Re-opening our buildings: Activities & Recommendations

GET EDUCATED
BUILD A PLAN
WORK THE PLAN

GET EDUCATED

Know Where you Stand: Gather HVAC plans and System Manuals, educate yourself on your options

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

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Who do you listen to – filter the noise for me

ASHRAE's (American Society of Heating Refrigerating and Air-Conditioning Engineers)

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 can reduce the airborne **concentration** of SARS-CoV-2 and the **risk of transmission** through the air.

CDC guidance states:
"Intensify cleaning, disinfection, and ventilation"

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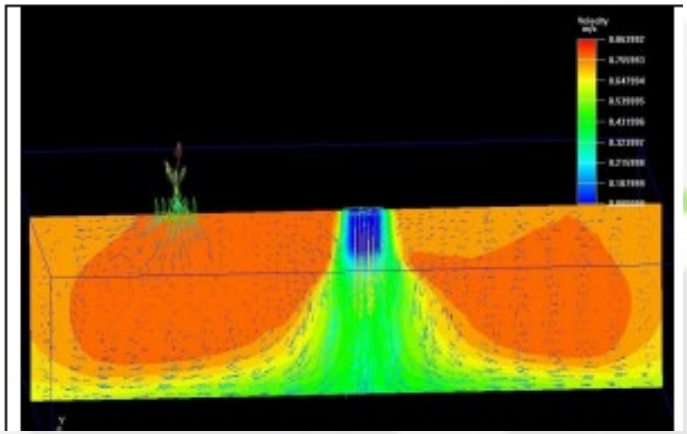
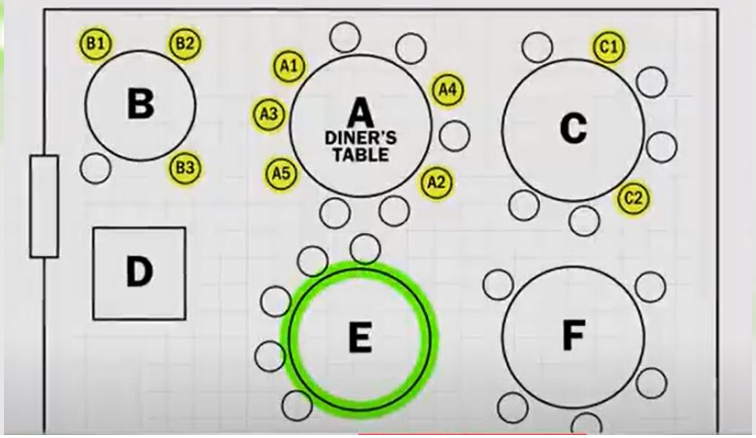
Room Air Recirculation can spread contaminants?
Partitions are not the solution.



HVAC diffusers are meant to mix the air

Chinese restaurant case study of transmission via HVAC



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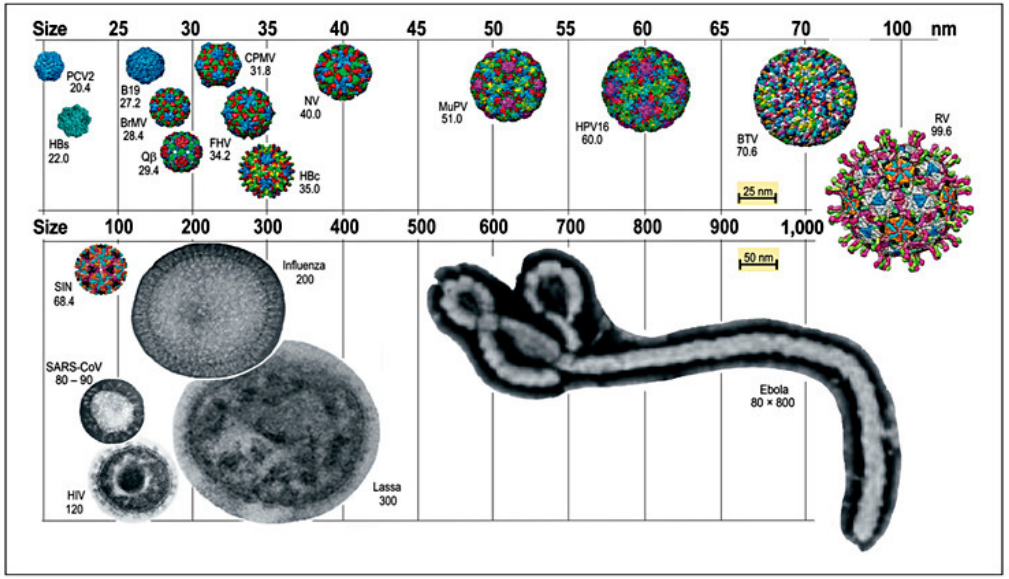
What do we know about Viruses?



