **Supply CFM** | **ΔP Setpoint** | **ΔP Actual** | **Supply CFM** |
| | | | | | |
| **Motor RPM** | **Voltage** | **Amp** | **Motor RPM** | **Voltage** | **Amp** |
| | | | | | |

## New Filter

Make: | Model:

| Size | Thickness | MERV |
|---|---|---|
| | | |

| Dirty | | | Clean | | |
|---|---|---|---|---|---|
| **ΔP Setpoint** | **ΔP Actual** | **Supply CFM** | **ΔP Setpoint** | **ΔP Actual** | **Supply CFM** |
| | | | | | |
| **Motor RPM** | **Voltage** | **Amp** | **Motor RPM** | **Voltage** | **Amp** |
| | | | | | |

# Appendix C – HVAC/BAS One Pager

| | On Startup | On Going Operation | Maintenance & Other Consideration |
|---|---|---|---|
| **HVAC Ventilation** | • Increase fresh air make up level to a maximum extent possible for 24 hours prior to the re-entry of the building<br>• Confirm the building is operating under positive pressure<br>• Review all outstanding repair recommendation<br>• Ensure your system capability and control strategies aligned with the occupancy plan | • Use demand ventilation with caution<br>• Consult engineers/contractors in the use of occupancy data to establish appropriate ventilation strategy<br>• Identify areas of poor ventilation or inappropriate pressure<br>• Review and adapt new Building Automation sequence of operation as required<br>• Larger & heavier droplets and particulates do not normally circulate back within the HVAC system<br>• However, if present in an occupied space, the supply air stream from the diffusers may push these larger/heavier droplets beyond than the recommend social distancing space. (See study by WHO)<br>• Consult with your operations and contractor/engineers for further system review | • Complete manufacturer's recommended spring start-up<br>• As addition health precaution, clean cooling tower components, and review water treatment operation<br>• Clean all evaporator coils<br>• Conduct periodic visual inspection of the system to ensure cleanliness<br>• If applicable, make sure your BAS data and capability is leveraged to inform decision making and maximize performance<br>• Increase ventilation will increase energy cost, consult with engineers to understand the impact<br>• Increase ventilation will increase system run-time and component wear/tear |
| **HVAC System Filtration** | • MERV 8 filter is currently the minimum standard. MERV13+ is recommended for effectively capturing air bourn viruses based on ASHRAE<br>• Check the specification of ventilation unit for use of highest rating filter possible. Area impacted may include,<br>o Static pressure in the system<br>o Reduced supply air flow<br>• Add additional differential pressure sensors or make sure existing differential pressure across filter is operating properly<br>• Review with operation, contractors and engineers to increase supply air flow in compensate for higher efficiency filter | • Consider changing filters after the initial re-entry period and ventilation flush.<br>• Continuing verification that filter selection meets operation requirement<br>• Modify filter change schedule as required<br>• Maintain extra stock on site<br>• Stock up additional PPE on site for protection of workers changing filters | • Ensure the proper fit of filters (minimize blowby)<br>• Not all same MERV filters are constructed equally. Speak with your contractors about the quality of the product<br>• Do not use compressed air around used filters<br>• Consult with your operations, contractors and engineers for the applicability of air purification of using UV-A/B/C |
| **Temperature /Humidity** | • In theory, the optimal environment to reduce the survival of airborne influenza virus may be above 30°C (86°F) at 50%RH, but it is not practical in general occupied environment<br>• Please review links provided below this table for more detail information<br>• Understanding your current operation setup. (i.e. do you have (de)-humidification system?)<br>• Verify existing humidity system & control is working properly | • Multiple sources sight an optimal operating humidity level between 35 - 55%RH<br>• Pay close attention to the operating performance as occupancy and ambient condition change<br>• Continue with regular review to understand your system's capability and attaining to the best operating result<br>• | • Enforce the proper maintenance and service routine based on manufacturer's recommendation on your (de)humidification systems<br>• Maintaining comfortable environment on hot & humid days will be a challenge as you increase outside air intake |
| **BAS** | • Inspect & calibrate all sensors if they have not be recently serviced<br>• Confirm operation of all trend log<br>• Confirm operation and capacity of all archiving<br>• Confirm operation of control loops on all major systems<br>• Complete a full backup of all database, programming, graphics and trending | • Modify control programming as required for new HVAC sequence<br>• Create additional alarming parameter to monitor the effectiveness and performance of the new HVAC sequence<br>• Create a system wide "epidemic mode" command that allows a one-click activation of all COVID-19 related HVAC sequence<br>• Consider engaging remote support if not already supported by your BAS provider | • Engage building analytics software to gain further insights on the system<br>• Continue with your regular BAS maintenance routine<br>• Periodically verify and optimize control loop to ensure its performance |

