SETTY

Re-Opening Our Buildings:

Activities & Recommendations

GET EDUCATED
BUILD A PLAN
WORK THE PLAN

GET EDUCATED

BUILD A PLAN

WORK THE PLAN

Know Everything Possible…

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Who do you listen to? Filter the noise for me!

ASHRAE Direction:

Transmission of SARS-CoV-2 through the air is sufficiently likely… Changes to building operations, including the operation of HVAC systems, can reduce airborne exposures.

Ventilation, Disinfection and Filtration provided by HVAC systems <u>can reduce</u> the airborne concentrations of SARS-CoV-2 and the risk of transmission through the air.

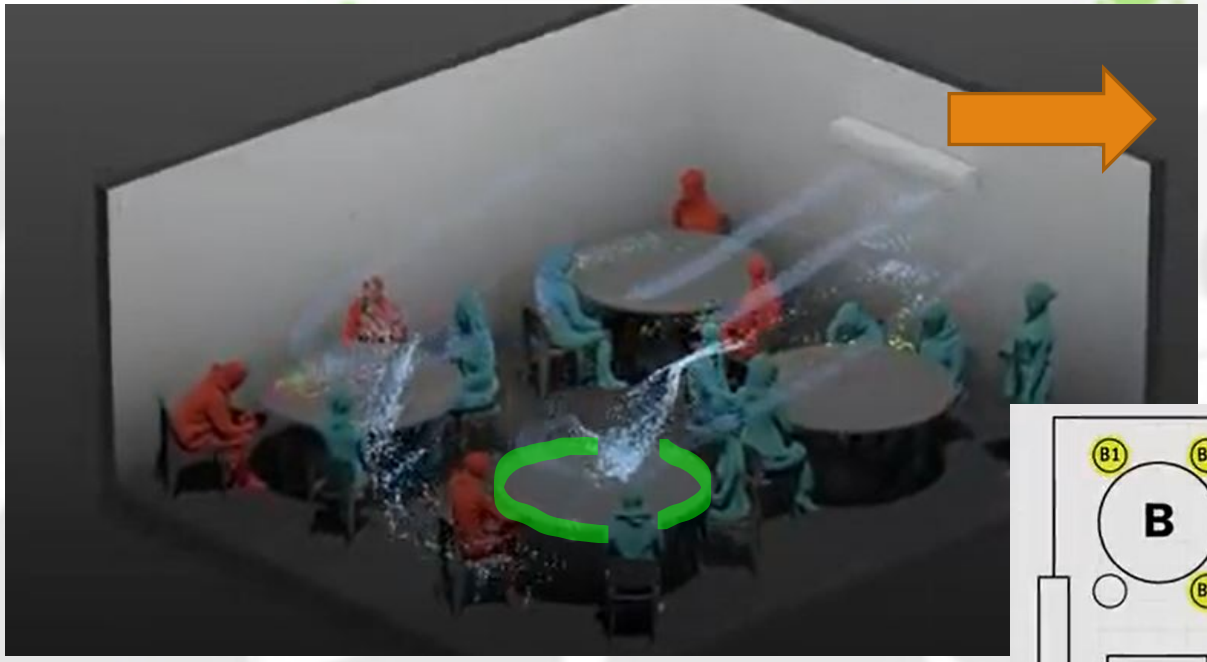
CDC Guidance:

“Intensify cleaning, disinfection, and ventilation”

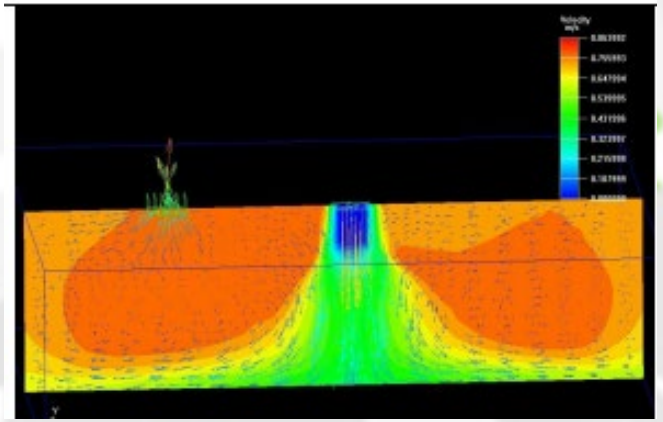
ASHRAE®

Room Air Recirculation can spread contaminants? Yes.

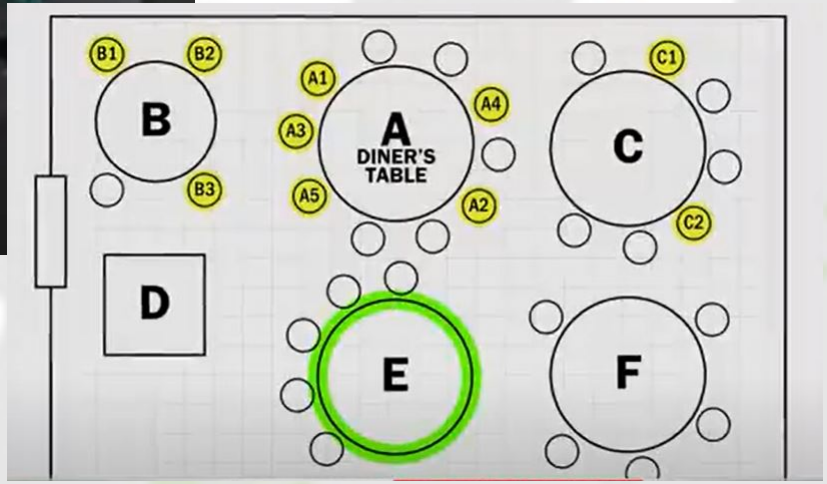
Partitions are not the solution.



