Safer SARS CoV-2 Indoor Environments

“Dilution is a Solution”

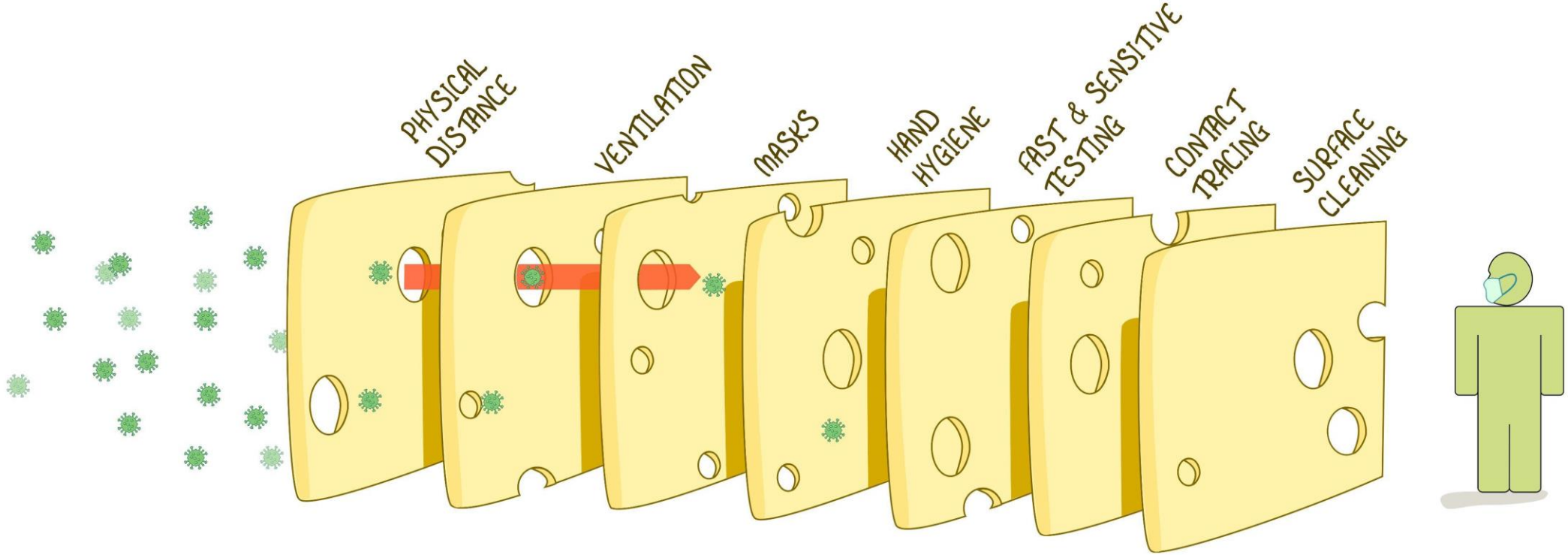
an HVAC engineers’ perspective

Recommendations and Case studies, an overview of best practices 11/8/20

Brian Formusa P.E.

The Swiss Cheese Respiratory Virus Defence

Recognising that no single intervention is perfect at preventing spread



Each intervention (layer) has imperfections (holes).
Multiple layers improve success.

Ian M Mackay
virologydownunder.com
Derived from @sketchplanator
Based on the Swiss cheese model of accident causation, by James T Reason, 1990
version 1.3
update: 12oct2020

Layering Up

- Social Distancing – droplet nuclei dispersal – aerosol, density, viral load
- Ventilation – Dilution is a Solution – outside air rate
- Density of people in space – Time in Space – Size of Space
- Presence of a threat – obvious emitters and those asymptomatic
- Portable HEPA units – Honeywell as a default

---visit ‘safe air spaces’ predictive model for all red factors combined---

- Filtration : MERV 13 ideal (6-8 usual) higher the better.
- Technologies for Air Treatment – UV / Ionization et al. – claims /tests
- Humidification 40-60% RH ideal - difficult to maintain in this climate
- Housekeeping - surface cleaning

