The following guidance is developed as healthcare facilities prepare for COVID patients, and is based on input from ASHE, ASHRAE Technical Committee for Healthcare and ASHRAE/ASHE Standard 170 Committee.

This guidance includes personal opinions. ASHRAE and ASHE are not responsible for the use or application of this information.

Please contact Michael.sheerin@tlc-eng.com (Chair ASHRAE Standard 170) with questions.
1. COVID in Perspective

Heavy and Wet DROPLETS

Cough
Sneeze
Talk
Breath
Spit

MORE VIRUS
CLOSE RANGE AEROSOL TRANSMISSION

CAN TAKE SEVERAL MINUTES

LESS VIRUS

Small, Floaty, DROPLET NUCLEI

INFECTED PERSON

VIRUS WITHIN A DROPLET

UNINFECTED PERSON

VIRUS CONTAMINATED SURFACE

Droplet Size

\(~100\mu m\)

\(~50\mu m\)

\(~5\mu m\) (microns)

0m 1m >10m (not to scale)
An annotated diagram showing the location of the AC in the restaurant in Guangzhou, China. CDC EID Journal
Health Facility Operators Took Action

- Based on What Was Known and
- What Was Still Unknown About COVID 19

Prioritization of Controls as Defined by CDC NIOSH
1. Engineering Controls
2. Administrative Measures - Management, Flow and Restrictions of Patients and Staff
3. Personal Protective Equipment
Ventilation Basics

**Increase Outside Air Quantity** – Supplemental Conditioned or Via Economizer Mode As Possible

**Increase Air Changes in Spaces** – Use Control Strategies with Existing Systems

  OR

  - Add Portable HEPA Fan/Filter Machine

**Increase Filtration Levels** – Beneficial AND Necessary with Increased Outside Air Quantities

  AND

  - Increases Air Cleaning of Recirculated Air

**Exhaust Sources of Contaminants** – Reduces/Removes Contaminants from Space
Passive Isolation

As prescribed in CDC Guidance*

**Most Basic Approach**

- One patient per room
- Close the door
- Implement related CDC Safety Protocols

Work with Clinicians, anticipate patient load and establish layered approach as needed

These rooms do not justify negative pressure or 100% exhaust, and are not meant for aerosol generating procedures

Airborne Infectious Isolation Room

- Air changes dilute contaminant level
- Exhaust removes contaminants
- Filtration removes contaminants
- Anteroom preserves pressure relationship

Diagram:
- **SA MERV 14** 260 CFM
- **100 CFM LEAKAGE**
- **EXH 410 CFM**
- **EXH 100 CFM**
- **UP BLAST**
- **EXH FAN MIN 10’ PLUME ON EPS**
- **VAV BOX W/O RHC**

Flowchart:
- **LIGTHS → DP**
- **T**
- **CORRIDOR**
  - 50 CFM NEG
  - 150 CFM
- **ANTEROOM**
  - 10 ACH
- **PATIENT ROOM**
  - 12 ACH
  - 100 CFM
- **RESTROOM**
  - 100 CFM
  - LOW RA
Ventilate the room and terminal clean before re-use

Follow CDC air change **clearance rates**

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**Table B.1. Air changes/hour (ACH) and time required for airborne-contaminant removal by efficiency** *

<table>
<thead>
<tr>
<th>ACH §</th>
<th>Time (mins.) required for removal 99% efficiency</th>
<th>Time (mins.) required for removal 99.9% efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>138</td>
<td>207</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>104</td>
</tr>
<tr>
<td>6⁺</td>
<td>46</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
<td>52</td>
</tr>
<tr>
<td>10⁺</td>
<td>28</td>
<td>41</td>
</tr>
<tr>
<td>12⁺</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>15⁺</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>50</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

*Dilution is the Solution to Pollution!*

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* All values assume a space 5000 square feet in size.
For HVAC Systems serving patient and medical procedure spaces, evaluate improving Central Air and other HVAC filtration from MERV 14 to MERV 16 (ASHRAE 2017b) or the highest level achievable.

**MERV-16 Filters**

- Strongly consider MERV-A, non-degrading, non-electro-static filter for consistent performance.
- MERV 16 is effective in capturing the SARS-CoV-2 virus.
- Dealing with particles in the range of 0.3 to 1.0 micron.
- Certified to filter at least 95% of airborne particles.

**MERV RATING CHART**

<table>
<thead>
<tr>
<th>Standard 52.5 Minimum Efficiency Reporting Value</th>
<th>Dust Spot Efficiency</th>
<th>Arrestance</th>
<th>Typical Controlled Contaminant</th>
<th>Typical Applications and Limitations</th>
<th>Typical Air Filter/Cleaner Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>n/a</td>
<td>n/a</td>
<td>&lt; 0.3 pm particle size</td>
<td>Cleanrooms</td>
<td>&gt;99.99% eff. On .10-.20 pm</td>
</tr>
<tr>
<td>19</td>
<td>n/a</td>
<td>n/a</td>
<td>Virus (unattached)</td>
<td>Radioactive Materials</td>
<td>Particles</td>
</tr>
<tr>
<td>18</td>
<td>n/a</td>
<td>n/a</td>
<td>Carbon Dust</td>
<td>Pharmaceutical Man.</td>
<td>Particulates</td>
</tr>
<tr>
<td>17</td>
<td>n/a</td>
<td>n/a</td>
<td>All Combustion smoke</td>
<td>Carcinogenic Materials</td>
<td>&gt;99.97% eff. On .30 pm Particles</td>
</tr>
<tr>
<td>16</td>
<td>n/a</td>
<td>n/a</td>
<td>.30-1 pm Particle Size</td>
<td>General Surgery</td>
<td>Bag Filter - Unsupported</td>
</tr>
<tr>
<td>15</td>
<td>&gt;95%</td>
<td>n/a</td>
<td>All Bacteria</td>
<td>Hospital Inpatient Care</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>90-% Droplet Nuclei (Sneeze)</td>
<td>n/a</td>
<td>Most Tobacco Smoke</td>
<td>Smoking Lounges</td>
<td>Box Filter - Rigid Style Cartridge Filters 6 to 12&quot; deep, 6-12 pockets</td>
</tr>
<tr>
<td>13</td>
<td>89.90%</td>
<td>&gt;98%</td>
<td>Proplet Nuclei (Sneeze)</td>
<td>Superior Commercial Buildings</td>
<td></td>
</tr>
</tbody>
</table>
HEPA to Outside