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

3 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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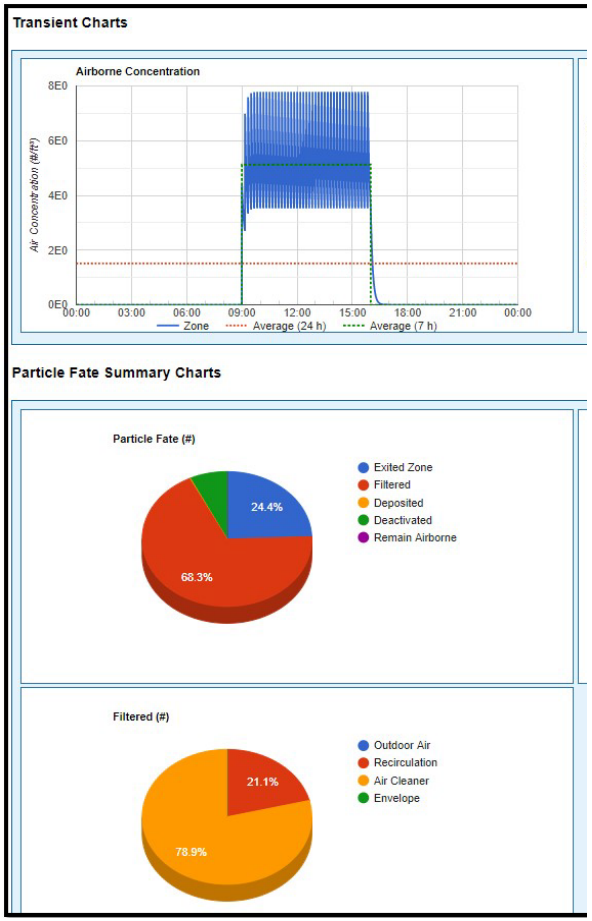
WORK THE PLAN

Wells-Riley Equation – Can I model transmission risk? Use Setty modeling spreadsheet.



NIST, FaTima

$$C = S[1-\exp(Iqpt/Q)]$$

C = new infections
S – number of susceptibles
I = number of infectors
Q = number of infectious doses
P = pulmonary ventilation rate per susceptible
t = exposure time
Q = flow rate of contaminated air

Translate?

We have the factors to individually adjust to reduce “C”. We can apply engineering principles to reduce airborne transmission

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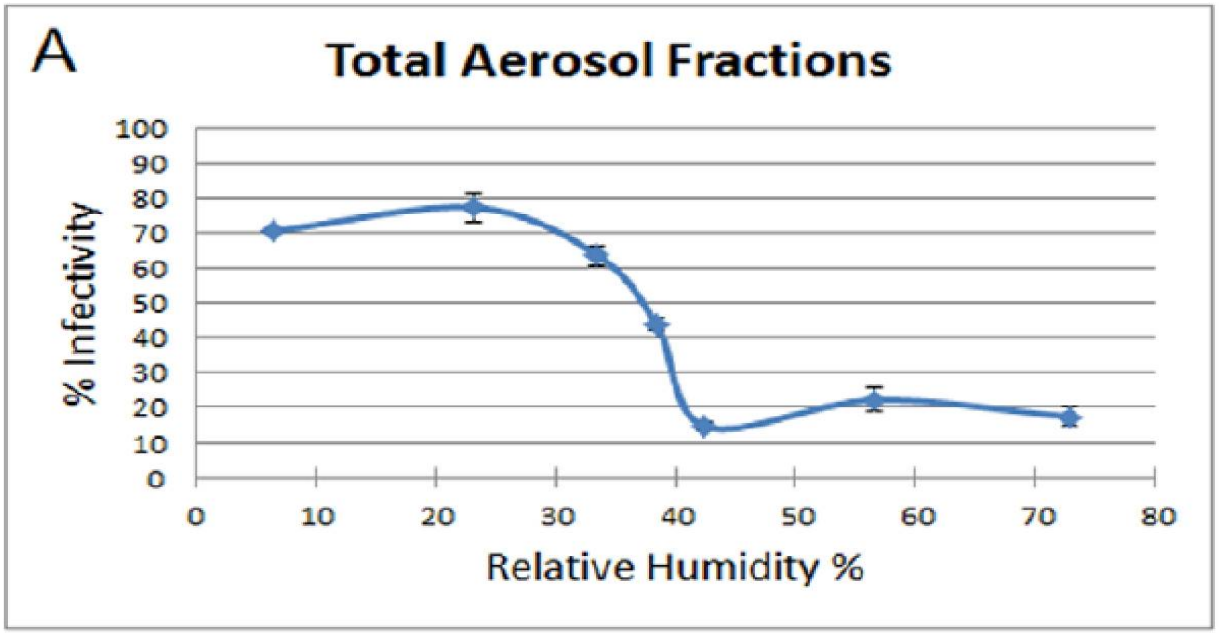
What do we know* about Airborne Transmission?

