Re-Opening Our Schools: Activities and Recommendations

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Learning Objectives

- Be able to explain to clients, school facilities and parents how dilution helps lower the transmission risk
- Understand when and where to use filtration and other air disinfectants
- Learn how to apply the risk mitigation strategies to schools
- Help clients formulate a re-opening plan for the Fall
- Be able to identify capital vs. operating budgets and how it will impact these projects

Course Outline

Virus Basics

Filtration Technology for schools

UV-C and Oxidation technology schools

Air Side systems Short Term

Air Side systems long term

Nurse’s stations

Airflow strategies for where social distancing is not possible

Air flush – Sequence of Operations

Classifications of Building

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: Engage your HVAC P.E. to audit and re-certify the building changes

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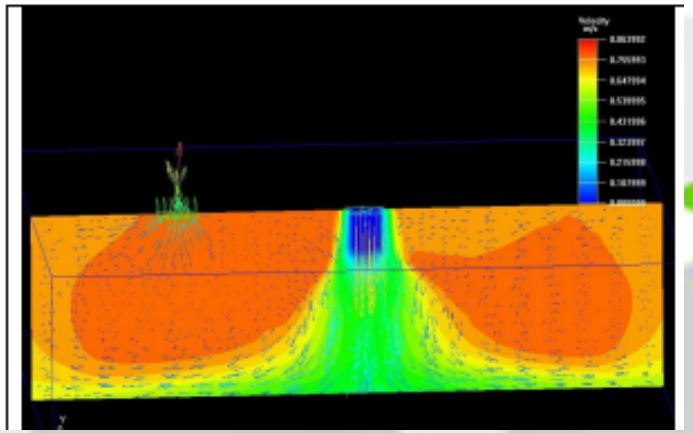
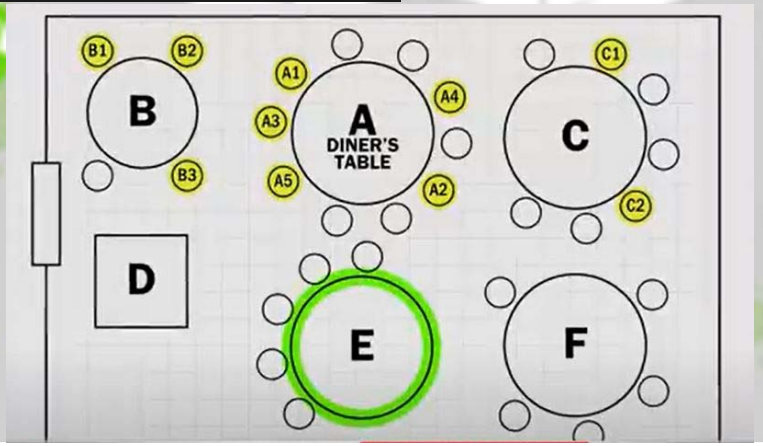
Room Air Recirculation can spread contaminants?
Partitions are not the solution.



HVAC diffusers are meant to mix the air

Chinese restaurant case study of transmission via HVAC



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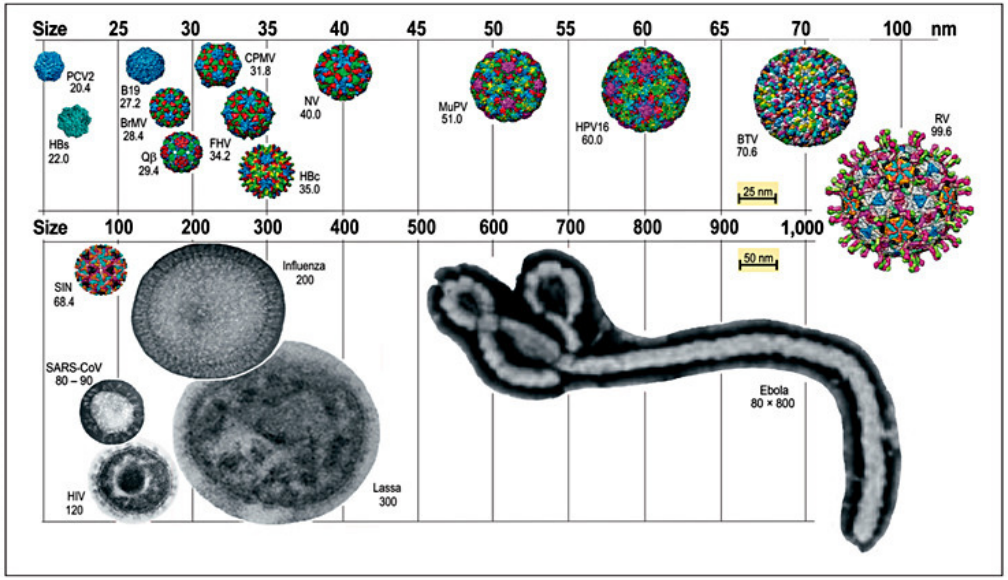
What do we know about Viruses?



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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What do we know about Airborne Transmission?