Single patient room with dedicated bathroom

Seal off return air grill in patient room

Place HEPA filtered negative air machine in patient room

Duct through exterior to outside
  • Remove window and enclose opening

Keep door to patient room closed

Verify negative pressure prior to placing room in service and monitor negative pressure while in service
HEPA UNIT

Portable HEPA Machines

Pre-Assembled System

Ceiling fan filter unit
Basics - HEPA

Stages Of Infectious Droplets And Droplet Nuclei

1. LARGE INFECTIOUS DROPLETS
   - Mucus/water encased.
   - Viruses are aerosolized by the infector or by toilet water.
   - Quickly fall to the ground after traveling up to 1 – 3 ft.

2. SMALL INFECTIOUS DROPLETS
   - Mucus/water coating starts to evaporate.
   - Fall to ground after traveling 3 - 5 ft.
   - Can become droplet nuclei.

3. INFECTIOUS DROPLET NUCLEI
   - Droplet size has decreased to <5 microns.
   - Can float in the air for prolonged periods due to microscopic size.

Efficiency (fraction) vs. Particle size (micrometers)

- 0.1 – 0.3 micrometers
- HEPA: 90–95%
- 0.2–0.3 micrometers: 80–85%
- 0.3–0.4 micrometers: 60–65%
- 0.4–1 micrometers: 35–45%
Healthcare Facilities - TODAY

- Understand COVID 19 Virus Mechanics
- Low Transmission Rate from Surface Fomites
- Confirmation that Most COVID Transmission is Close Contact Droplet/Aerosol
- Proximity and Time Duration with Infected Persons Matters
- Low COVID Viability Beyond Space of Origin
- No Documented Case of Viable Virus at Air Handler
- Airborne Infectious Isolation Rooms used for Aerosol Generating Procedures
- Lower Relative Humidity (<40%) Increases Susceptibility
- Resurgence at Any Time is Possible
Patients with COVID-19 do not need to be in single-pass, 100% outside air environments.

Greater outside air fractions do provide some dilution but are no more effective at mitigating infection than providing highly filtered (MERV 16 or greater) supply air.

“Negative” (clean-to-dirty) airflow patterns will inhibit the migration of air in spaces that contain COVID-19 patients to adjacent spaces.
When patient census grows beyond small scale surge capacity, consider:

- Convert units, wings or floors where all patients in “hot” zone are considered pandemic infected
- Use anterooms/vestibules to segregate “hot” from “cold” zones
- Rather than convert individual rooms one-at-a-time, use HEPA machines to create pressure difference at unit hot/cold boundary
- Create one-way flow if possible, with PPE donning in one anteroom and doffing in another
  - Large enough to accommodate two caregivers, working in “buddy system”
  - Handwash in the anteroom or adjacent
- If necessary, create positive pressure zones for staff respite inside hot zone, using HEPA machines to establish pressure differences, using anterooms/vestibules if practical
- This approach conserves PPE
- 100% exhaust not required – no known case of infection via ducted/filtered return
The benefits of designating COVID patient suites includes the ability to establish the suite as a negative relative pressure zone to adjoining suites.

Use a HEPA fan filter machine to establish negative relative pressure in the suite. Consider using at least two machines for redundancy purposes.

This arrangement avoids the need for HEPA units in each patient room and the necessary HVAC air re-balance and correspondent make-up air issues.
Alternate Strategy – Source Control

Consider Local Exhaust Source Control at Patient Head for Patients on CPAP, Nebulizer or other AGP


Can Be Custom Built On Site
Alternate Strategy – Source Control

- Consider Local Exhaust Source Control at Patient Head for Patients on CPAP, Nebulizer, or other AGP

- Patient Tent w HEPA Headboard (i.e., Demistifier)
  [link](https://www.peacemedical.com/2000A%2020214.pdf)

- Portable Snorkel Exhaust (i.e., SentryAir used for soldering) [link](https://www.sentryair.com/portable-floor-sentry.htm)
McCormick Center, Chicago
COVID care
Treatment Bay
Limited Resources
Pressurized / Airflow past patient
Operating Room – COVID Patient

- Temporary vestibule
- HEPA unit in vestibule to create negative zone
- Seal other entries
NEED INFO - START HERE:

See the ASHRAE COVID page https://www.ashrae.org/technical-resources/resources

Have questions? Need help?
Contact: Michael.Sheerin@tlc-eng.com