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



Influenza A is the subject of the study

*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.

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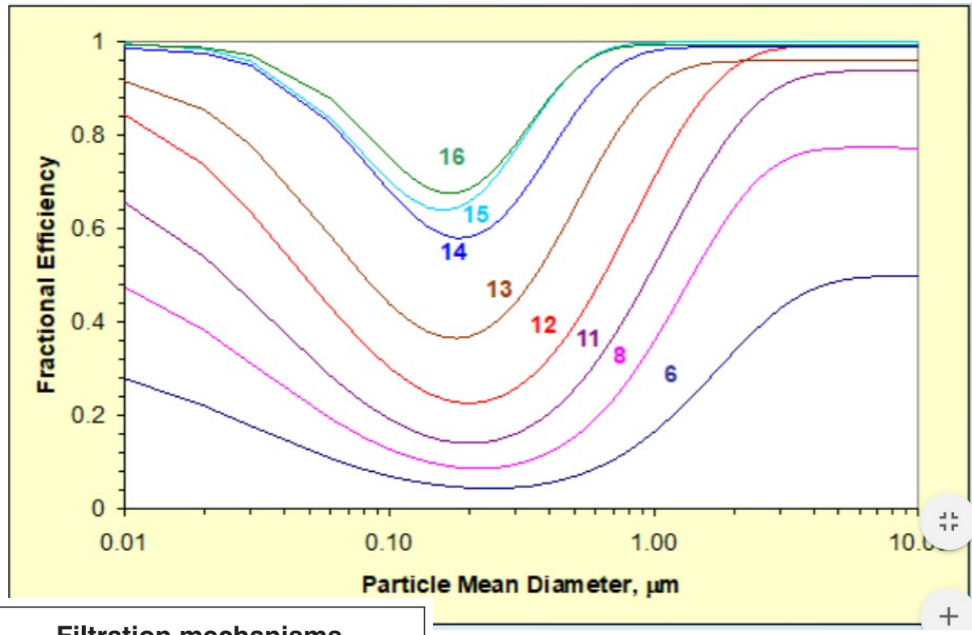
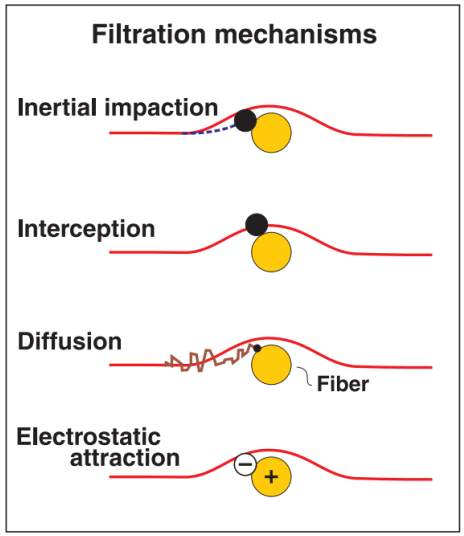
Filtration – target MERV 13

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.