Dilution Ventilation

- HVAC Systems – see if there is an outside air intake, if open, cfm?
- cfm= airflow rate in cubic feet per minute (house bath fan is ~50 cfm) 400 cfm max. in 10” round duct
- 10-20 cfm per person is needed in general – see tables
- Natural ventilation as a benefit – cross ventilate, be upstream
- Case Studies – school BCSD, Montessori, Hailey Senior Center…
- Shared spaces on same HVAC system – look and discover
- Calculation Procedure of Outside air – ASHRAE 62.1

ASHRAE 62.1 Ventilation Standard

- Minimum code requirements – per person & area calculation
- Examples: 30’ x 33’ x 9h’ room (use actual expected #/people)
  - Office: 5 persons, 17 cfm/person = 85 cfm required
  - Restaurant: 70 persons, 10 cfm/person = 700 cfm
  - Bar/Lounge: 100 persons, 10 cfm/person = 900 cfm
  - Retail Sales: 15 persons, 16 cfm/person = 240 cfm
  - Hotel Lobby: 30 persons, 10 cfm/person = 300 cfm
  - Hotel Assembly 120 peops, 6 cfm/person = 720 cfm
- Outside air costs: ~ $1/cfm/yr heat and cool
- Tables: use specific and area dependent, overhead air delivery x 1.25
  https://www.ashrae.org/File%20Library/Technical%20Resources/Standards%20and%20Guidelines/Standards%20Addenda/62_1_2013_p_20150707.pdf

Treating Air – Filtering / UV / Ionization

Pathogen Killing Technologies:

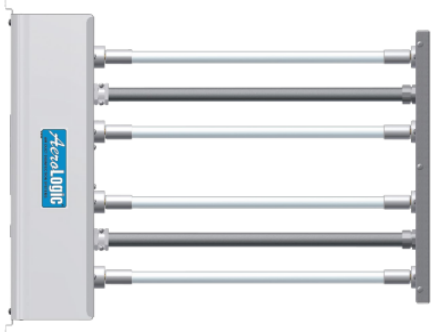
Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses short-wavelength ultraviolet (ultraviolet C or UV-C) light to kill or inactivate microorganisms.

- Generally impractical to retrofit, potential skin and eye damage if exposed to it. Usually for hvac unit coil treatment.
- Case study – Bob Coplin, neuro-musc. Therapy and UVC LED. Sterilize. Hospital in- room coffers. Coil irradiation. UVC requires residence time, exposure and intensity.

Ionization: Needlepoint Bi-polar ionization. Not new technology but the new generation of low voltage equipment doesn't produce Ozone which is an indoor air pollutant. Some tests indicate that high (impractical) concentrations (5-10 times higher than those achieved with typical equipment) can have a good virus deactivation rate. Hopefully normally tested (me) lower concentrations actually help. However there is another beneficial effect - ions cause virus particles to agglomerate, become larger and fall to floor or be swept back to filters. +/- ion attraction. **However:** effectiveness still lacks full scale test data.

Case Studies – YMCA/Montessori/County Bldgs and lab test data -GPS

Other technologies: The jury of professionals is out for deliberation – lacking test data



A Prediction Model: info@safeaccess.app : https://safeairspaces.com/

Example: Typical Office: 1000 sf

Summary of Inputs

Air changes per hour (ACH)= 0.6
Outdoor air supply (cfm/person) = 17.0
Outdoor air supply (cfm/sq.ft) = 0.08
Space per person (sq.ft/person) = 200
Filtration CADR (cfm) = 0.0
Floor area (sq.ft) = 1001
Volume (cubic.ft) = 8047
Occupants (#) = 5
Masks = On
High emitter = Off
Low emitter = On

Summary of Estimation

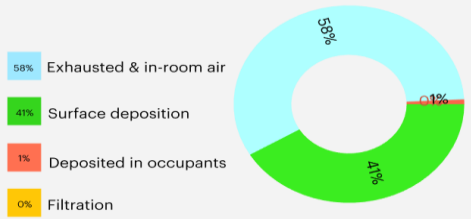
Average inhaled & deposited dose by all ocupants (picoliters) = 19
Average inhaled & deposited dose per ocupant (picoliters) = 3.9
Average infectious virus inhaled & deposited per occupant = 12

