

ISHRAE
COVID-19 Guidance Document
for Air Conditioning and
Ventilation

“ How to operate air conditioning and ventilation systems to control spread of coronavirus disease (COVID-19) in Residences, Workspaces and Healthcare Facilities. ”

Preface

On 11th February 2020, the International Committee on Taxonomy of Viruses (ICTV) announced "severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)" as the name of the virus that has caused the new disease COVID-19.

A month later, the World Health Organisation made an assessment and announced the disease to be a pandemic. COVID-19 has led to severe global socio-economic disruption impacting millions around the globe.

India, with the rest of the world is facing the adverse effects of COVID-19. Concerns have been raised about the likelihood of the spread of the disease through operation of Air-conditioning and Ventilation Systems. Infectious diseases can spread by several different routes including transmission through air. The questions being asked are whether their spread can be accelerated or controlled by heating, ventilating, air-conditioning and refrigeration (HVACR) systems, depending on how the system is designed and operated.

To put a **comprehensive guideline** together, a COVID-19 Task Force was set up by **ISHRAE's Technical Committee**. This Guideline has been prepared after a detailed study and analysis of information and literature available till date.

ISHRAE recommends that all facilities operated with air conditioning and ventilation, on the Indian Sub Continent, follow this guideline.

In preparing this document, the COVID-19 Task Force has extracted, examined, analysed and compiled information pertaining to the Climatic regions of the Indian Sub Continent. The Team referred to publications in peer reviewed journals and reports from other relevant organizations around the world in arriving at this conclusive guideline.

The COVID-19 Task Force comprises members from academia, designers, manufacturers, service providers and subject matter experts of related sciences such as Filtration, Healthcare Facility design, Indoor Air Quality, Safety, Thermal Comfort, System Design and Operation & Maintenance

I acknowledge the efforts of the Task Force members. This document is ISHRAE's contribution to generate awareness, keep building occupants and service providers safe and win over COVID-19.



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Introduction

The COVID-19 pandemic, commonly known as CORONA has engulfed the world and India is no exception. The COVID-19 virus belongs to the CORONA family to which SARS and MERS also belong. As the COVID-19 virus is still not fully understood, the behavior of SARS and MERS is considered as a reference to the extent they do not contradict the present observations. The COVID-19 virus affects the respiratory track and starts with symptoms similar to the common flu. This virus is a mutated strain and as of today no vaccine is available.

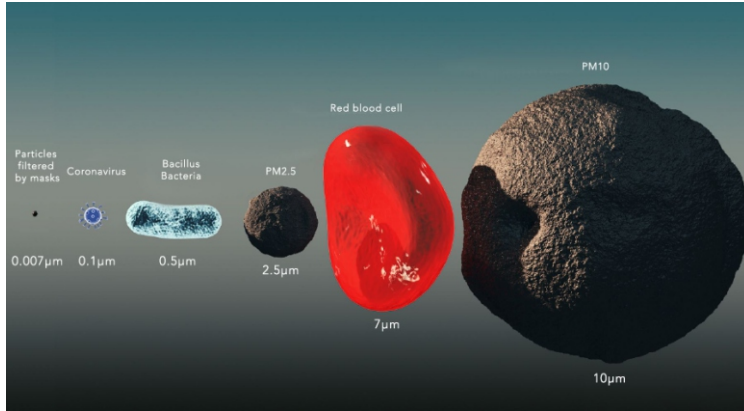


Figure 1 : Size of particle [1]

The COVID-19 infection may result in deteriorating health or a patient's body immunity may resist the infection, but still remain a carrier. Close contact with those who are infected and coughing or sneezing without mask protection can spread the infection. The best prevention as of today is ensuring isolation and distancing from an infected person. The difficult part is the carrier is asymptomatic in the incubation period varying from 7 to 15 days. Most Governments have therefore adopted distancing and isolation to avoid contact by locking down cities and countries to different degrees.

COVID-19 Transmission Routes

The size of a coronavirus particle is in the range of 80-160 nanometers. It is transferred via infected microscopic airborne particles and contaminated aerosol droplets. Droplets and small particles of a broad spectrum of diameters get generated during the course of coughing & sneezing and, to a lesser extent, even by talking and breathing (refer Figure 2, which is indicative).