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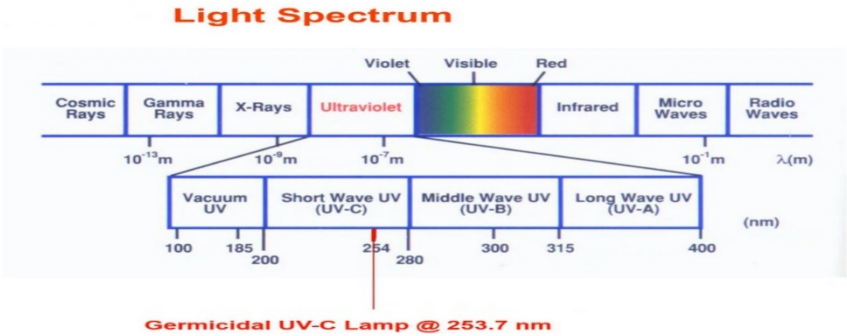
DISINFECTION

UV-C and IAQ Tech to Consider

- Electronic air filters/air cleaners - Agglomeration
- **UV-C in air handlers and UV-C 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



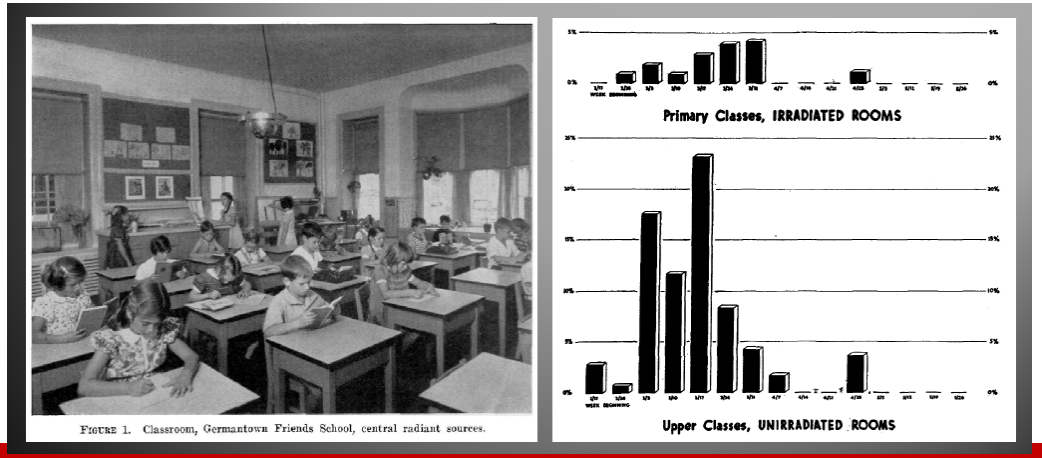


FIGURE 1. Classroom, Germantown Friends School, central radiant sources.

