State of Qatar
MINISTRY OF PUBLIC HEALTH

GUIDANCE FOR LIFTING RESTRICTIONS IN THE CONTEXT OF COVID-19:

SAFE BUILDING OPERATION OF HVAC SYSTEM GUIDELINES

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Background

Qatar has started to ease its coronavirus restrictions and existing measures. The following guidance is provided to help owners and operators to create a safe indoor environment and prevent the spread of COVID-19.

The indoor air quality (IAQ) has become a public health concern especially during COVID-19 crisis. The urban population spends longer times substantially indoors where dispersal of pollutants may be inadequate. Therefore, exposure to indoor air pollution could be much higher than outdoor air pollution.

Scope of this document

In this document, we summarize advice on the operation and use of building services in areas with a coronavirus (COVID-19) outbreak, in order to prevent the spread of COVID-19 depending on HVAC or plumbing systems related factors.

The suggestions below are meant as an addition to the general guidance for employers and building owners that is presented in the MOPH document "Workplace Guidance COVID-19". The text below is intended primarily for HVAC professionals and facility managers it is useful as well for building owners, occupational and public health specialists. The building related precautions are covered and some common practices to enhance the quality of indoor air in buildings are explained. The scope is limited to commercial and public buildings (e.g. offices, schools, shopping areas, recreational facilities, sport premises, etc.) where only occasional occupancy of infected persons is expected; hospital and healthcare facilities (usually with a larger concentration of infected people) are excluded.

COVID-19 and indoor air quality precautions

Indoor Air Quality (IAQ) refers to the air quality whiten and around buildings and structures, especially as it relates to the health and comfort of building occupants. Understanding and controlling common pollutants indoor can help reduce your risk of indoor health concerns[1]. Improving and periodic maintenance of the quality is beneficial specially and during the COVID-19 crisis. The size of a Coronavirus particle is within 80-160 nanometers, and it remains active in common indoor conditions from 3 hours to several days on room surfaces if no cleaning method has been performed[2]. Practicing physical distancing, cleaning hands frequently and covering the mouth while coughing or sneezing is the first step to control the spread.

Infectious aerosols can be disseminated through buildings by pathways that include air distribution systems. The ventilation and filtration provided by (HVAC) can reduce the airborne concentration of SARS-Cov-2 and thus the risk of transmission through the air. As the COVID-19 continues its global spread, the importance of ensuring healthy indoor air quality is paramount to help lower the curve of infections. Studies have demonstrated higher ventilation rates that have a direct impact on lowering the spread of microbial in spaces[3].

Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus. Non-HVAC measures for breaking the chain of infection, such as effective surface cleaning, contact and isolation precautions mandated by employee and student policies, are effective strategies for reducing the risk of dissemination of infectious aerosol in buildings and transportation environments.

1. https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality
2. https://www.rehva.eu/rehva-journal
3. https://www.ruskin.com/News-Articles/entryid/851/combating-covid-19-with-healthy-ventilation-rates

Transmission routes

Important for every epidemic are the transmission routes of the infectious agent. In relation to COVID-19 the standard assumption is that the following two transmission routes are dominant:

- Via large droplets (droplets/particles emitted when sneezing or coughing or talking).
- Via surface (fomite) contact (hand-hand, hand-surface, etc.).

A third transmission route that is gaining more attention from the scientific community is the faecial-oral route. Aerosol transmission, particularly in these indoor locations where there are crowded and inadequately ventilated spaces where infected persons spend long periods of time with others, cannot be ruled out. More studies are urgently needed to investigate such instances and assess their significance for transmission of COVID-19.

Two exposure mechanisms via air:

A. Close contact transmission through large droplets (> 10 microns), which are released and fall to surfaces not further than about 1-2 m from the infected person. Droplets are formed from coughing and sneezing (sneezing forms many more particles typically).

B. Airborne transmission through small particles (< 5 microns), which may stay airborne for hours and can be transported long distances. These are also generated by coughing, sneezing, and talking. Small particles (droplet nuclei or residue) form from droplets which evaporate (10 microns droplets evaporate in 0.2 sec) and desiccate. The size of a coronavirus particle is 80-160 nanometers, and it remains active for many hours or couple of days (unless there us proper cleaning and disinfection). Airborne transmission for COVID-19 is likely but not yet documented. There is also no reported data or studies to rule out the possibility of the airborne-particle route.