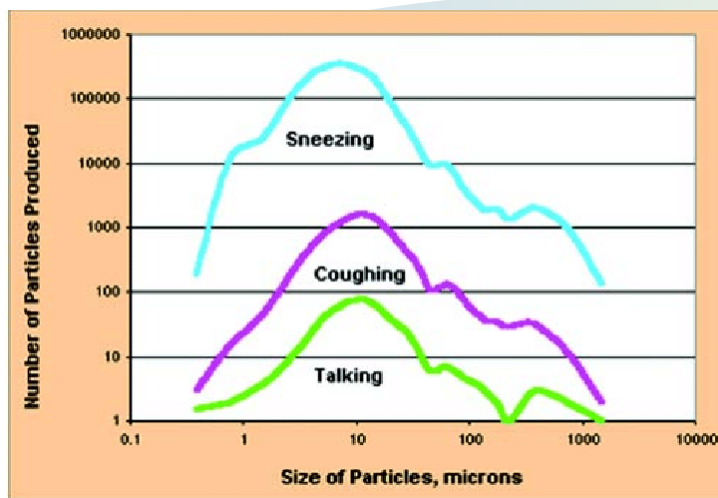


Figure 2- Particles emitted during Talking, Coughing & Sneezing [2]

Most large cough droplets fall on nearby surfaces and objects – such as desks and tables, where they remain active for hours and even 2-3 days. People can get infected by touching those contaminated surfaces or objects; and then touching their eyes, nose or mouth. If people are standing within 1-2 meter of an infected person, they can be infected by breathing-in droplets sneezed or coughed out or exhaled by them.

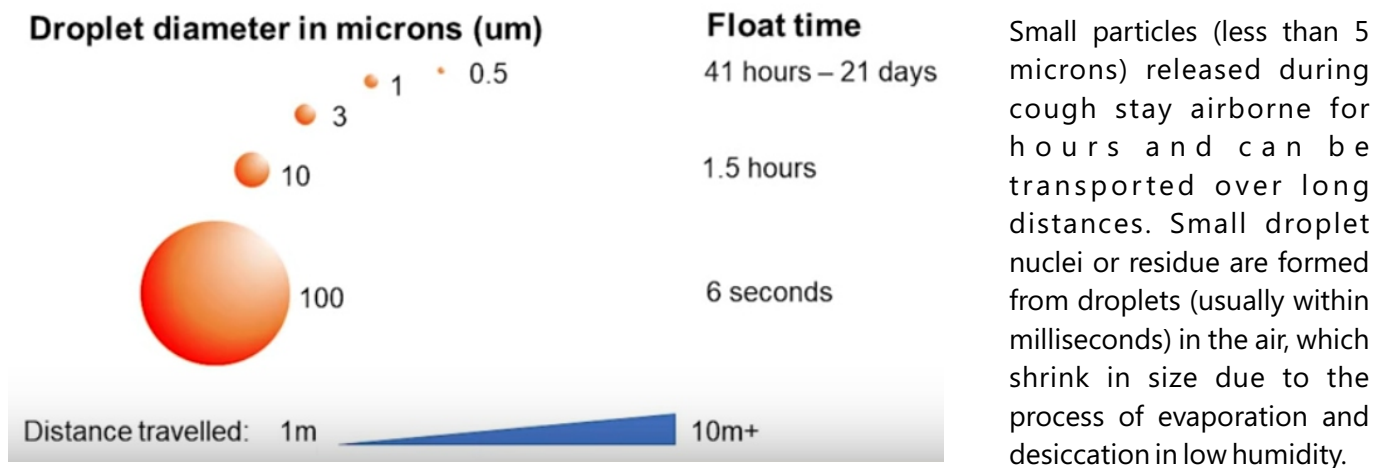


Figure 3- Infectious droplets shrink, travel far and evade surface cleaning when air is dry [3]

It is known that most of the infectious particles ranging from 0.65 to 3.3µm in the cough-generated aerosols were immediately respirable [4]. There is also no reported data or studies to rule out the possibility of the airborne-particle route. One indication for this: Corona virus SARS-CoV-2 has been isolated from swabs taken from exhaust vents in rooms occupied by infected patients.

Apart from cough generated aerosols, the particulates suspended in the air also represents a substrate for viruses and consequently their transmission through this path [5]. In the indoor environment, one of the sources of dust is atmospheric dust (PM2.5 and PM10) coming in through fresh air intakes. The other prominent source is the dust generated by humans and processes. **Reduction of indoor dust levels is a step towards mitigation of this source of COVID-19 transmission.**

The faecal transmission route for SARS-CoV-2 infections is implicitly recognized by WHO. It is known that flushing toilets are creating plumes in the air containing droplets and droplet residue when toilets are flushed with open lids. **This makes it important that with the use of exhaust fans toilet air should not come into the other occupied areas.** If toilet seats are equipped with lids it is recommended to flush the toilets with closed lids in order to minimize the release of droplets and droplet residues from plumes in the air.

Another path for transmission is when virus-laden aerosols are deposited on apparel and on the floor and then get re-suspended into the air due to the movement of people. That is why sanitizing the floors frequently and limiting the movement of people is helpful in curtailing this route of transmission. In healthcare facilities sanitization of apparel is recommended as per protocol [6].