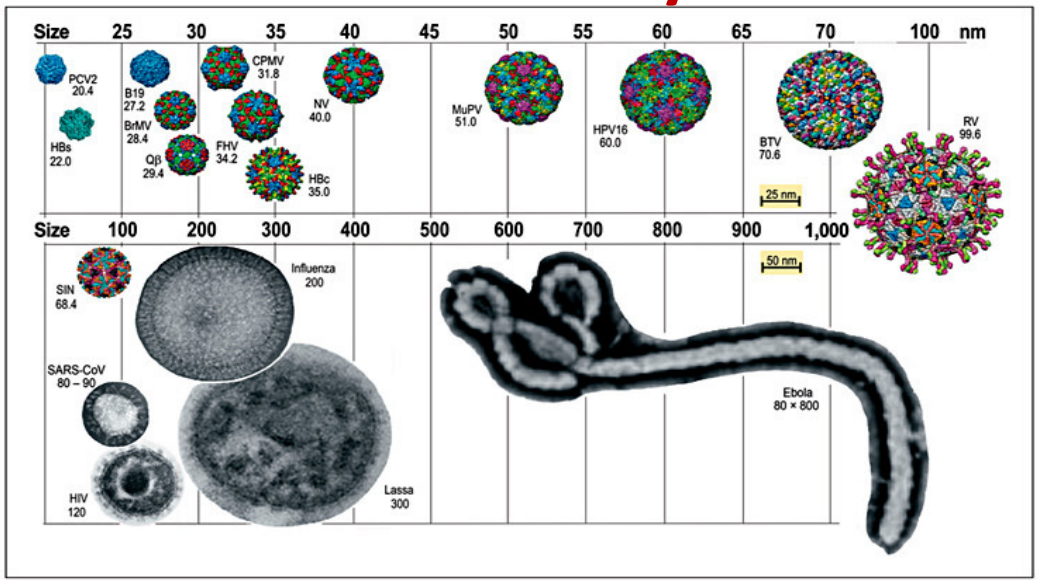
The 'Chinese Restaurant' Case Study of Transmission via HVAC.



HVAC is Designed to Mix the Air!



What Do We Really Know About SARS-CoV 2 (COVID19)?



For Detailed SARS/COVID guidance:
https://www.cdc.gov/coronavirus/2019-ncov/index.html

Coronaviruses are ***Enveloped Viruses —*** one of the easiest types of viruses to kill with the appropriate approach.

Viruses can be Categorized into Three Groups:

1. Enveloped Viruses
Easiest to kill
(e.g., Influenza A Virus)

2. Large, Non-enveloped Viruses
Difficult to kill
(e.g., A Rotavirus)

3. Small, Non-enveloped Viruses
Hardest to kill
(e.g., Rhinovirus, Norovirus)

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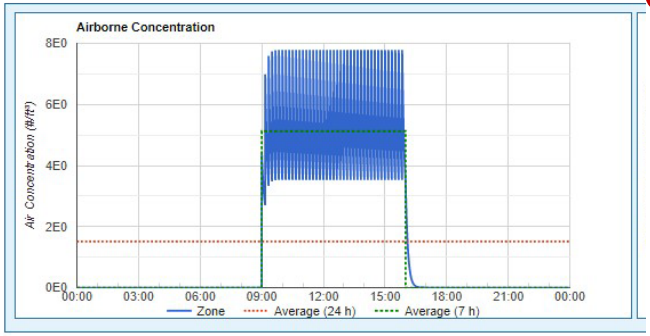
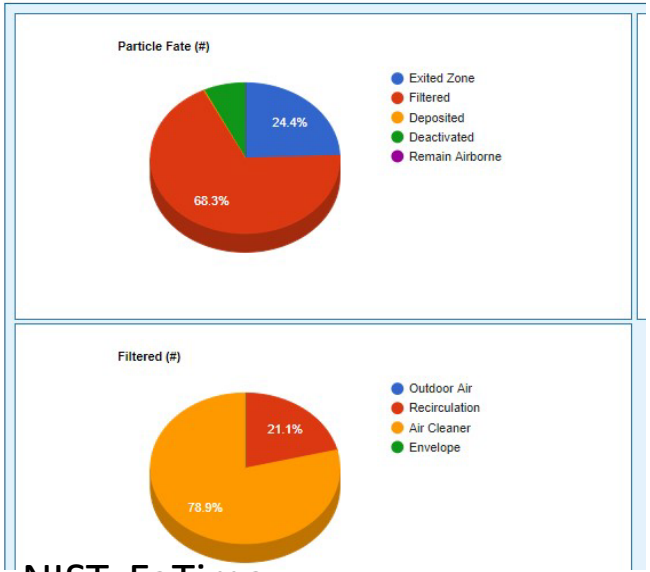
Transient Charts



Particle Fate Summary Charts



NIST, FaTima

Wells-Riley Equation

Can We model transmission risk? Yes, we can.

$$C = S*[1-\exp(I*q*p*t/Q)]$$

C = New Infections
S = # of Susceptibles
I = # of Infectors
Q = # of Infectious Doses
P = Pulmonary Ventilation Rate per Susceptible
t = Exposure Time
Q = Flow Rate of Contaminated Air