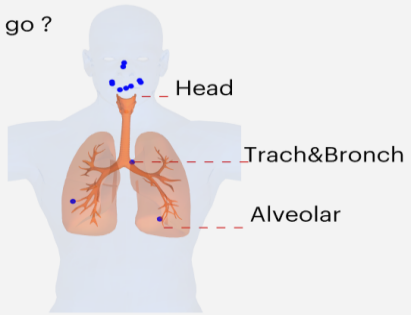
Current Status

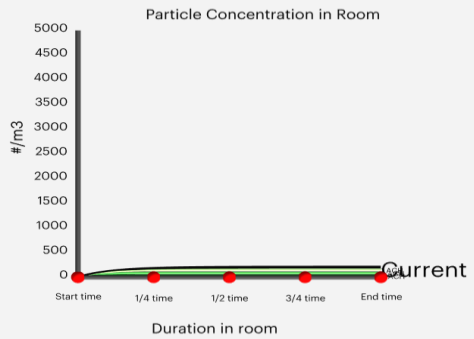
Extreme risk

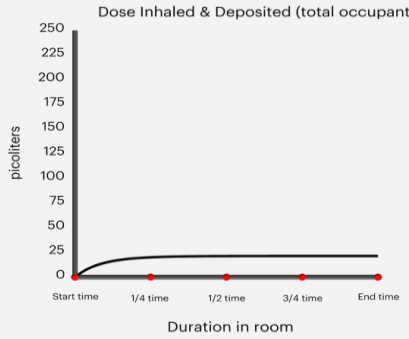
Infection probability	# Susceptible occupants	Estimated # of infections
0.47	× 5	⟶ 2

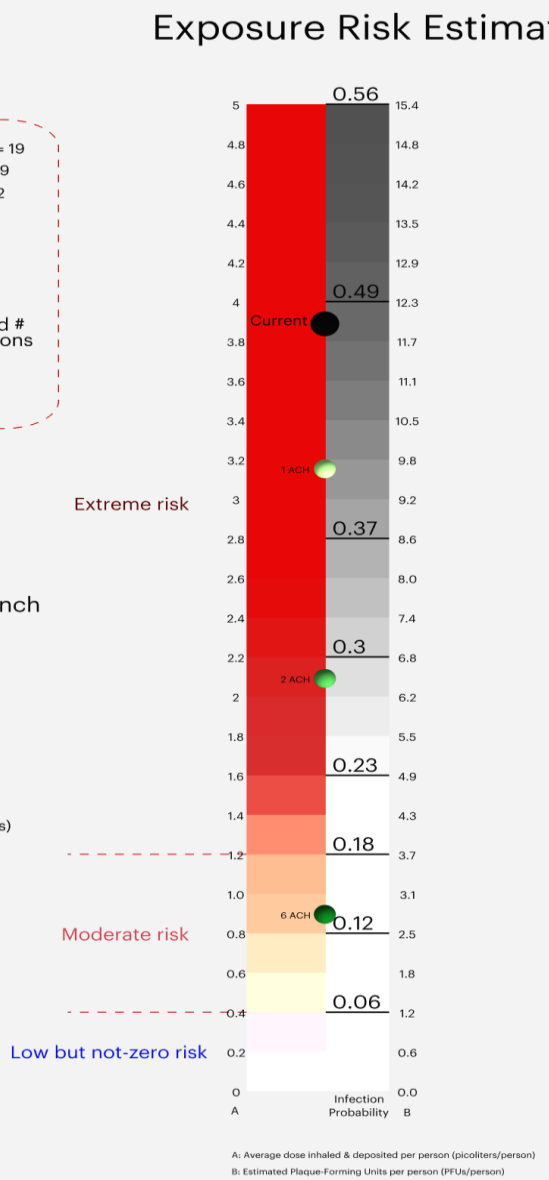
Where do the particles go ?