Effect of Environmental Conditions

1. RELATIVE HUMIDITY

Relative humidity is found to affect the infectivity (the ease with which infection can take place) of virus through the respiratory route. The normal human body has excellent protection systems to prevent respiratory infections. There are several layers of filters starting with the mouth and the windpipe. The moist surfaces having mucous layer collect the larger particles before they enter the trachea and pharynx in the upper respiratory tract. In the lower respiratory tract, the bronchi & alveoli can trap smaller particles to various degrees of efficiency.

When we breathe dry air the mucous membrane in the lungs become dry. The fluid over lining the cells becomes more viscous, and the little hairs called cilia, which protect our lungs from deep settling of viable & non-viable particles, cannot work and particles settle more deeply in the lungs. If we consider oxygen & CO₂ transport and the blood, it is only one cell membrane that separates the airspace from the blood. So, if something goes from our lungs into the blood, we get infected.

Moisture in the air is the first arm of our immune system and we now know that our body cannot fight off foreign particles or invaders as adequately as when we're in a dry environment. Further, the infectivity of the bacteria too increases with low humidity. Relative humidity of at least 40% is considered the threshold [7]. Studies indicate that 80% relative humidity and above tend to neutralize the COVID-19 virus. However, too much humidity leads to higher levels of dust mites and fungi, two of the worst culprits for indoor allergy sufferers. Mold and fungi are known to exacerbate respiratory conditions such as asthma.

All things considered, the relative humidity level of 40%~70% is considered to be the most suitable environment for humans & decreases problems from pathogens.

2. TEMPERATURE

Temperature tends to be a factor that directly affects the comfort of building or hospital occupants. Comfort temperature is generally considered between 24 - 30 °C, after accounting for air velocity, relative humidity and clothing. The study of the transmission of COVID-19 virus in 100 cities of China indicates that high temperature and high humidity significantly reduce the transmission of influenza [8].

Studies conducted at various RH levels have shown that using viral culture methods low temperatures (7–8 °C) were optimal for airborne influenza survival, with virus survival decreasing progressively at moderate Temperatures (20.5–24 °C) and further decreases at higher (greater than 30 °C) temperatures [9].

As per some recent studies, SARS-CoV-2 has been found highly stable on surfaces for 14 days at 4 °C; one day at 37 °C and 30 minutes at 56 °C were needed to inactivate the virus [10].

Residential Applications

Residential spaces are cooled by Room Air conditioners, Evaporative Coolers and Fans.

- **Room Air conditioners** control temperature and reduce humidity.
- **Evaporative coolers** are effective in Hot and Dry climates only. They reduce temperature by evaporating water.
- **Fans** provide body comfort by convection and evaporation due to increased air motion.

ROOM AIR CONDITIONERS

Room air conditioners re-circulate air within a single occupied zone. Capacities vary from 1 to 3 TR (Tons of Refrigeration). Installed for a single room application, the entry of occupants into such spaces is controllable.

Recirculation of cool air by Room Air conditioners, must be accompanied by outdoor air intake through slightly open windows and exhaust by natural exfiltration.

Fresh Air intake through a fan filter unit will prevent outdoor dust entry (containing high levels of PM 10 and PM 2.5 particles) and exhaust through kitchen and toilet exhaust fans kept operational.

Set Room Temperature between 24°C and 30°C. Maintain relative humidity between 40% and 70%. (In humid climates set temperature closer to 24°C for de humidification and in dry climates closer to or at 30°C and use fans to increase air movement).

In dry climates, do not allow Relative Humidity to fall below 40%. Water evaporating from a pan kept in the room will increase humidity if it falls below 40%.

EVAPORATIVE COOLERS

Evaporative coolers, often known as **desert coolers** provide effective cooling in Hot and Dry Climates. A Fan draws hot and dry outdoor air over water-saturated pads, causing the water to evaporate and cool the Air. Air leaving the Evaporative Cooler, is up to 15°C cooler than outdoor air, is directed inward.

Most evaporative coolers do not have air filters as original equipment, but they can be fitted to the cooler during or after installation. This is advisable to prevent dust entry and maintain hygiene. Evaporative cooler tanks must be kept clean and disinfected and the water drained and refilled frequently.

Horizontal-flow Evaporative Coolers installed in windows can effectively cool a room or a section of a room. Windows must be kept open to release humid air. Portable evaporative coolers that do not draw outdoor air are not recommended, since their cooling reduces with humidity rising inside the space.

Evaporative coolers must draw air from outside to ensure good ventilation.

FANS

Fans, such as ceiling and Pedestal type, are an inexpensive yet effective method to provide indoor comfort. They increase body comfort by increasing air motion to dissipate heat by convection and evaporation.