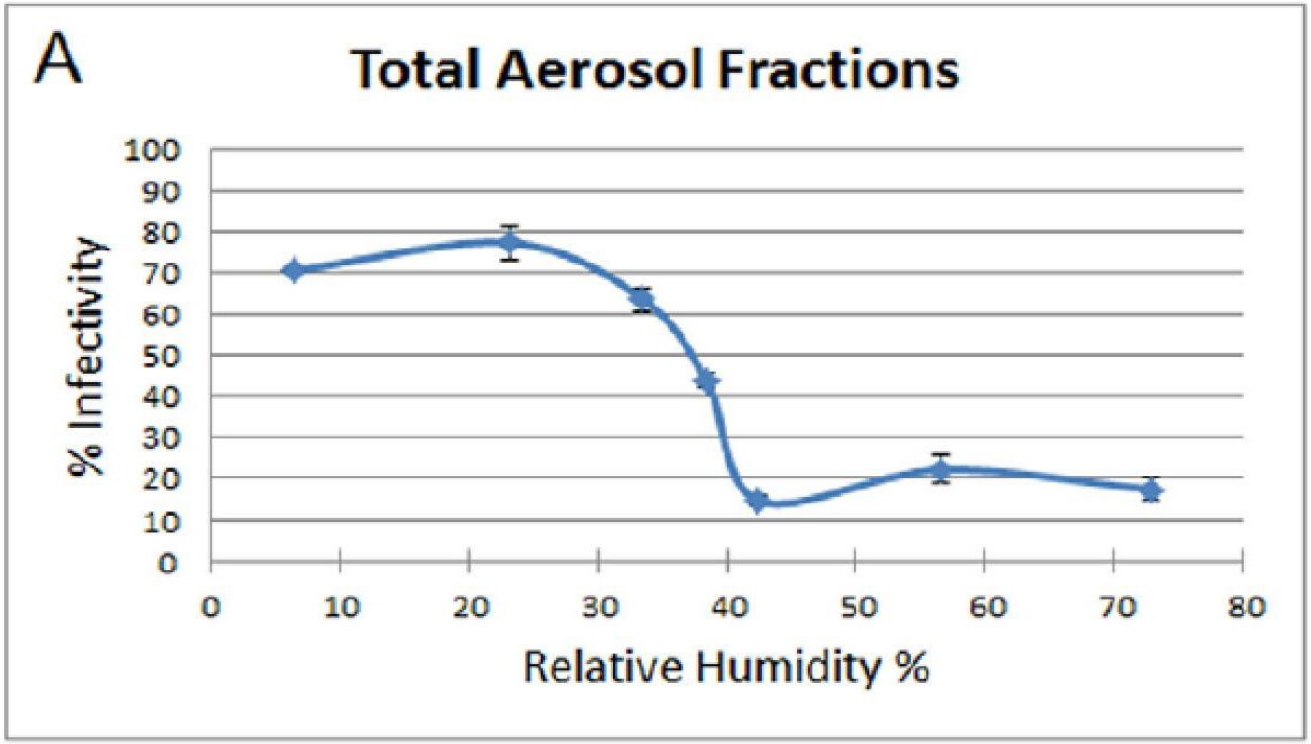
Translate, please?

1. We know what factors must be individually adjusted to reduce "C", the # of New Infections!

2. We can apply known engineering principles to reduce the airborne transmission!

What do we know* about Airborne Transmission?

Relative Humidity between (40%-60%) slows the Transmission of Viruses



- Influenza A is the subject of this study data.
- High %RH results in Droplet Stability!

* *Noti, John D., et al. "High humidity leads to loss of infectious influenza virus from simulated coughs." PloS one 8.2 (2013).*
* *Wan Yang and Lindsey Mars, "Mechanisms by Which Ambient Humidity May Affect Viruses in Aerosols", 2012 Oct.*

RELATIVE SIZES

1 micron	=	10^{-6} meter
	=	1/1000 of a millimeter
Human Hair	=	80 microns
Smallest Visible Particle	=	40 microns
Red Blood Cells	=	7 microns
Bacteria	=	0.3 to 30 microns
Virus	=	0.003 to 0.05 microns

What is a micron?

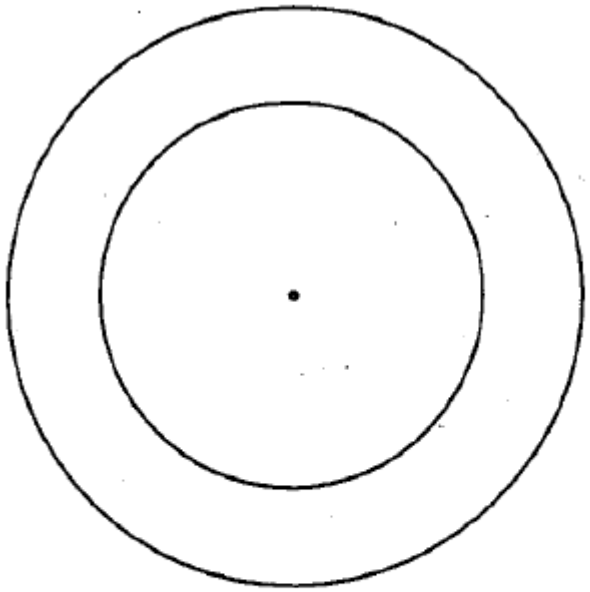


Figure 2
If the small dot in the middle represented a one micron diameter circle, the middle circle would represent a 50 micron diameter particle, the limit of visibility for the unaided eye, and the large circle would represent the 75 micron cross section of a human hair.

There are 1,000,000 microns in a meter

There are 25,400 microns in an inch

It would take 4,500 micron diameter particles to fill the cross section area of a human hair