ASHRAE's (American Society of Heating 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 and **filtration** provided by HVAC systems can reduce the airborne **concentration** of SARS-CoV-2 and the **risk of transmission** through the air.

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Centers for Disease Control

CDC Resources/References

CDC provides guidance on the Opening and Continued Operation of Educational Facilities on the CDC website.

CDC is leaving specific decisions up to local jurisdictions and agencies.

CDC guidance states:

"Intensify cleaning, disinfection, and ventilation"

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Know Limitations

Compliance will not mitigate all risks. Guidance is to provide direction on viable means of harm reduction and reduce the risk of transmission.

Many infectious diseases (including SARS-CoV-2) are primarily transmitted through direct person-to-person contact or through large aerosol droplets exchanged at close range (approximately 6 ft).

It is possible to transmit infectious aerosols between spaces through HVAC systems so additional consideration is warranted.

Disinfection of surfaces and Sanitizing procedures are still considered a primary means of mitigation.

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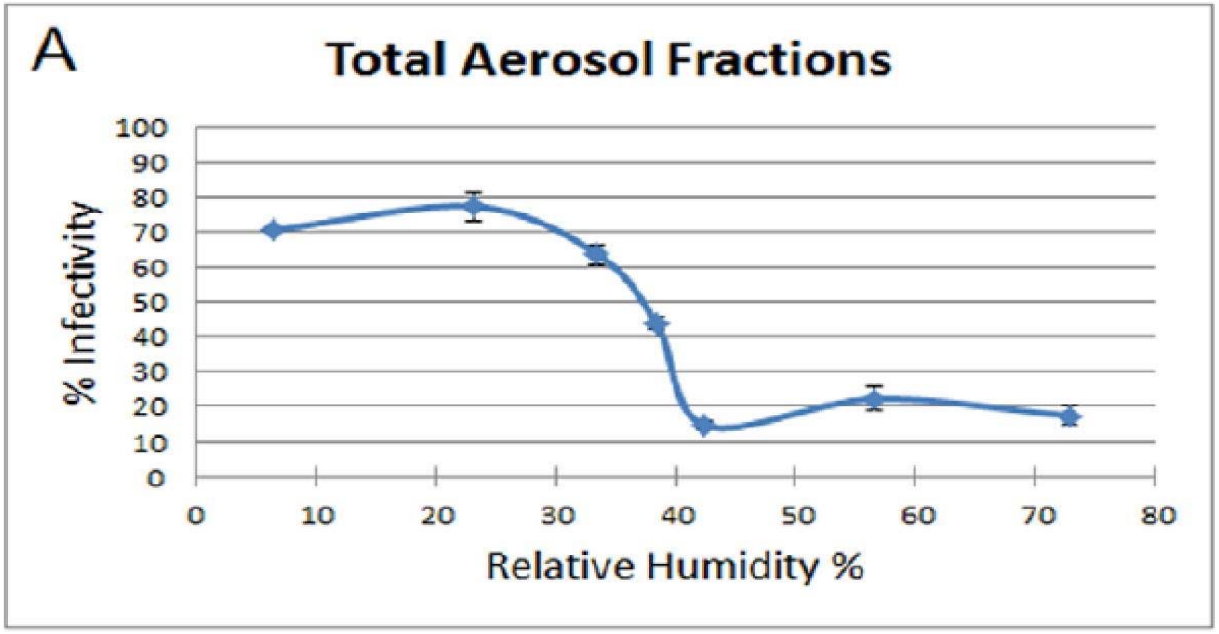
What do we know* about Airborne Transmission?

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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General Concepts

1. Shutdown of HVAC systems is not typically recommended (Environmental) Recommended 72°-76°F 40-60% RH
2. Increase Outdoor Air Rates (Dilution) More is better
3. Improve Filtration (Pathogen Reduction) More is better
4. Permanent Apply air cleaning and disinfecting equipment (Pathogen Reduction)
5. Interim Filtration and Disinfecting equipment (Pathogen Reduction)
6. Air Distribution and Path (Pathogen Reduction)
7. Continuous Monitoring

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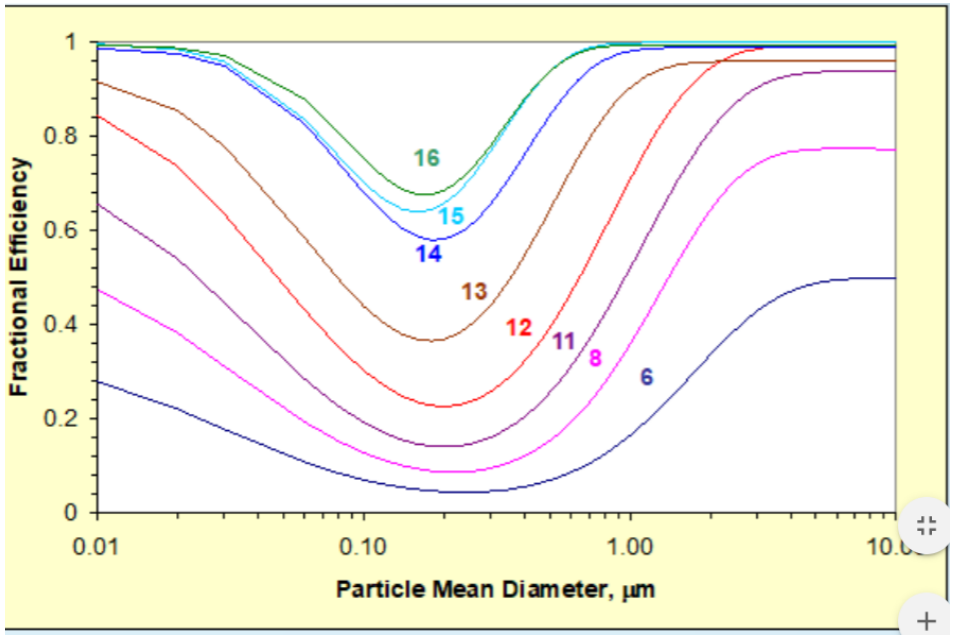
Filtration