Fans should be operated with windows kept partly open. If an exhaust fan is located at a nearby location then it must be kept running to exhaust air for better ventilation.

Commercial and Industrial Facilities

Commercial Establishments and Industrial Facilities have multiple occupancy as well as transient visitors. It is this aspect that necessitates precaution in operating their Air conditioning Systems.

For the purpose of Guidance for operation during a Pandemic like COVID-19, Air Conditioning is **Categorized** based on the **types of Indoor Units installed** :

(These indoor Units may be connected via refrigerant or chilled water pipes to DX Outdoor Units, VRF Outdoor Units or a Chiller)

The best action to limit risk of COVID-19 infection by air is to ventilate indoor environments with outdoor air as much as possible. Mechanical ventilation systems and air conditioning systems, which provide ventilation, can perform this function more effectively than simply opening the windows, because they improve the quality of the outdoor air with filtration.

CATEGORIES OF INDOOR UNITS :

- i) **Multiple Cassette Units:** Ceiling mounted units that can each cool up to 50 sqm and can be controlled individually or as a group.
- ii) **Multiple Hi Wall Units:** Used due to ease of installation and low Cost.
- iii) **Tower Units:** For larger spaces, where most occupants are not stationary thus allowing for higher drafts.
- iv) **Ducted Units:** A mini central Air conditioning system that is easy to operate.
- v) **Fan Coil Units :** Installed in guest rooms, individual office spaces or patient wards.
- vi) **Air Handling Units:** Can provide better ventilation, filtration and Coil disinfecting.

OPERATING GUIDELINES FOR ALL CATEGORIES

- A) **Air Filters must be kept clean as given in the Section** - Operation & Maintenance.
- B) **Provide adequate Ventilation** (Fresh Air and Exhaust).
- C) **Inspect and clean the indoor unit Coils, as given in the Section** - Operation & Maintenance.
- D) **Set Room Temperature between 24°C and 30°C.** Maintain relative humidity between 40% and 70%.
(In humid Climates set temperature closer to 24°C for de-humidification and in Dry Climates closer to or at 30°C Use Fans to increase air movement)
- E) **Heat Recovery Wheel (HRW) :** It is advisable to keep this wheel in off mode to reduce cross contamination. Upon restarting, the wheel must first be sanitized.
- F) **Toilet and Kitchen Exhaust Fans** must be kept in operating mode.

RECOMMENDATIONS FOR CATEGORY I), II) AND III) INDOOR UNITS :

If fresh air is not provided, it is advisable to introduce a fresh air duct attached to a central inline fan filter unit and distribute the fresh air by grilles into the space or near the indoor units. For Cassette Units the fresh air duct may be connected to the available port of the Cassette Unit. In case fresh air cannot be provided through a fan it is recommended to actively use operable windows.

A minimum fresh air volume of 8.5 cum/ hour per person and 1.1 cum/ hour per sq m (5 cfm per person and 0.06 cfm per sq ft) is recommended.

A separate Treated Fresh Air DX Unit may be provided in the case of a multiple unit installation. This will reduce the impact of reducing available cooling capacity by supplying non treated fresh air.

RECOMMENDATIONS FOR CATEGORY IV), V) AND VI) INDOOR UNITS :

Fresh air must be provided by an inlet duct and fan. It is advisable to provide a MERV 13 or higher filter fitted on the Air Handling Unit. If a filter of higher filtering capability is retrofitted into an existing system, care shall be taken to ensure that the fan and motor capacities are adequate to handle the higher pressure drop.

A minimum fresh air volume of 8.5 cum/ hour per person and 1.1 cum/ hour per sq m (5 cfm per person and 0.06 cfm per sq ft) is recommended. The recommendation is to maximize supply of outside air within the limits of the system.

In buildings without mechanical ventilation systems it is recommended to actively use operable windows. Add a TFA (treated fresh air) unit if recommended Fresh Air intake impacts cooling performance. Install UVGI (Ultraviolet germicidal irradiation) for larger Ducted Units and AHUs to keep Coils continuously clean and disinfected. It is advisable to inspect the AHUs and ducts for Air tightness and low leakage.

ADDITIONAL RECOMMENDATIONS FOR INDUSTRIAL FACILITIES

Minimum air changes of around 10-15 ACHP is advised for good ventilation. The mechanical exhaust air shall be 70% to 80% of fresh air quantity to maintain necessary positive pressure in the space.

In cases of evaporative cooling / air washers it is advisable to disinfect the water using UVGI or Ionization or chemical dosing. Run the system in fan only mode for 30-60 minutes every day to dry the cooling pads. Then run only the pumps for water circulation without fans in operation for 30 minutes, to wash out any bacterial growth. Finally flush the water from the tanks and re-start the system with fresh water.