Particles to ~50 microns are visible to the naked eye

Remember that It's All About…

1. FILTRATION.
2. DISINFECTION.
3. DILUTION.
4. AIR CHANGE RATES.

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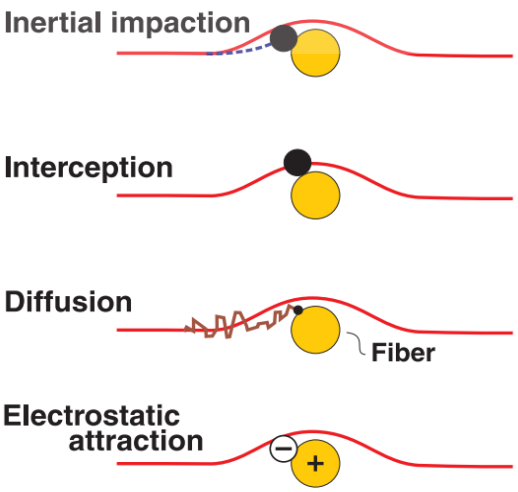
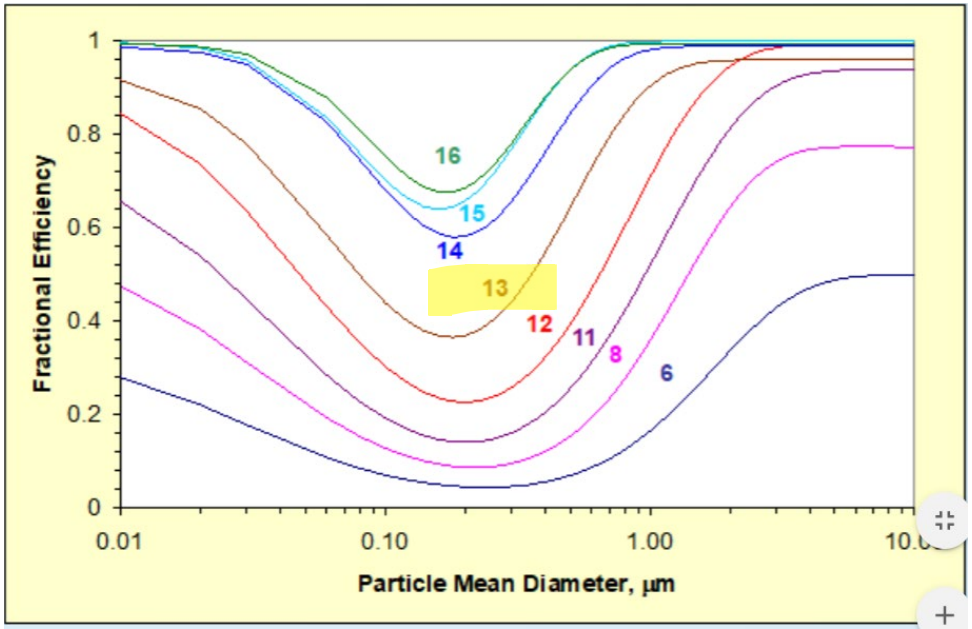
1. FILTRATION

Std. 52.2 Minimum Efficiency Reporting Value (MERV)	Application Guidelines: Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
16	**0.30 to 1.0 µm Particle Size**	Hospital inpatient care	**Bag Filters**
	All bacteria	General surgery	Nonsupported (flexible) microfine fiberglass or synthetic
15	Most tobacco smoke	Smoking lounges	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Droplet nuclei (sneeze)	Superior commercial	**Box Filters**
14	Cooking oil	buildings	Rigid style cartridge filters 150 to 300 mm
	Most smoke		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
13	Insecticide dust		media.
	Copier toner		
	Most face powder		
	Most paint pigments		
12	**1.0 to 3.0 µm Particle Size**	Superior residential	**Bag Filters**
	Legionella	Better commercial	Nonsupported (flexible) microfine fiberglass or synthetic
11	Humidifier dust	buildings	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Lead dust	Hospital laboratories	**Box Filters**
10	Milled flour		Rigid style cartridge filters 150 to 300 mm
	Coal dust		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
9	Auto emissions		media.
	Nebulizer drops		
	Welding fumes		
8	**3.0 to 10.0 µm Particle Size**	Commercial buildings	**Pleated Filters**
	Mold	Better residential	Disposable, extended surface, 25 to 125 mm
7	Spores	Industrial workplaces	(1 to 5 in.) thick with cotton-polyester blend media,
	Hair spray	Paint booth inlet air	cardboard frame.
6	Fabric protector		**Cartridge Filters**
	Dusting aids		Graded density viscous coated cube or pocket filters,
5	Cement dust		synthetic media.
	Pudding mix		**Throwaway**
	Snuff		Disposable synthetic media panel filters.
	Powdered milk		
4	**>10.0 µm Particle Size**	Minimum filtration	**Throwaway**
	Pollen	Residential	Disposable fiberglass or synthetic panel filters
3	Spanish moss	Window air conditioners	**Washable**
	Dust mites		Aluminum mesh, latex coated animal hair, or foam rubber
2	Sanding dust		panel filters
	Spray paint dust		**Electrostatic**
1	Textile fibers		Self charging (passive) woven polycarbonate
	Carpet fibers		panel filter

Note: A MERV for other than HEPA/ULPA filters also includes a test airflow rate, but it is not shown here because it has no significance for the purposes of this table.

Target MERV13!