Conclusion in relation to the airborne transmission route

At this date we need all efforts to manage this pandemic from all fronts. Therefore, we propose, especially in "hot spot" areas to use the ALARA principle (As Low As Reasonably Achievable) and to take a set of measures as recommended by MOPH (see: Getting workplace ready for COVID-19).

Practical recommendations for building services operation

1. Increase air supply and exhaust ventilation

A. Extended operation times are recommended: change the clock times of system timers to start ventilation a couple of hours earlier and switch off later than usual.

B. Do not switch off ventilation at nights and weekends but operate at lowered speed and rates.

C. Outside air ventilation rates should be increased to as much as the systems can accommodate (up to 100%), depending on outside climate conditions and the systems' ability to maintain air handling system discharge air conditions, airflow rates, temperature, and humidity conditions necessary in order to maintain good thermal, humidity, and indoor air quality.

D. The general advice is to supply as much outside air as reasonably possible. The key aspect is the amount of fresh air supplied per person (refer to appendix A for more information). By applying the smart working utilization (e.g., working from home), the number of employees will be reduced. While the remaining employees will increase the spacing among them to foster the ventilation cleaning effect.

E. It is recommended to open windows (when possible and safe to do so) more often to boost air exchange rates in buildings that are without mechanical ventilation systems. However, during hot summer, it's not recommended to open the window.

F. Ensure that there is adequate ventilation when cleaners and disinfectants are used to prevent occupants or students from inhaling toxic fumes.

G. Exhaust ventilation systems of toilets should always be kept on 24/7.

2. Humidification and air-conditioning

A. The evidence does not support that moderate humidity (RH 40-60%) will be beneficial in reducing viability of SARS-CoV-2, thus the humidification is not a method to reduce the transmission and spread of the virus. However, while the weight of evidence at this time (Derby et al. 2016), including recent evidance using meta genomic analysis (Taylor and Tasi, 2018), suggests that controlling RH reduces transmission of certain airborne infectious organisms, including some strains of influenza, this document encourages designers to give careful consideration to temperature and RH.

B. In addition, immunobiologists have correlated mid-range humidity levels with improved mammalian immunity against respiratory infections (Taylor and Tasi, 2018). Mousavi et al. (2019) reported that the scientific literature generally reflects the most unfavorable survival for microorganisms when the RH is between 40% and 60%.

3. Safe use of heat recovery sections

A. Under certain conditions virus particles in extract air can re-enter the building. Heat recovery devices may carry over virus attached to particles from the exhaust air side to the supply air side via leaks.

B. Recirculation must be switched to 100% outdoor air and inspect heat recovery equipment to be sure that leakages are under control.

4. No use of recirculation

A. Virus particles in return ducts can also re-enter a building when centralized air handling units are equipped with recirculation systems.

B. Recirculation (return) dampers should be closed (via the Building Management System or manually).

C. Recirculation air filters are not a reason to keep recirculation (return) dampers open as these filters do not filter out particles with viruses effectively since they have standard efficiencies and not HEPA efficiencies.

5. Filters and duct cleaning

A. Considering Qatar's weather conditions, regular cleaning of the filters or changing them when necessary is essential to improve the indoor air quality. Due to using more fresh air led into the building for more ventilation in this pandemic, the amount of dust and debris that enter the building will also increase, which means an intensive cleaning and disinfection should be done regularly.

B. Air filters should be regularly cleaned, and MERV (10-12) air filters must be used. MERV 13 are the preferred choice for the system upgrade. If the system can operate and provide pre-upgrade airflows.

In the event of a significant drop in fan static pressure and the inability to install this grade of filters, the typical bag filters (MERV 10-12) should be cleaned/replaced more frequently. It is recommended to install a separate mobile/fixed unit of filtration in the room to purify the air.