In case of re-circulating system, it is recommended to limit return air circulation. The return air system could be converted to an exhaust system.

The same process must be followed in case evaporative cooling is used for a commercial facility.

Healthcare Facilities

CONVERTING GENERAL PATIENT ROOMS OR ICUs INTO COVID-19 PATIENT AREAS – CONSIDERATIONS PERTAINING TO HVAC SYSTEMS

COVID-19 positive patients and patients with COVID-19 related symptoms are to be accommodated in designated “Airborne Infection Isolation Rooms” in hospitals to control spread of the disease. However due to the surge in the number of such patients, healthcare facilities may not have adequate number of “AII” rooms to accommodate all such patients. Hence, healthcare facilities would need to convert their existing patient rooms or ICUs into COVID-19 patient rooms or COVID-19 ICUs to handle the current pandemic. The most important factor in this scenario is to ensure that the virus laden airborne particles do not leak out of the rooms occupied by COVID-19 patients and also to maintain the concentration of virus laden particles inside the COVID-19 patient room at a minimum. This is required to control the spread of infections and also to protect the healthcare workers.

As it is in normal practice, most of these patient rooms would be served by a HVAC system that would be of a recirculatory type, wherein the air from the room is taken back to the AHU for thermal conditioning and brought back. The same HVAC system could also be connected to a few other areas of the hospital. In some cases, there might be no dedicated return air duct and it could be a ceiling return system. If a COVID-19 patient had to be admitted to such a room, it would present a significant risk of the virus laden particles spreading out from the designated COVID-19 patient rooms.

To convert an existing patient room or ICU into a COVID-19 patient area, it is first necessary to convert the room into a non-recirculatory system (100% once through system) [11, 12]. On an emergency basis, this can be achieved by blanking (blocking) off the return air vents in the COVID-19 patient room. It is important to make sure that the AHU will have provision to receive adequate outdoor air supply. The outdoor air source for the AHU shall not be from within the building and all care shall be taken to avoid intake of outdoor contaminants, to the best possible extent. Additionally, an independent exhaust blower shall be provided to extract the room air and exhaust out into the atmosphere, preferably, after suitable “exhaust air treatment”. The exhaust air quantity shall be greater than the supply air quantity such that a negative pressure of minimum 2.5Pa (preferably >5 Pa) is achieved in the room. It is advisable to install differential pressure meters to measure this metric. The supply air quantity shall be such that it will provide a minimum of 12 air changes per hour. The position of the extract air in the room shall be just above the head of the patient's bed [12].

TREATMENT OF EXHAUST AIR FROM COVID-19 PATIENT AREAS

The exhaust air is most likely to contain particles carrying a viral load and hence a suitable technique should be deployed to prevent the spread of infections. Treatment of exhaust air can be done preferably by HEPA filtration [11]. (HEPA filters shall be tested and certified for performance in accordance to international standards like IEST, EN, ISO, IS etc.). These HEPA filters shall be a minimum of H13 (EN1822-1) filter class or equivalent. When not possible, treatment of exhaust air by Chemical disinfection is acceptable. When both the methods are not viable, the exhaust air shall be let off into the atmosphere through an upward plume at a height of 3 m above the tallest point of the building, thereby lowering the viral load concentrations to insignificant levels by dilution. This exhaust discharge shall be well away from other air intake points and populated places.

When HEPA filters are used to treat the exhaust air, it is preferable to install them at the primary point of air extraction in the room and the exhaust blower shall be at the discharge end of the exhaust duct (where applicable).

Chemical disinfection of the exhaust air from COVID-19 patient room can be done by bubbling the exhaust air through a “Diffused air aerator tank” (preferably of non-metallic material) holding a 1% sodium hypochlorite solution [13, 14, 15]. The concentration shall be checked on a regular basis and dosing undertaken based on need. The aeration tank shall be placed in an unpopulated outdoor area and not inside enclosed space. Suitable PPE shall be used while handling the hypochlorite solution and direct contact with skin and eyes shall be avoided. The above chemical inactivation procedure for treatment of exhaust air is suggested based on the available information at this time.

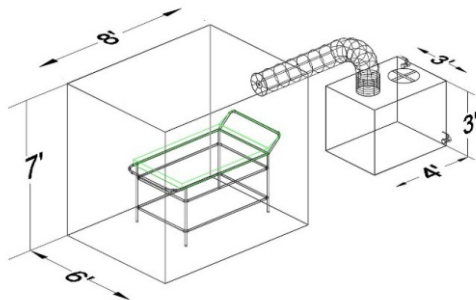
The other two options available for exhaust air treatment being UV irradiation and heating. MER Darnell et al. [16] observed that, an exposure time of 45min at a temperature of 75 °C resulted in complete inactivation of SARS-CoV. Similarly, an UVC (254 nm wavelength) irradiation with an exposure time of 15 minutes at irradiation intensity of 4016 μW/Cm2 resulted in complete inactivation of SARS-CoV.