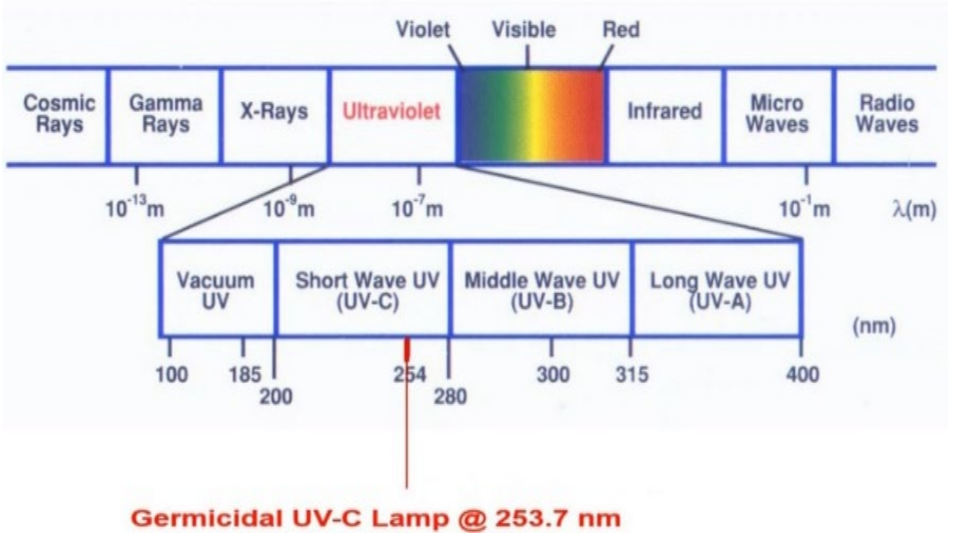




2. DISINFECTION

- Electronic Air Filters/Cleaners (Agglomeration)
- **UV-C in Air Handlers, in Upper-Air Units**
- UVGI – Ultraviolet Germicidal Irradiation
- UV-V can generate ozone
- UV-A (400-315 nm)
- Photocatalytic Oxidation (PCO)
- **Bipolar Ionization** (Refer to ASHRAE)
- Vaporized Hydrogen Peroxide (VHP)
- Pulsed Xenon (Pulsed UV)
- 405 nm visible light (“Near UV”)
- Non-ionizing Polarization
- Far UV (205 to 230 nm)
- Glass Filters

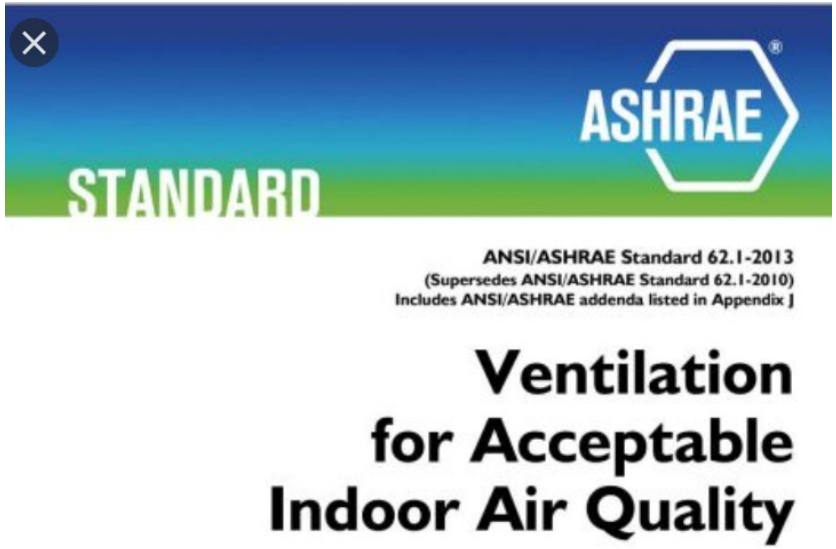
UV-C and IAQ
Tech to Consider..



3. DILUTION

Outside Air requirements are governed by ASHRAE 62.1.

There is No Relaxation in Code Requirements!



Outside air ventilation rates should be increased to as much as the systems can accommodate (up to 100 percent!), 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.

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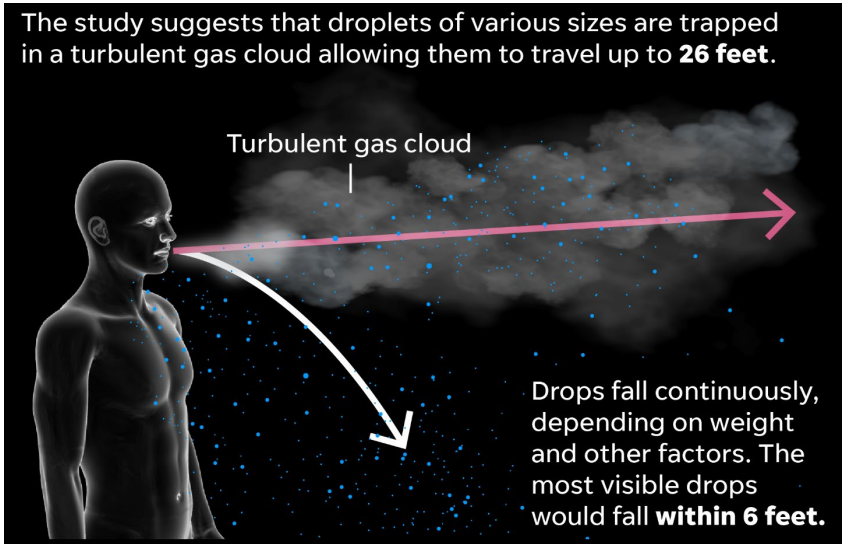
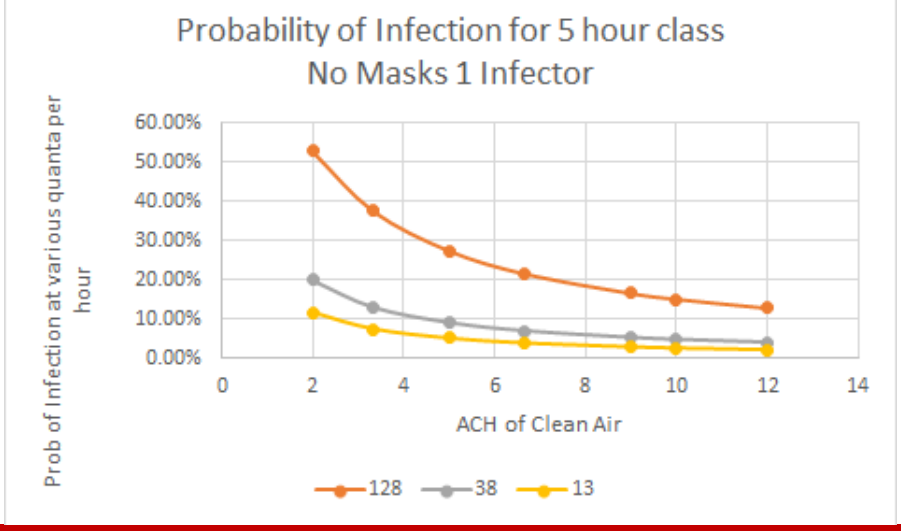
4. AIR CHANGE RATES OF CLEAN AIR





Increasing air change rate can decrease in-room concentration of Infectious Particles or **Quanta.**

There is a point of diminishing return in the reduction of Quanta within a room:

Six (6) Air Changes per Hour

An Air Change per Hour is defined as how many times the air in the room is turned over and passed through a filtered device or Outside Air and complies with ASHRAE Std. 62.1 and ASHRAE position document on filtration and cleaning.