C. Filter frames should be inspected to make sure the filters' mechanical seals are intact and that the filters fit tight on their frames and are sealed to minimize air bypassing/short-circuiting the filters.

D. Add portable room air cleaners with HEPA or high-MERV filters to enhance the delivery rate of clean air.

E. Cleaning procedures and methods should be followed according to the manufacturer's instructions. Air filters maintenance scheme to be followed as indicated by the manufacturer.

F. In the case of using traditional air conditioning units, such as the window units and split units, which provide no fresh outside air, the installation of exhaust fans is recommended to improve the amount of air change per hour (ACH) for each classroom (please refer to appendix A). In case of classrooms are connected to a common corridor, a central exhaust fan with Transfer grilles fixed on each classroom door could be used.

G. Duct inspection and cleaning (if needed) are required to lower the risk of growth of mold or dust build-up inside.

H. For more information, the facility manager should refer to ASHRAE epidemic Taskforce filtration and disinfection | updated 21/10/2021.

6. In Conclusions

- General recommendation is to stay away from crowded and poorly ventilated spaces;
- Applying the smart working utilization (working from home) and ensure the spacing between the employees in the office to increase ventilation is a major key to avoid transmission;
- Ventilation operation times may need to be extended depending on occupancy, it is not recommended to switch ventilation off, but operated at lowered rates.
- Toilet ventilation is recommended to be kept 24/7 in operation.
- Recirculation must be switched to 100% outdoor air and Inspect heat recovery equipment to be sure that leakages are under control.
- Outdoor/indoor air filter cleaning is essential and regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection.

General review of the building's HVAC design and operational practices prior to reopening

- Mechanical systems should operate in occupied mode for a minimum period of one week prior to reopening while assuring the outside air dampers are open to evaluate the system.
- Review HVAC design for potential system modifications.
- Review Modes of operation of HVAC system:
- Sequence of operations

- Setpoints (temperature, Humidity)
- Schedules (Occupied and Unoccupied)
- Verification that equipment and systems are properly functioning and have the enhanced capabilities to address public health considerations, with a focus on buildings with air circulating system.
- Review air distribution conditions of existing spaces (diffusers, registers & grilles).
- Review existing Indoor Air Quality issues, if any, and investigate the status of compliant and address any deficiencies identified.
- General inspection of spaces to identify any potential water leaks or mold growth concerns that could negatively impact occupant health.
- Check filters because dirty filters affect airflow and pressure differentials, change and clean the filters according to their condition and to the manufacturer's instructions.
- Increase the exhaust rate if possible.
- Review outdoor airflow rates compared to the most current version of ASHRAE standard 62.1 or current state-adopted code requirements.
- Check outside air intake regularly for any potential risk such as exhaust nearby, and provide proper clearance. Stop air short circuiting from nearby exhaust systems.

General recommendation on how to operate and maintain HVAC system

- Maintain proper indoor air temperature and humidity to maintain human comfort within 40%-60% RH and from 20- 24 degrees Celsius for temperature.
- Clean or replace existing HVAC air filtration to MERV 10-12 (MERV 13 preferred) or the highest compatible with the filter rack and seal edges of the filter to limit bypass. Make sure the air handling systems and fans can overcome the additional pressure drop of the new filters and still maintain airflow at acceptable levels.
- Maintain equal pressures on all the floors in multi-floor buildings. Maintain slightly positive pressure compared to outside in both single-story and multistory buildings.
- Shut off or seal off using blanks and tape, return air to the central air conditioning systems in the spaces where infected people may be present, and use exhaust fans discharging air directly to the outside away from outdoor public gathering spaces, outdoor air intakes, and operable windows.
- Verify proper separation between outdoor air intakes and exhaust discharge outlets to prevent/limit re-entrainment of potentially contaminated exhaust air.
- Consider having airflows and system capacities reviewed by design professionals to determine if additional ventilation can be provided without adversely impacting equipment performance and building indoor environmental quality.
- Measure building pressure relative to the outdoors. Adjust building air flows to prevent negative pressure differential.