It is to be noted that the exhaust systems could have viral load deposits, some of which may be active. Therefore, suitable personal and environmental protection protocols shall be followed during any maintenance activity on the exhaust system, for personnel protection and to avoid environmental spill. It may be noted that the treatment of exhaust air by HEPA filtration is the preferred method and the other suggested methods may be adopted due to non-availability of HEPA systems.

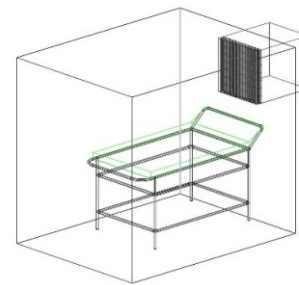
Disinfection of the condensate water from the air conditioning system shall be done as mentioned in the O&M section of this document.

SETTING UP MAKE-SHIFT ISOLATION ENCLOSURES

In resource constrained healthcare settings, several COVID-19 patients may be required to be admitted to a single large room. This presents a significant risk to the health care workers as well as a possibility for environmental spread of virus laden particles. For such instances, a make-shift patient isolation enclosure could provide the necessary protection. This could be a temporary makeshift cubicle or tent constructed out of a skeleton structure (of plastic or metal) and plastic sheet or canvas covering. The tent shall be covered on all sides excepting the front, where PVC strip curtains can be provided. Arrangements for light and a fan inside the tent can be provided for the comfort of the patient, as necessary. The tent shall be provided with an exhaust blower to extract the air inside the enclosure and exhaust out into the atmosphere after suitable treatment. Exhaust air treatment can be done as mentioned earlier. The exhaust blower shall be so sized that a negative pressure of >2.5Pa is maintained inside the enclosure [12].



Isolation enclosure with Chemical disinfection for exhaust air. (Dimensions are only indicative)



Isolation enclosure with HEPA filtration for exhaust air

In case of air-conditioned patient rooms where exhaust blowers cannot be fixed, or in case of patient rooms served by unitary air conditioners, the Isolation enclosure can be installed inside the patient room with HEPA filtered exhaust air. The exhaust air, after HEPA filtration can be discharged inside the room. This provides a localized negative pressure zone inside the room and helps control infection spread and offers protection to the healthcare workers.

QUARANTINE AREAS

Quarantine refers to separation of individuals who are not yet ill, but have been exposed to COVID-19 and therefore have a potential to become ill. Quarantine can happen at home or in quarantine centre, where several such individuals may be under quarantine. In a quarantine situation, it is the physical distancing and avoidance of contact (direct and indirect) transmission that is the key.

A quarantine centre shall be well ventilated and preferably be maintained at a negative or neutral differential pressure. When mechanical ventilation is resorted to, it shall be a once through system (non- recirculatory system) that provides a “clean to dirty” (towards the patient and away to the exhaust) air flow pattern. Care shall be taken to ensure that the exhaust air shall be let discharged into areas that have very less or no human traffic. Rooms with stand-alone air conditioning systems, that do not recirculate the air to the other parts of the building are preferred to be used as quarantine rooms.

Portable Room Air Cleaners

At the outset, it is important to note that a portable air cleaner will only clean the air that passes through the cleaner. The air cleaner will not be able to protect people from direct (droplets) and indirect (surface contamination) exposure but can help reduce the indoor concentration of contaminants through the action of dilution. Thus, over a period of time, the air in a space can be cleansed with the right air cleaners.

There are many technologies used in portable air cleaners. With regards to removing virus and bacteria, specifically, technologies vary from passive filtration to active filtration with all sorts of claims. With any active filtration technology, it is important to ensure the single pass efficiency and the possibility of any harmful by-products that may be released due to the active nature of the cleaning. Some of the technologies used are Ionization, Bi-polar ionization, PCO, ESP, ozone generators etc. The efficacy of some of these is not yet clearly proven and in fact some of these technologies may have contra-indications. UVGI, if deployed correctly has proven to be useful in inactivating bio-aerosols.

Passive technologies include HEPA filtration that can remove particles down to 0.1 micrometers or even smaller particles. An H13 certified or equivalent HEPA filter should be able to remove these viruses from the air that passes through the cleaner.