GET EDUCATED

BUILD A PLAN

WORK THE PLAN

What is the Gameplan?

1st…Financial Budgeting Guiding Principles

Establish a budget using a CABA scorecard.

1) Cost per building or per system.
2) Speed of implementation – done by the Fall of 2020?
3) Level of Risk Mitigation
4) Increase maintenance/staffing needs, such as extra cleaning and disinfecting.

Imagine Hope PCS - Lamond Campus Scorecard

Building Score Card		
Certification Levels	**Points**	**Grade**
Zero Star	<30	F
One Star	30	D
Two Stars	50	C
Three Stars	75	B
Four Stars	90+	A

Certification Level	FACILITY DOES NOT COMPLY		ONE STAR	TWO STARS	THREE STARS	FOUR STARS			
Categories	**Category Multiplier**	**Tasks**	**Risk Mitigation Level One**	**Risk Mitigation Level Two**	**Risk Mitigation Level Three**	**Risk Mitigation Level Four**	**Maximum Points**	**Existing Points**	**Target Points**
Prerequisite	N/A	Identify Stakeholders							
		Establish a Budget							
		Perform a Facility Audit							
		Testing & Balancing of main air handlers							
		Develop a Facility Strategic Programming / Space planning							
		Complete Checklist							
		PPE Score							
		Ventilation Air Change per Hour (Fresh Air)	None 0 Points	Minimum per ASHRAE 62 1 Point	10% above code 2 Points	30% above code 4 Points	4	1	2
		Air Rotation per Hour - All air should see a filter	1 Air Changes (Once an hour)	2 Air Changes (Once an hour)	4 Air Changes (Once an hour)	6 Air changes (Once an hour)	4	1	4

2nd…Assemble Your Stakeholders Team

- Owner
- Architect
- HVAC Engineer of Record
- Building Officials
- Installing Contractor(s)
- TAB Agents
- Building Automation System (BAS) Provider
- Commissioning Provider (CxP)
- Operators
- Maintenance Technicians
- Building Users

Create a District or Campus Health and Safety Committee.

Include all key stakeholders (environmental health and safety, administration, education staff, operations staff, local healthcare providers)

Identify Key Reference Standards/Authorities to Follow.

Consider OSHA, CDC, State Agencies, Insurance Provider Recommendations

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3rd…Get Organized, Do HVAC Pre-Assessment and Begin

Gather Information- Administrative Phase

Baseline/Indoor Air Quality – Professional Engineer

- **Check Temps and Humidity** – find out how much OA you have.
- **Gather HVAC Plans and Manuals** and maintenance information on systems in place
- Understand your **Building Management System (BMS)**

Maintenance/Prioritize HVAC Backlog – Building Engineer

- Ex: Outside Air Dampers, building management systems
- Review Filter Order Information for existing MERV 13 or higher
- Work with vendors and procurement officers to make sure supplies will not be interrupted

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4th…Develop Playbooks for Operations

Entry/Circulation

- Security and Entry Protocols
- Phased entry, thermographic scanning, disinfection protocols, questionnaire, telepresence. Temperature apps

Operational

- Verify Health of Occupants. Develop metrics for action. Understand “people flow”.

5th…Facilities & Maintenance PPE

Eye Protection and Masks

- Surgical or cloth mask respiration filtering.
- Safety glasses (side shields preferred).
- Face shields.

Disposable Gloves

- Can be vinyl, rubber, or nitrile
- Double gloves reduces likelihood of cuts/punctures
- Can be worn under work gloves if necessary

Post-Maintenance Activities

- Wash hands with soap and water
- Use an alcohol-based hand sanitizer.
- Change clothes if soiled.

- ✓ Staff needs to wear PPE while doing service calls
- ✓ Dispose of filters per OSHA guidelines and treat with CAUTION (Flush with bleach solution before disposing)
- ✓ Create a PPE storage area with decontamination ability

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BUILD A PLAN

WORK THE PLAN

Short & Long Term Recommendations.

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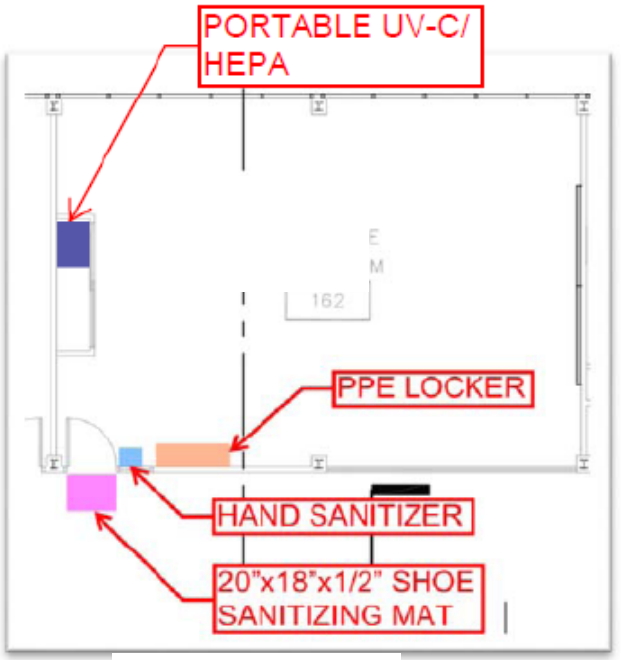
Short Term Recommendations