Operation while facility is occupied

1. Measure/trend all information possible, including temperature (dry bulb), relative humidity, carbon dioxide concentration, zone population, etc. (may be done with central building automation system BAS if available; mobile/handheld devices may be used if central monitoring is not available).
2. Follow-up on temperature control, humidity control, or elevated carbon dioxide concentration issues observed to address cause(s).
3. Document any unusual observations other than those that can be recorded by control systems.
4. Share pertinent information between all appropriate groups: maintenance, energy, environmental health & safety, building managers, administrations, etc.
5. Create reporting methodology for tracking and reporting of critical infections.
6. Develop indoor air quality plan as well as maintenance policies for new/added equipment such as local air cleaners, humidifiers, additional filtration in mechanical equipment, etc.
7. Proper and regular cleaning should be performed on filters, and toilets exhaust fans.
8. Identify an area that could be used as an isolation room for suspected cases.

HVAC Maintenance and Filter Replacement during the COVID-19 Pandemic

For HVAC systems suspected to be contaminated with SARS-CoV-2, it is not necessary to suspend HVAC system maintenance, including filter changes, but additional safety precautions are warranted.

- The risks associated with handling filters contaminated with coronaviruses in ventilation systems under field-use conditions have not been evaluated.
- Workers performing maintenance and/or replacing filters on any ventilation system with the potential for viral contamination should wear appropriate personal protective equipment (PPE):
    - A properly fitted respirator (N95 or higher)
    - Eye protection (safety glasses, goggles, or face shield)
    - Disposable gloves
- Consider letting the filter load up further than usual to reduce the frequency of filter changes.
    - Don't let pressure drop increase enough to disrupt room pressure differentials.
    - Confirm filters remain snug in their frames.
- When feasible, filters can be disinfected with 10% bleach solution or another appropriate disinfectant approved for use against SARS-CoV-2 (please refer to the MOPH website for cleaning and disinfection guidance) before removal. Filters (disinfected or not) can be bagged and disposed of in regular trash.
- When maintenance tasks are completed, maintain ace personnel should immediately wash their hands with soap and water or use an alcohol-based hand sanitizer.

Mechanical Air Filters

- Consist of media with porous structures of fibers or stretched membrane material to remove particles from airstreams. Some filters have a static electrical charge applied to the media to increase particle removal. The fraction of particles removed from the air passing through a filter is termed "filter efficiency" and is provided by the Minimum Efficiency Reporting Value (MERV) under standard conditions:
    - MERV ranges from 1 to 16; higher MERV= higher efficiency
    - MERV more than or equal to 13 (or ISO ePM1) are efficient at capturing airborne viruses
    - MERV 14 (or ISO equivalent) filters are preferred
    - High efficiency particulate air (HEPA) filters are more efficient than MERV 16 filters
- Increased filter efficiency generally results in increased pressure drop through the filter. Ensure HVAC systems can handle filter upgrades without negative impacts on pressure differentials and/or airflow rates prior to changing filters.
- Generally, particles with an aerodynamic diameter around 0.3 nanometers are most penetrating; efficiency increases above and below this particle size.
- Overall effectiveness of reducing particle concentrations depends on several factors:
    - Filter efficiency
    - Airflow rate through the filter
    - Size of the particles
    - Location of the filter in the HVAC system or room air cleaner
- For more information, see Appendix B, ASHRAE position document on filtration and air cleaning in.

References

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Appendix

Appendix A: Minimum Ventilation Rates in breathing zone adopted from ASHRAE

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values		
			Occupant Density				
	cfm/ person	L/s· person	cfm/ ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2	Air Class	OS (6.2.6.1.4)
Correctional Facilities							
Booking/waiting	7.5	3.8	0.06	0.3	50	2	
Cell	5	2.5	0.12	0.6	25	2	
Dayroom	5	2.5	0.06	0.3	30	1	
Guard stations	5	2.5	0.06	0.3	15	1	
Educational Facilities							
Art classroom	10	5	0.18	0.9	20	2	
Classrooms (ages 5 to 8)	10	5	0.12	0.6	25	1	
Classrooms (age 9 plus)	10	5	0.12	0.6	35	1	
Computer lab	10	5	0.12	0.6	25	1	
Daycare sickroom	10	5	0.18	0.9	25	3	
Daycare (through age 4)	10	5	0.18	0.9	25	2	
Lecture classroom	7.5	3.8	0.06	0.3	65	1	ü
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3	150	1	ü
Libraries	5	2.5	0.12	0.6	10		
Media center	10	5	0.12	0.6	25	1	
Multiuse assembly	7.5	3.8	0.06	0.3	100	1	ü
Music/theater/dance	10	5	0.06	0.3	35	1	ü
Science laboratories	10	5	0.18	0.9	25	2	