One must be aware of the number of air changes when installing portable air cleaners in a given space. Ideally, one must design air cleaners with about 3-4 air changes per hour. The higher the air changes, the better the efficiency of cleaning. One must be careful when reading the CADR numbers on most commercial products as they will give either the highest number (based on highest fan speed) which will be very noisy or will give the free-flow air handling capacity of the fan motor (i.e. without filters installed), rather than the actual airflow rate (with all filters installed).

Hence, one must analyze the Air Flow, in Cum per hour (or equivalent CFM) of the unit at different speeds and choose the machine with the right Air Flow, based on room size and fan speed, to ensure proper filtration and comfort, that includes a desired level of quietness.

Operation & Maintenance

These recommendations are limited to operation of HVAC systems during the COVID-19 pandemic (excluding COVID-19 areas in healthcare).

Residential applications : The room may be kept well ventilated during the period of non-use of AC with fans running. As an extra precaution the frequency of service can be increased. It is advisable to clean the indoor unit filters by the end user as per the instruction given in the user manual by the manufacturer. In case there is need to call a technician, it is advisable to call the company authorized technician. Careful evaluation should be done by the customer and the service technician on the nature of breakdown and decide on the repairs location site / workshop. In-case of a major breakdown, it is advisable to request for a replacement machine to have minimum contact time with the technician.

Commercial Applications : Most Commercial establishments have remained closed during the lockdown. These establishments will need maintenance for both Engineering and Health safety. The air-conditioned spaces of establishments under prolonged lockdown will pose health hazards due to fungus and molds in the ducts and open spaces depending on the humidity and temperature prevailing within. Further there may be bird droppings, and excreta of rodents as well increased level of insects. The system not be designed for sufficient fresh air intake and ventilation. The following steps are recommended for the start-up of air conditioning system.

1. The user or the owner should get the area sanitized
2. Study the fresh air and exhaust system adequacy as per the guidelines and inform the user to modify the system if found inadequate.
3. Carry the preventive maintenance on all the units as per manufacturer's guidelines. This should include disinfecting and cleaning of :
 - a. Filters, grilles, diffusers & internal surfaces : it is recommended to use 5% Cresol solution (containing 50% Cresol and 50% Liquid soap solution). Mix 1 liter of this solution in 9 liters of water. The surface shall be sprayed with this solution, left for 10 minutes and then washed / wiped clean with water / cloth. (the above methodology is only for washable filters)
 - b. Condensate drain pan : Disinfecting / treatment of condensate drain pan is suggested using UV treatment or 1% sodium hypochlorite dosing. This will apply only if the HVAC equipment is working on a re-circulatory mode.
 - c. Coils : Follow standard recommendations of coil cleaning and then sanitize using the same protocol as that of the filters specified above
4. In case the area has ducted air distribution, it is advisable to clean the ducts by an appropriate method that may include sanitization.
5. The following process is recommended at start-up :
 - a. Open all the doors and windows of the space.
 - b. Ensure that all cleaning protocols as advised above are complete
 - c. Run the fresh air system at the maximum intake of air setting.
 - d. Start and run the exhaust systems if available.
 - e. Start the air conditioning system in fan mode only, without filters and run it for minimum of two to four hours with doors open and exhaust system operational.
 - f. Install the clean & sanitized filters
 - g. Start the AC in normal mode and run for two hours with doors open and then close the doors and windows.
6. The fresh air and ventilation system should be kept on throughout the off cycle and on the weekend and holidays in air circulation mode.

Guidance For Service Technicians

The safety of service technicians is paramount . The recommendations are as follows:

Do's

- Carry company identity card, authorized letter (during lock-down) .
- Avoid public transport, use personnel vehicle as far as possible. Disinfect the vehicle before and after the visit on daily basis special attention to be given to the handle, steering, gear rod, hand brake, dashboard, seat, seat belt, etc., The driver if accompanying, should stay inside the vehicle, except for essential health breaks & emergency.

- Check for home quarantine stickers/ stamp at the customer's location. Do not enter in case of any such stamp/sticker, and re-schedule the service.
- Maintain social distancing norm and wear a face mask. Avoid personal contact, including handshakes
 - with co-workers /customers
- Carry your own water bottle and food as required.
- Wash hands often for at least 20 seconds using soap. Always carry alcohol-based sanitizer and use whenever hand washing is not possible
- Use prescribed PPE (Personal protection Equipment).
- Carry a sanitary bag of adequate size, to keep the replaced item and dispose safely.
- Follow proper disposal methods for used PPE's (Mask, Gloves, Goggles).
- Monitor your health closely. If you develop symptoms like fever, cough, sore throat, tiredness or shortness of breath, immediately inform the office and take necessary action as advised by the government. Do not continue to work under these circumstances.
- Avoid using of alcohol-based sanitizer, before working with electrical sources.