- **Test and Balance**, Know the real numbers
- **Switch to MERV13/14 filters** on major AHU's
  - Compensate for reduction in airflow – filter change impact to be evaluated with HVAC Professional
- **Enable Remote Operation of BAS** systems where possible
- Introduce **Portable HEPA/UV-C Machines**
- PPE storage cabinet and **Separate Waste Stream**
- **Evaluate Exhaust Fans**, create a non-occupied air flush routine
- Recommend two hours before and two hours after occupancy
- If there is a DOAS – **Increase OA – strive for dilution**



Typical Classroom Layout

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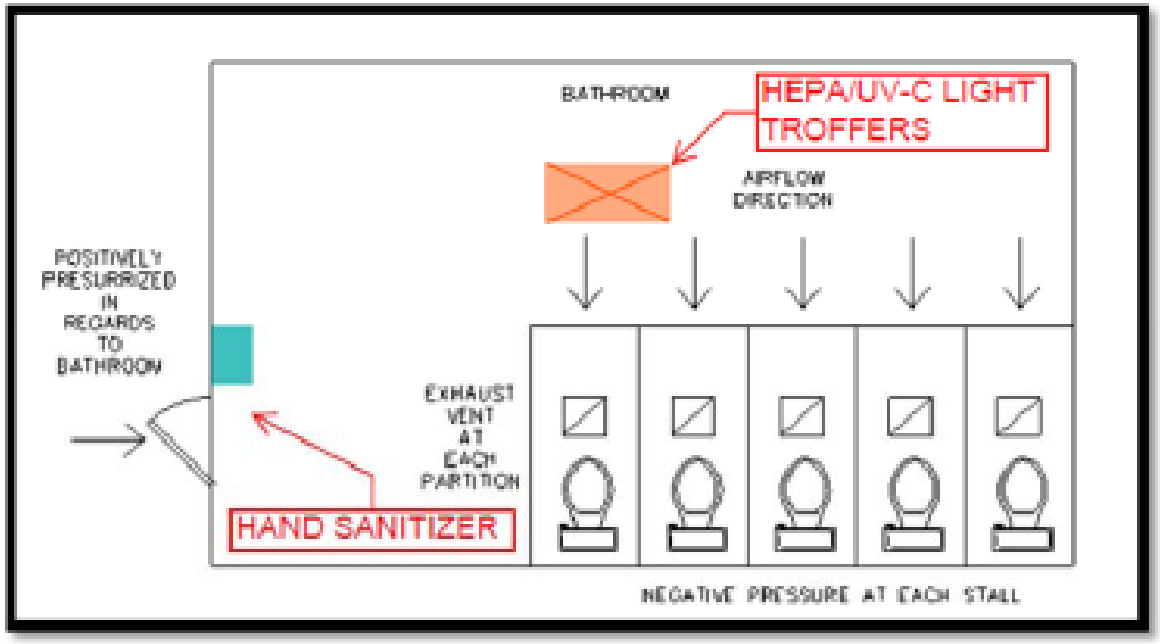
Longer Term Recommendations

Areas where you Can't Social Distance!



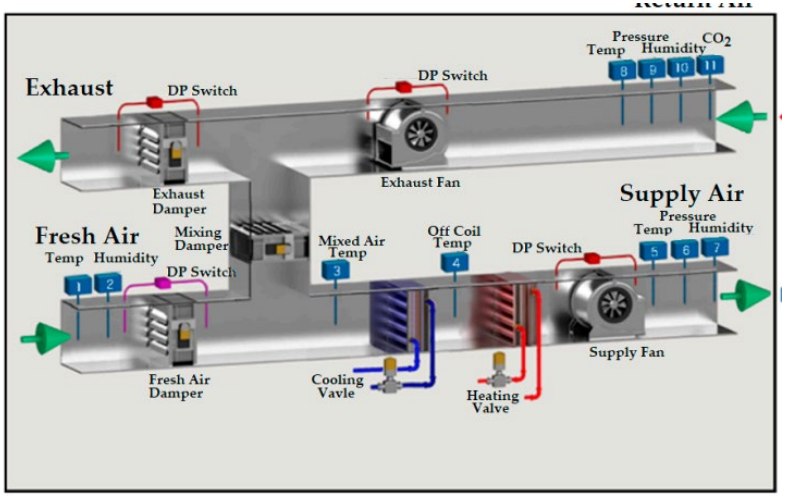
Typical Bathroom Layout

Survival of Severe Acute Respiratory Syndrome Coronavirus, Dept. of Health Hong Kong, extended survival in stool samples vs. air

Longer Term Recommendations

Future Strategies to The Plan.

- Disinfectant Mats at all entrances
- Evaluate by climate zone, **DOAS with energy recovery** per ASHRAE 90.1
- **Convert all AHU's** to operate with MERV 13/14 **with motor upgrades**
- Include **UV-C to all AHU's**
- Plan for **Humidifiers, 40% RH min**
- Operator to switch to **"Building Air Flush" Mode**
- Mailroom and Loading isolation
- Consider Airflow Paths, **Supply High/Return low**
- **Upgrade Restrooms Exhaust** to minimize transmission
- **Isolation Suites** and Janitor's Closets
- Big Spaces – **Increase OA percentages**. Limit Occupancy? Air Scrubbers?
- **Advanced Building Management Controls to create a Pandemic Mode**