Minimum Ventilation Rates in Breathing Zone (Continued)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values		
			Occupant Density				
	cfm/ per- son	L/s· per- son	cfm/ ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2	Air Class	OS (6.2.6.1.4)
Educational Facilities (continued)							
University/college laboratories	10	5	0.18	0.9	25	2	
Wood/metal shop	10	5	0.18	0.9	20	2	

Food and Beverage Service

Cocktail lounges	7.5	3.8	0.18	0.9	100	2	
Cafeteria/fast-food dining	7.5	3.8	0.18	0.9	100	2	
Kitchen (cooking)	7.5	3.8	0.12	0.6	20	2	
Restaurant dining rooms	7.5	3.8	0.18	0.9	70	2	

Food and Beverage Service, General

Break rooms	5	2.5	0.06	0.3	25	1	ü
Coffee stations	5	2.5	0.06	0.3	20	1	ü
Conference/meeting	5	2.5	0.06	0.3	50	1	ü
Corridors	—	—	0.06	0.3	—	1	ü
Occupiable storage rooms for liquids or gels	5	2.5	0.12	0.6	2	2	

Hotels, Motels, Resorts, Dormitories

Barracks sleeping areas	5	2.5	0.06	0.3	20	1	ü
Bedroom/living room	5	2.5	0.06	0.3	10	1	ü
Laundry rooms, central	5	2.5	0.12	0.6	10	2	
Laundry rooms within dwelling units	5	2.5	0.12	0.6	10	1	
Lobbies/prefunction	7.5	3.8	0.06	0.3	30	1	ü
Multipurpose assembly	5	2.5	0.06	0.3	120	1	ü

Miscellaneous Spaces

Banks or bank lobbies	7.5	3.8	0.06	0.3	15	1	ü
Bank vaults/safe deposit	5	2.5	0.06	0.3	5	2	ü
Computer (not printing)	5	2.5	0.06	0.3	4	1	ü
Freezer and refrigerated spaces (<50°F [10°C])	10	5	0	0	0	2	
Manufacturing where hazardous materials are not used	10	5.0	0.18	0.9	7	2	
Manufacturing where hazardous materials are used (excludes heavy industrial and chemical processes)	10	5.0	0.18	0.9	7	3	
Pharmacy (prep. area)	5	2.5	0.18	0.9	10	2	
Photo studios	5	2.5	0.12	0.6	10	1	
Shipping/receiving	10	5	0.12	0.6	2	2	

Minimum Ventilation Rates in Breathing Zone (Continued)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values Occupant Density	Air Class	OS (6.2.6.1.4)
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2		

Miscellaneous Spaces (continued)

Sorting, packing, light assembly	7.5	3.8	0.12	0.6	7	2	
Telephone closets	—	—	0.00	0.0	—	1	
Transportation waiting	7.5	3.8	0.06	0.3	100	1	ü
Warehouses	10	5	0.06	0.3	—	2	

Office Buildings

Breakrooms	5	2.5	0.12	0.6	50	1	
Main entry lobbies	5	2.5	0.06	0.3	10	1	ü
Occupiable storage rooms for dry materials	5	2.5	0.06	0.3	2	1	
Office space	5	2.5	0.06	0.3	5	1	ü
Reception areas	5	2.5	0.06	0.3	30	1	ü
Telephone/data entry	5	2.5	0.06	0.3	60	1	ü

Outpatient Health Care Facilities [a,b]