# Appendix D – A Must & Better Approach to HVAC Measures

| Measures | Must | Better |
|---|---|---|
| Increase Outdoor Air Intake (Dilution Ventilation) | Manually open outdoor air damper further, closely monitor occupant comfort and system performance | Use your BAS control to maximize dilution ventilation based on outdoor condition and HVAC equipment capabilities |
| Increase Filtration Efficiency | Periodically visually inspect filter performance and pressure drops across the filter to determine if filter change is required | Install proper airflow stations with pressure sensors to monitor the supply airflow and pressure drops across filters. Create appropriate algorithms and alarm for the new filtration capability |
| Increase Ventilation | Revised ventilation unit schedule | Implement occupancy counter with BAS to determine the proper schedule |
| Exhaust (Purge) Indoor Air | Manually run all exhaust fans and close all return air passages | Program BAS to have a “building purge” that automatically puts the building in exhaust mode |
| Connecting building performance to occupant health & comfort | Periodically engage occupants to gather feedback on comfort and health | Install distributed space environment sensors to measure Indoor Environmental Quality. Use analytics to predict potential issues and validate performance |

# Appendix E - Electrical System Check List

## HVAC system

- ☐ Ensure that all disconnect switches are in its normal operating position
- ☐ Check fuses in all disconnects
- ☐ Confirm that all disconnects, and starters are in the normal seasonal operation position

## Electrical Rooms

- ☐ Conduct a visual inspection of each room.
- ☐ Visually inspect each panel (lighting, distribution, etc.) for tripped breakers and ensure that all breakers are in its normal operating position.
- ☐ Look for any indication of water entry, rodents, etc.
- ☐ Ensure that there is clear access to the room and no obstructions to access panels
- ☐ Ensure that all disconnects switches are in its normal operating position
- ☐ Confirm the operation of building transformers with observation of heat and humming sound

## Outdoors

- ☐ Verify the integrity of security fences or other enclosures
- ☐ Visual inspection on any oil leaks from the transformers

## Lighting

- ☐ Visually inspect indoor lighting operation in all areas as lamps or ballast may be out
- ☐ If applicable, confirm lighting control operation such as schedule or operation and day light savings if applicable.
- ☐ Check private offices and meeting rooms for any manual light switches
- ☐ Confirm all stairwell and garage lightings are operational
- ☐ Confirm all signage are operational
- ☐ Confirm that all accent lighting, soffit lighting, etc. are operational
- ☐ Confirm all washroom lighting are operational
- ☐ Confirm all motion activated washroom fixtures are operational
- ☐ Confirm all emergency lights are operational

## Emergency Back-up power

- ☐ Conduct your regular battery testing routine to verify function and operating capacity of any battery packs
- ☐ Check battery charge, oil level, grounding and circuits
  Turn off any block heater
- ☐ Conduct your regular generator testing to verify function and capacity
- ☐ Conduct your regular Automatic Transfer Switch (ATS) testing to verify operation

## Other Inspections

- ☐ Engage with all speciality system contractors (fire alarm, security, elevator, BAS, etc) to confirm the electrical power supply is normal
- ☐ Remind your tenant to verify the operation of their Audio-Visual system

## Appendix F – Technical Resource

| Resource | Link | Note |
|---|---|---|
| ASHRAE Technical Resource on COVID-19 | https://www.ashrae.org/covid19 | A comprehensive resource sites with everything from ASHRAE |
| CDC Resource | https://www.cdc.gov/coronavirus/2019-ncov | CDC Resource on COVID-19 |
| Canada Government | https://www.canada.ca/covid-19/ | Resource from the Canadian Government on COVID-19 |
| COVID-19 Canadian Outbreak Tracker | https://bit.ly/caCovidTracker | A dashboard tracking the COVID-19 outbreak in Canada by Esri Canada |
| W.H.O. COVID-19 Pandemic | https://www.who.int/emergencies/diseases/novel-coronavirus-2019 | Resources from the World Health Organization |
| Harvard Medical School COVID-19 Resource Centre | https://www.health.harvard.edu/diseases-and-conditions/coronavirus-resource-center | Some informative reports and research summaries |
| CDC Guidelines | https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html | Guideline for businesses and employers responding to COVID-19 |


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