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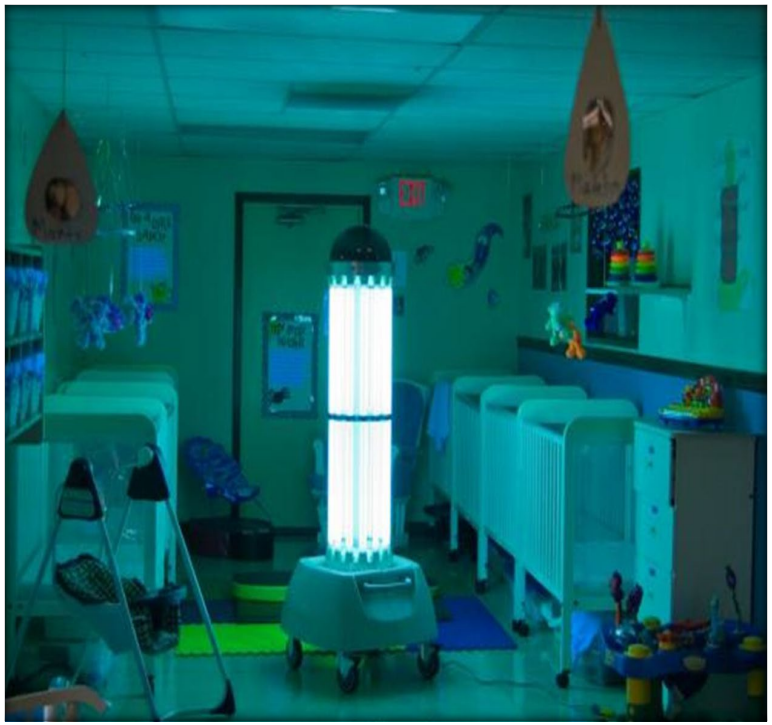
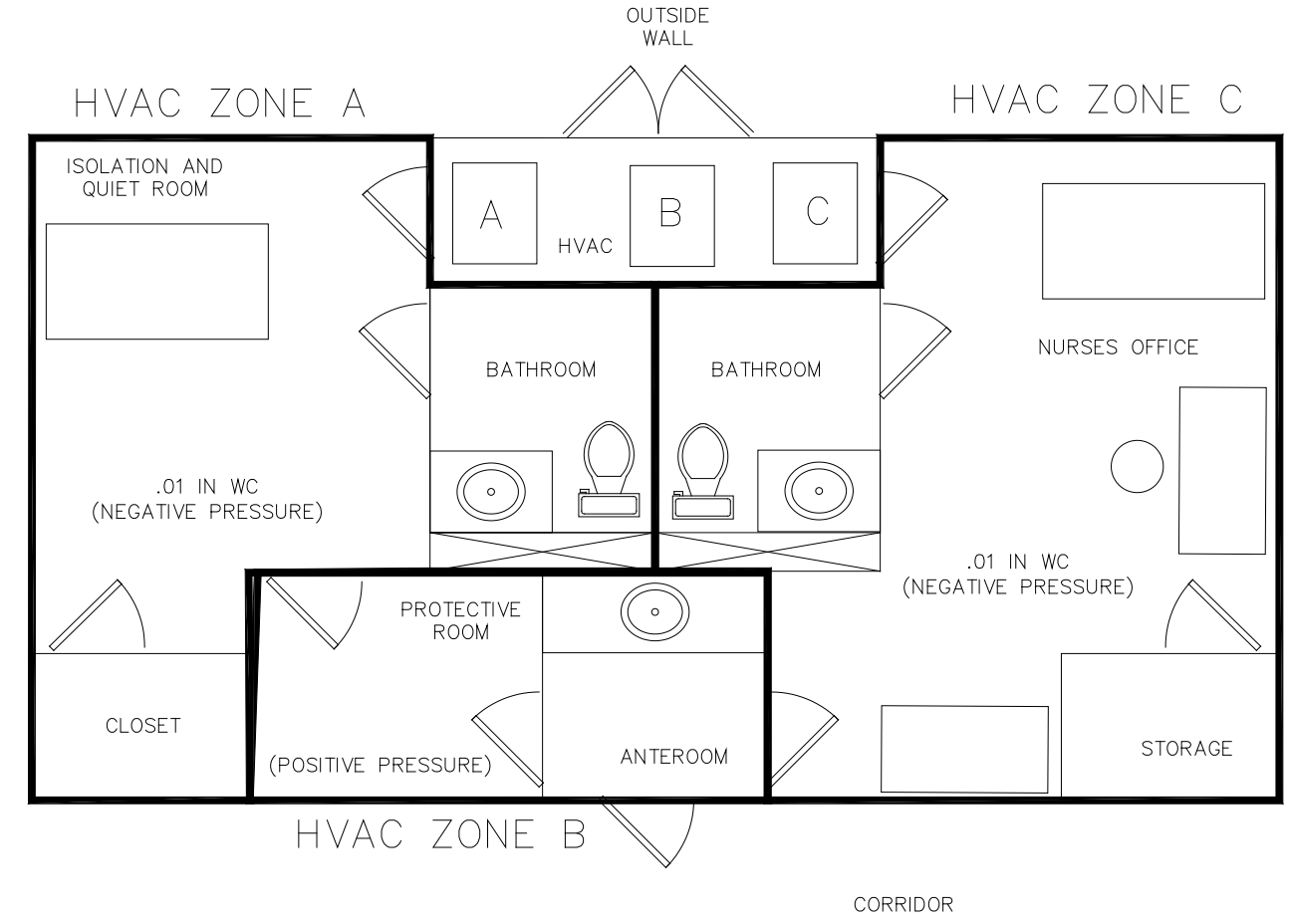
Longer Term Recommendations

Specialized Areas

- Isolation rooms – Follow ASHRAE 170
- Conduct on Risk Assessments by Area
- Provide Isolation Rooms for dense occupancies.
- 100% Outside Air.
- Anteroom/Protective Equipment Room
- Normal Non-Isolation nursing station
- Biohazard Waste and PPE storage
- Dedicated Zone HVAC



Recommendations – *Long Run – specialized areas*



WORK THE PLAN

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Looking Back…

Know Where you Stand: Gather HVAC plans and System Manuals

Speed & Cost: Establish your budget

Prepare: With your HVAC P.E., create your statement of work plan

Execute Phase 1: Put into place the Fast, short term interim adjustments

Execute Phase 2: Mid to longer term projects; harden your buildings

Audit: Is it working - Adjust

Questions?

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