Watch out for Ozone

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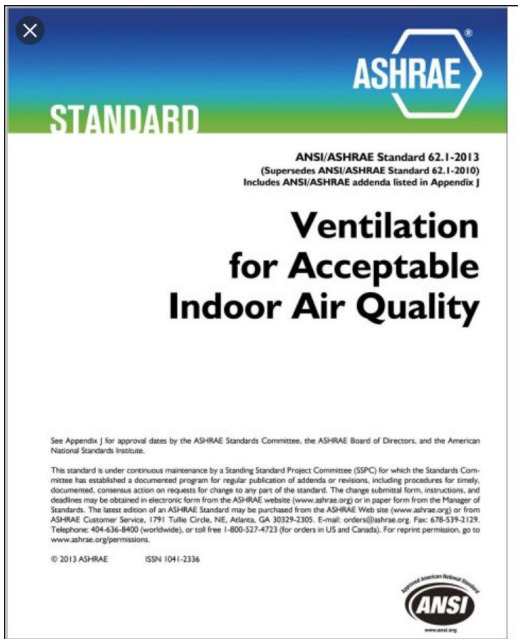
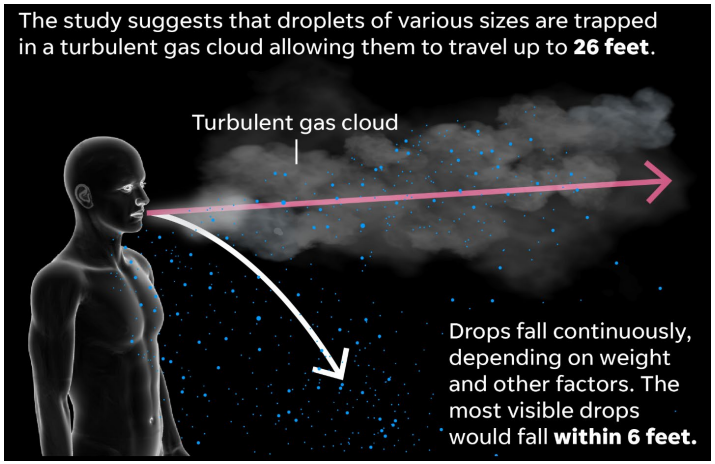
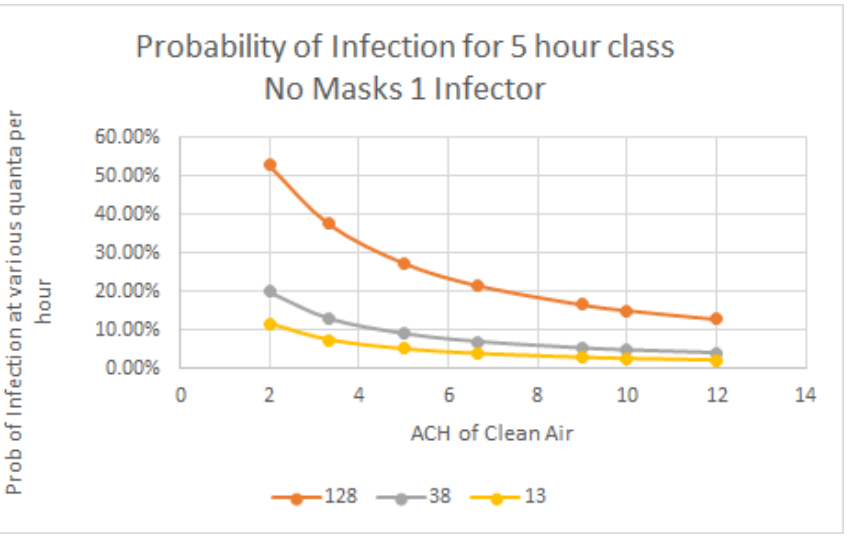
Outside Air Ventilation - Dilution

- Outside Air requirements are governed by ASHRAE 62.1
- There is no relaxation in the 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.





Air Change 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:

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

What is the game plan?

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BUILD A PLAN

WORK THE PLAN

First: Financial Budgeting Guiding Principles

As you establish a budget use 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 and 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 or elec. disinfectant	1 Air Changes (Once an hour) 0 Point	2 Air Changes (Once an hour) 1 Point	4 Air Changes (Once an hour) 2 Points	6 Air changes (Once an hour) 4 Points	4	1	4
		DOAS (Dedicated Outside Air System)	None 0 Points	Minimum per ASHRAE 62 1 Point	DOAS size 10% above code 2 Points	DOAS 30% above code 4 Points	4	0	0

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Second: 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 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

Third: Get Organized, 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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Fourth: Develop Playbooks for Operations

- Entry/Circulation - Security and Entry Protocols
  - *Phased entry, thermographic scanning, disinfection protocols, questionnaire, telepresence. Temperature apps*
- Operational – Sick Child? Develop metrics for action – 10% out sick, close school? People flow

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Fifth: 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
- After maintenance activities, wash hands with soap and water, or 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