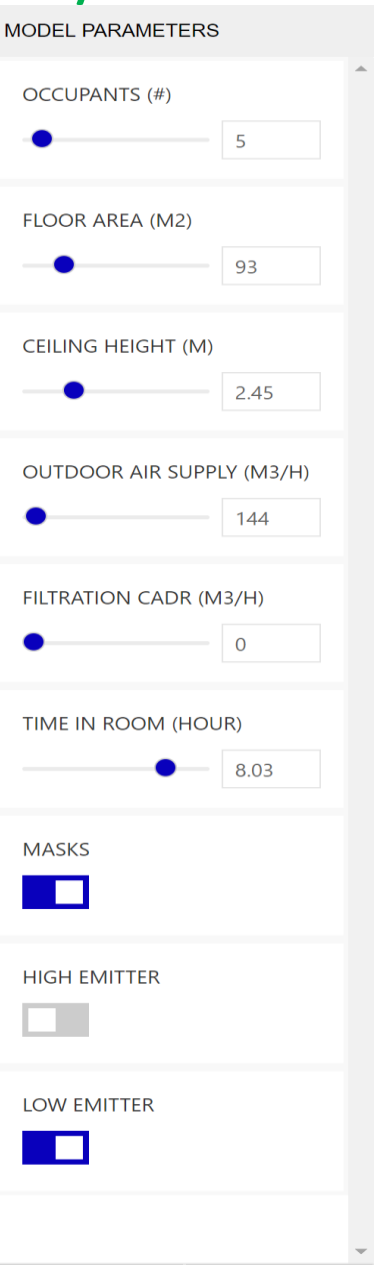












Checklist:

- See presentation slide deck
- Audit your HVAC systems – and know your ventilation targets
  - Outside air volume targets - contractors may not know the ASHRAE outdoor air calculation procedure. Measurement /Audit?
  - Use these ventilation tables and the 8th column to right for the higher "DEFAULT VALUES" - # of people is actual expected https://www.ashrae.org/File%20Library/Technical%20Resources/Standards%20and%20Guidelines/Standards%20Addenda/62_1_2013_p_20150707.pdf
  - Run the HVAC systems to flush the bldg. at night
  - Upgrade filtration, MERV 8 to13, filter leaks? Disable any CO_2 demand control ventilations controls, bypass wheel type HRV?
  - Consider adding portable HEPA filtration units.
- ASHRAE recommendations: https://www.ashrae.org/technical-resources/commercial#general
  - A more technical approach is here: https://www.ashrae.org/technical-resources/resources
- See White paper by Tim Ross P.E. / YMC & Brian Formusa P.E. from SVED Webinar materials
- **DILUTION IS A SOLUTION!** More outside air - less people = better dilution and a healthier room.

Additional Slides for Reference

- **The MERV Rating Scale**

The air filter rating ranges from 1-20 in the standard MERV chart. The higher the MERV rating, the more efficient it is at pulling articles from the air. As said earlier, a true HEPA filter will be in the top 5 of the MERV scale. You will likely not see too many non-professional air filters all the way at 20, considering they're used in commercial spaces or hospitals.

Ratings 1-4

These are your normal minimal and air conditioning filter that can operate well enough to pull away dust mites and pollen. It isn't enough to take away smoke or mold, though.

Ratings 5-8

This area is more mass-produced for industrial areas, taking out hair spray, cement dust, and other particles that might be harmful to humans. Mold spores are taken by these air filters, but these are more suited for commercial areas as well.

Ratings 9-12

Likely where you'll find most of your quality air filters, this rating area is where you'll find more heavy-duty air filtration. Mechanics, wielders, and superior residential and commercial buildings will employ the use of these air filters. This is also where you'll find most of your HEPA filters if it's not a "true" HEPA filter.