Birthing room	10	5	0.18	0.9	15	2	
Class 1 imaging rooms	5	2.5	0.12	0.6	5	1	
Dental operatory	10	5	0.18	0.9	20	1	
General examination room	7.5	3.8	0.12	0.6	20	1	
Other dental treatment areas	5	2.5	0.06	0.3	5	1	
Physical therapy exercise area	20	10	0.18	0.9	7	2	
Physical therapy individual room	10	5	0.06	0.3	20	1	
Physical therapeutic pool area	—	—	0.48	2.4	—	2	
Prosthetics and orthotics room	10	5	0.18	0.9	20	1	
Psychiatric consultation room	5	2.5	0.06	0.3	20	1	
Psychiatric examination room	5	2.5	0.06	0.3	20	1	
Psychiatric group room	5	2.5	0.06	0.3	50	1	
Psychiatric seclusion room	10	5	0.06	0.3	5	1	
Speech therapy room	5	2.5	0.06	0.3	20	1	
Urgent care examination room	7.5	3.8	0.12	0.6	20	1	
Urgent care observation room	5	2.5	0.06	0.3	20	1	
Urgent care treatment room	7.5	3.8	0.18	0.9	20	1	
Urgent care triage room	10	5	0.18	0.9	20	1	

Minimum Ventilation Rates in Breathing Zone (Continued)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values	Air Class	OS (6.2.6.1.4)
					Occupant Density		
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2		

Public Assembly Spaces

Auditorium seating area	5	2.5	0.06	0.3	150	1	ü
Courtrooms	5	2.5	0.06	0.3	70	1	ü
Legislative chambers	5	2.5	0.06	0.3	50	1	ü
Libraries	5	2.5	0.12	0.6	10	1	
Lobbies	5	2.5	0.06	0.3	150	1	ü
Museums (children's)	7.5	3.8	0.12	0.6	40	1	
Museums/galleries	7.5	3.8	0.06	0.3	40	1	ü
Places of religious worship	5	2.5	0.06	0.3	120	1	ü

Retail

Sales (except as below)	7.5	3.8	0.12	0.6	15	2	
Barbershop	7.5	3.8	0.06	0.3	25	2	ü
Beauty and nail salons	20	10	0.12	0.6	25	2	
Coin-operated laundries	7.5	3.8	0.12	0.6	20	2	
Mall common areas	7.5	3.8	0.06	0.3	40	1	ü
Pet shops (animal areas)	7.5	3.8	0.18	0.9	10	2	
Supermarket	7.5	3.8	0.06	0.3	8	1	ü

Sports and Entertainment

Bowling alley (seating)	10	5	0.12	0.6	40	1	
Gym, sports arena (play area)	20	10	0.18	0.9	7	2	
Health club/aerobics room	20	10	0.06	0.3	40	2	
Health club/weight rooms	20	10	0.06	0.3	10	2	
Spectator areas	7.5	3.8	0.06	0.3	150	1	ü
Stages, studios	10	5	0.06	0.3	70	1	ü
Swimming (pool and deck)	—	—	0.48	2.4	—	2	

Transient Residential

Common corridors	—	—	0.06	0.3		1	ü
Dwelling unit	5	2.5	0.06	0.3	F	1	ü

CFM = Cubic Feet per Minute, L/S = Liters Per Second , ft^2 = square feet, Ra = outdoor airflow rate required per unit, Rp

=outdoor airflow rate required per person

Appendix B ; ASHRAE position document on filtration and air cleaning

MERV and application Guidelines:

Std. 52.2 Minimum Efficiency Reporting Value(MERV)	Application Guideline:		
	Typical Controlled Contaminant	Typical Application: and Limination:	Typical Air Filter/ Cleaner Type
16 15 14 13	0.30 to 1.0 µm Particle Size All bacteria Most tobacco smoke Droplet nuclei (sneeze) Cooking oil Most smoke Insecticide dust Copier toner Most face powder Most paint pigments	Hospital inpatient care, General surgery, Smoking lounges, Superior commercial buildings	Bag Filters Nonsupported (flexible) microfine fiberglass or synthetic media. 300 to 900mm(12 to 36in) deep, 6 to 12 pockets. Box Filteres, Rigid style cartridge filters 150 to 300mm (6 to 12in.) deep may use lofted (air laid) or paper (wet laid) media.
12 11	1.0 to 3.0 µm Particle Size Legionella Humidifier dust Lead dust	Superior residential Better commercial buildings Hospital laboratories	Bag Filters Nonsupported (flaxible) microfine fiberglass or synthetic media. 300 to 900mm (12 pockets. Box Filters Rigid style cartridge filters 150 to 300mm (6 to 12in) deep may use lofted (air laid) or paper (wet laid) media.
10 9	Milled Flour Coal dust Auto emissions Nebulizer drops Welding fumes		