Easy to Implement Recommendations – Short & Long Term

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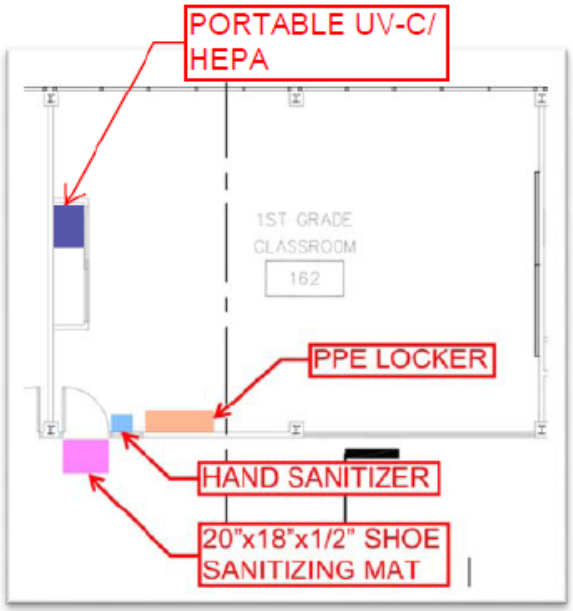
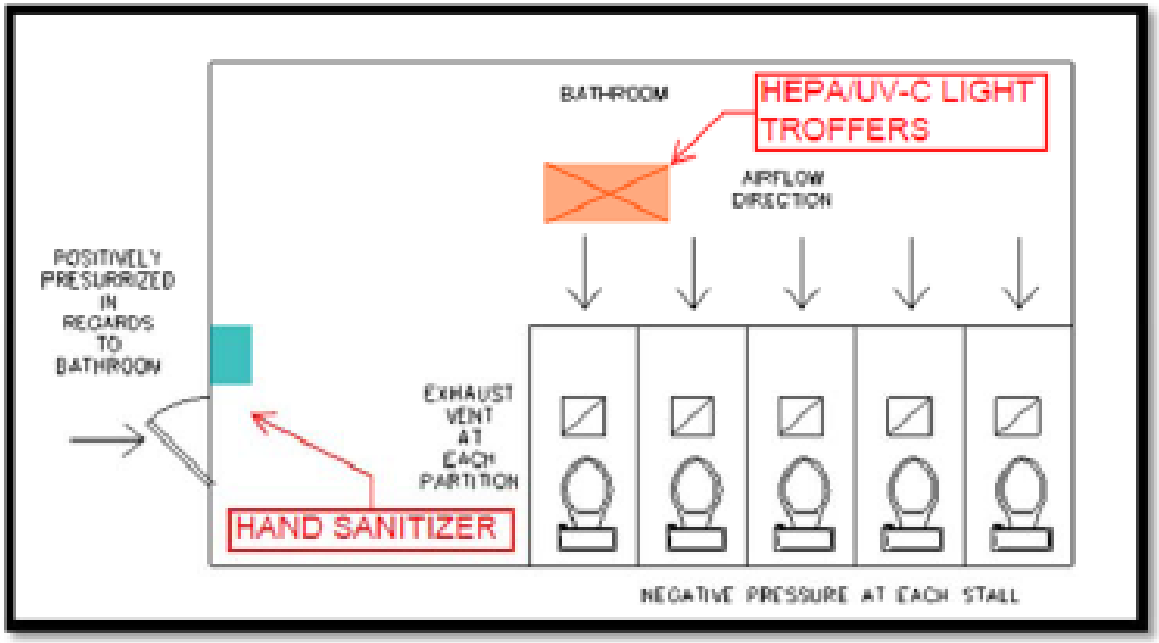
Common Sense Recommendations – *Short Run*

- 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
- 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