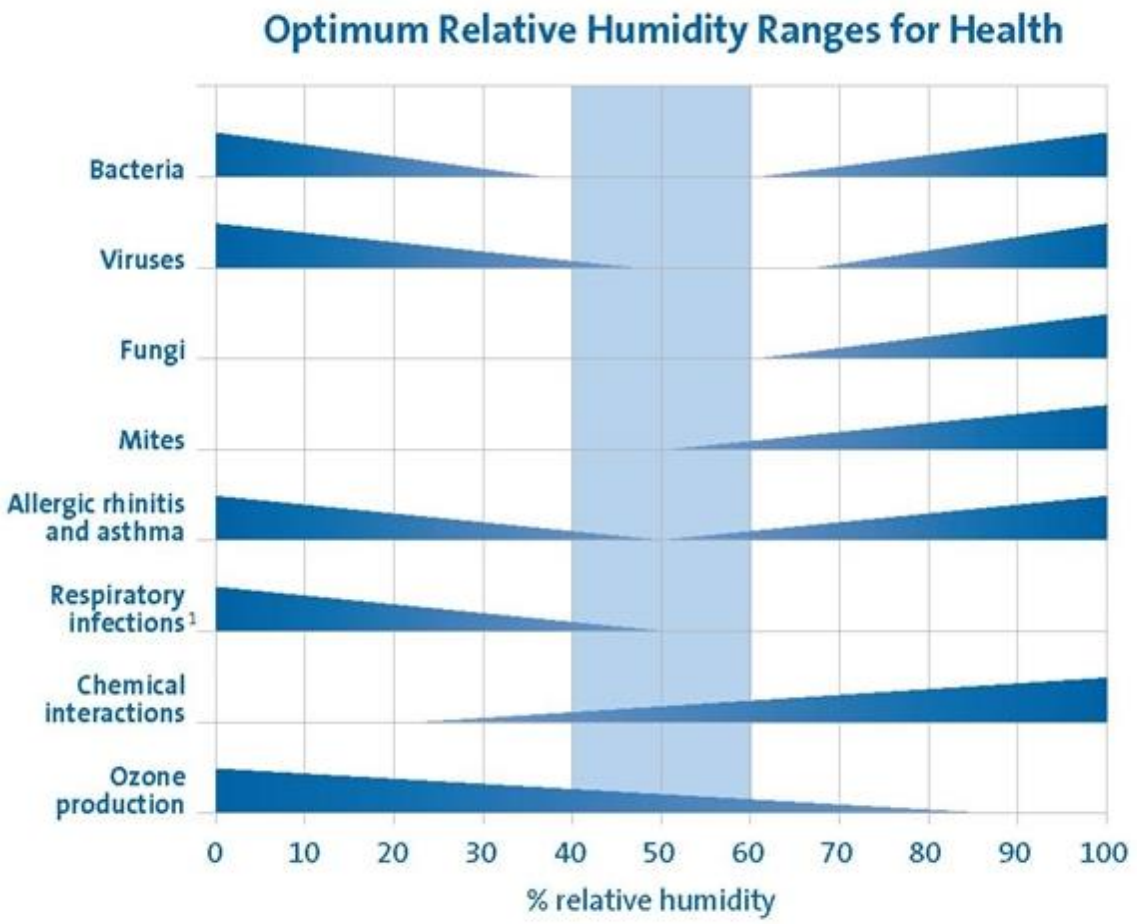
Ratings 13-16

These are the more sterile filter areas that you'll find in general surgeries, hospital inpatient care, and smoking lounges. They will take away most tobacco smoke and all bacteria. This is likely all you'll need if you want an air filter for your allergies and smoking habits. If not, you can likely settle on a 9-12 rating.

Ratings 17-20

While these are the true HEPA filters area, these are mostly used for cleanrooms, radioactive materials, and other pharmaceutical needs. You can put these in your home if you have bad allergy or asthma problems. They take most particles from the air, from carbon and combustion smoke to viruses that might go through the air

Humidification



Humidification 40-60% RH is ideal but difficult to maintain in this climate. Drier air may adversely impacts respiratory immune response. 40-60% is hard on viruses.