Don'ts

- Never board unknown persons in the vehicle.
- Never touch the common items provided at the customer place such as newspaper, common towel, etc.
- Never handle other person's belongings or share food and water from others.
- Never use another person's crash helmet or PPE
- Do not hand over one's mobile phone to another person/colleague.
- Do not share the pen especially for service report signature from customer, instead ask the customer to use their own pen.
- Never enter premises which are marked as isolated or quarantined.

ADDITIONAL PRECAUTIONS AT HOSPITALS & LABORATORIES

Do's

- The tools and tackles should be sanitized before and after every visit including the bag.
- Compulsorily wear Surgical nose mask, before entering inside the Hospital, & Laboratory sites. Change the mask every six hours or as soon as it becomes wet.
- All technicians should wear a clean, long-sleeved gown or full body suit, N95 Respirator, gloves, face cover if they need to enter into COVID patient's isolation ward or COVID-19 lab. After exit, dispose the used PPE's into the designated in "RED" color bin.
- Carry a disposable bag of adequate size, to keep the removed/replaced item and disinfect them at suitable location in the hospital premises.
- Barricade the area, while rendering the service to avoid trespassing. For rendering the service outside the conditioned zones such as for chillers, outdoor units, Fresh Air AHUs, cooling towers ensure that the authorities have cleaned and disinfected before the work is started.
- Maintain complete record of the time spent in the premises

Don'ts

- Come in close contact with the patients and visitors in the hospital site.
- Touch bio-hazardous components such as surgical knife, needles and lab equipment's, used cotton and clothes etc.
- Use handrails, touch objects such as lift buttons, door handles and fixtures with your bare hands.

HOW TO DISINFECT TOOLS & TACKLES:

- First, clean the surfaces, removing any contaminants, dust, or debris. You can do this by wiping them with soap water (or a cleaning spray) and a hand towel. Wash towel with soap water.
- Then apply a surface-appropriate disinfectant. The quickest and easiest way to do this is with the following
 - o Disinfecting wipes
 - o Disinfectant spray
 - o Isopropyl alcohol
 - o Hydrogen peroxide

THE PROCEDURE FOR USE OF MASK AND REMOVAL OF GLOVES IS CRITICAL AS GIVEN BELOW [17, 18]

<p>WHEN TO USE A MASK</p> <p>For healthy people wear a mask only if you are taking care of a person with suspected 2019-nCoV infection</p> <p>Wear a mask, if you are coughing or sneezing</p> <p>Masks are effective only when used in combination with frequent hand-cleaning with alcohol-based hand rub or soap and water</p> <p>If you wear a mask then you must know how to use it and dispose of it properly</p> 	<p>HOW TO PUT ON, USE, TAKE OFF AND DISPOSE OF A MASK</p> <p>Before putting on a mask, clean hands with alcohol-based hand rub or soap and water</p> 	<p>HOW TO PUT ON, USE, TAKE OFF AND DISPOSE OF A MASK</p> <p>Cover mouth and nose with mask and make sure there are no gaps between your face and the mask</p> 
<p>HOW TO PUT ON, USE, TAKE OFF AND DISPOSE OF A MASK</p> <p>Avoid touching the mask while using it; if you do, clean your hands with alcohol-based hand rub or soap and water</p> 	<p>HOW TO PUT ON, USE, TAKE OFF AND DISPOSE OF A MASK</p> <p>Replace the mask with a new one as soon as it is damp and do not re-use single-use masks</p> 	<p>HOW TO PUT ON, USE, TAKE OFF AND DISPOSE OF A MASK</p> <p>To remove the mask: remove it from behind (do not touch the front of mask); discard immediately in a closed bin; clean hands with alcohol-based hand rub or soap and water</p> 

CONTAMINATED Glove Removal

1



Pinch and pull cuff of glove. Scoop with finger.

2



Form beak, pulling glove inside out over all fingers and thumb.

3



Pinch opposite glove with beaked hand.

4



Pull glove off.

5



With ungloved hand, slide finger down inside of glove and remove glove.

6



Dispose of removed gloves into appropriate waste receptacle.

IMPORTANT: If blood is visible in body fluids, gloves must be discarded into biohazard bag.

7



Wash hands with soap and running water.

IMPORTANT: Do not touch your face before washing hands!

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The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), was founded in 1981 at New Delhi by a group of eminent HVAC&R professionals. ISHRAE today has over 30,000 HVAC & R professionals and Student -members. ISHRAE operates from 43 Chapters and sub Chapters spread across India with its Head Quarters in Delhi. ISHRAE is led by a team of elected officers, who are members of the Society, working on a voluntary basis, and collectively called the Board of Governors.

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- Advancement of the Arts and Sciences of Heating, Ventilation, Air Conditioning and Refrigeration Engineering and Related Services.
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