Recommendations – *Long Run – Areas where you can't social distance*

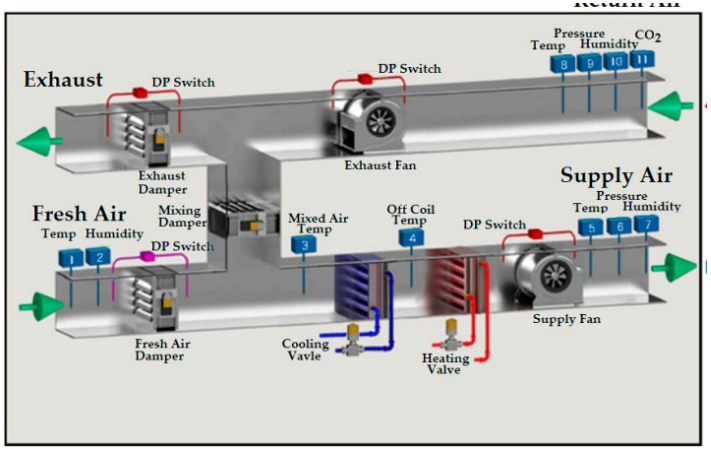


Typical Bathroom Layout

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

Recommendations – *Future Strategies to the Plan*

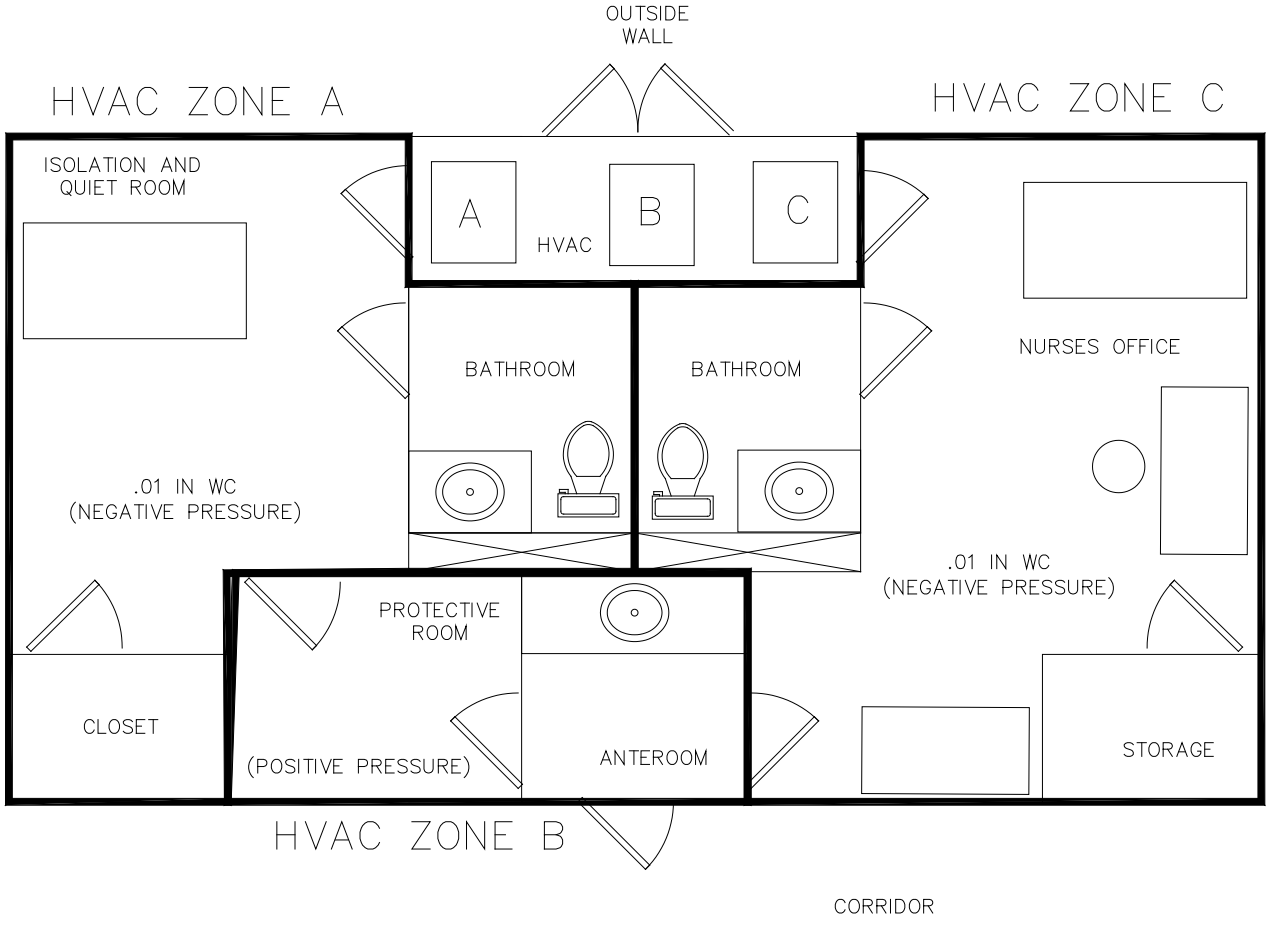
- Disinfectant **Mats** at all entrances
- Evaluate by climate zone, **DOAS** with energy recovery per ASHRAE 90.1
- Convert all AHU's to operate with **MERV 13/14 with motor upgrades**
- Include UV-C to all AHU's
- Plan for humidifiers in the class, 40% RH
- Operator to switch to **"Building Air Flush"** 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



Recommendations – *Long Run – specialized areas*

- Nurses Stations
  - Isolation rooms – Follow ASHRAE 170
  - Conduct on risk assessment by area
  - Provide one isolation per 500 students (minimum of 2)
  - 100% Outside Air unit
  - Anteroom/Protective Equipment Room
  - Normal non-isolation nursing station
  - Biohazard waste and PPE storage
  - Dedicated HVAC

Recommendations – *Long Run – specialized areas*



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Questions?

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