8 7 6 5	3.0 to 10.0 µm Spores Hair spray Fabric protector Dusting aids Cement dust Pudding mix Snuff Powdered milk	Commercial buildings Better residential Industrial workplaces Paint booth inlet air	Pleated Filters: Disposable, extended surface, 25 to 125mm (1to 5in) thick with cotton-polyester blend media, cardboard frame. Cartridge Filters: Graded density viscous coated cube or pocket filters, synthetic media. Throwaway: Disposable synthetic media panel filters.
4 3 2 1	> 10.0 µm Particle Size Pollen Spanish moss Dust mites Sanding dust Spray paint dust Textile fibers Carpet fibers	Minimum filtration Residential Window air conditioners	Throwaway: Disposable fiberglass or synthetic panel filters Washable Aluminium mesh, latex coated animal hair or fram rubber panel filters Electrostatic Self charging (passive) woven polyearbonate panel filer

MERV Rating	Air Filter will trap Air Particles size .3 to 1.0 mictrons	Air Filter will trap Air Particles size 1.0 to 3.0 microns	Air Filter will trap Air Particles size 3 to 10 microns	Filter Type Removes These Particles
MERV 1	<20%	<20%	<20%	Fiberglass & Aluminum Mesh
MERV 2	<20%	<20%	<20%	
MERV 3	<20%	<20%	<20%	Pollen, Dust Mites, Spray Paint,
MERV 4	<20%	<20%	<20%	Carpet Fiberes
MERV 5	<20%	<20%	20% to 34%	Cheap Disposable Filters
MERV 6	<20%	<20%	35% to 49%	
MERV 7	<20%	<20%	50% to 69%	Mold Spores, Cooking Dusts,
MERV 8	<20%	<20%	70% to 85%	Hair Spray, Furniture Polish
MERV 9	<20%	Less than 50%	85% or better	Better Home Box Filters
MERV 10	<20%	50% to 64%	85% or better	
MERV 11	<20%	65% to 79%	85% or better	Lead Dust, Flour, Auto
MERV 12	<20%	80% to 90%	90% or better	Fumes, Welding Fumes

MERV 13	Less than 75%	90% or better	90% or better	Superior Commercial Filters
MERV 14	75% to84%	90% or Better	90% or Better	
MERV 15	85% to 94%	90% or Better	90% or Better	Bacteria, Smoke, Sneezes
MERV 16	95% or Better	95% or Better	90% or Better	
MERV 17	99.97%	95% or Better	99% or Better	HEPA & ULPA
MERV 18	99.997%	99% or Better	99% or Better	
MERV 19	99.9997%	99% or Better	99% or Better	Viruses, Carbon Dust, <.30pm
MERV 20	99.99997%	99% or Better	99% or Better	

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High Efficiency Particulate Air (HEPA) Filters

- By definition, true HEPA filters are at least 99.97% efficient at filtering 0.3 µm mass median diameter (MMD) particles in standard tests.
- Most penetrating paticle size may be smaller than 0.3 µm, so filtration efficiency of most penetrating particles can be slighty lower.
- HEPA filter efficiency is better than MERV 16.
- DUE to hight pressure drops, HEPA filters may not be able to retrofitted into HVAC systems.
- To function property, HEPA filters must be sealed properly in filter racks.
- Filters are often delicate and require careful handling to prevent damage and preserve performance.
- HEPA filters can be located in HVAC systems or in:
    - Portable HEPA Air Cleaners
    - Pre-Assembled Systems
    - Ad Hoc Assemblies

Health Protection & Communicable Disease Control Department