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 Level for Filtration for Schools is MERV 13 or higher



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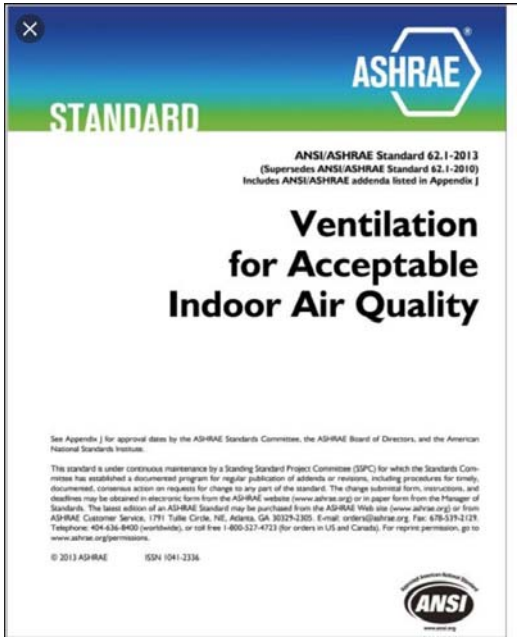
Outside Air Ventilation

- Outside Air requirements are governed by ASHRAE 62.1
- There is no relaxation in the code requirements
- Ionization is not allowed to substitute OA 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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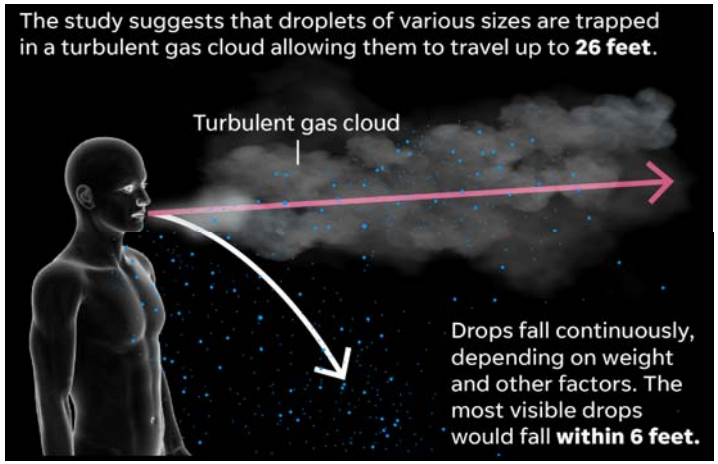

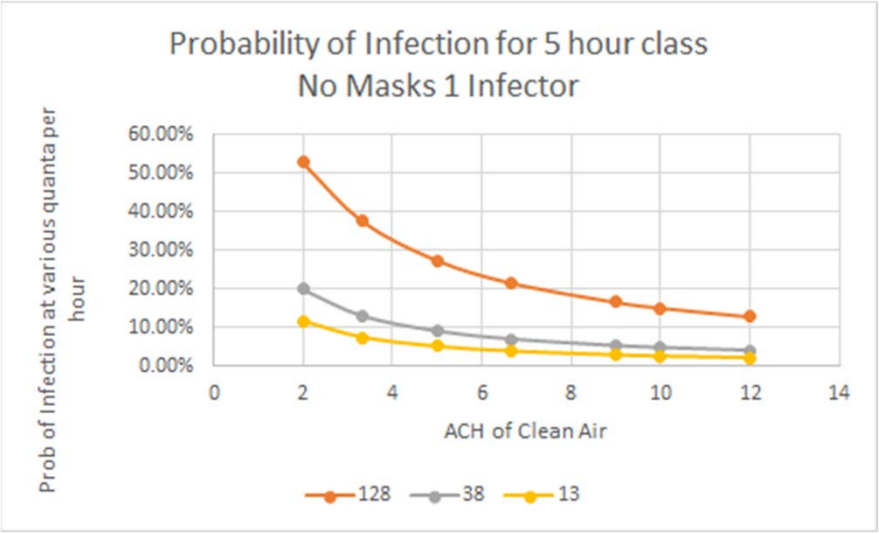

Air Change of Clean Air

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

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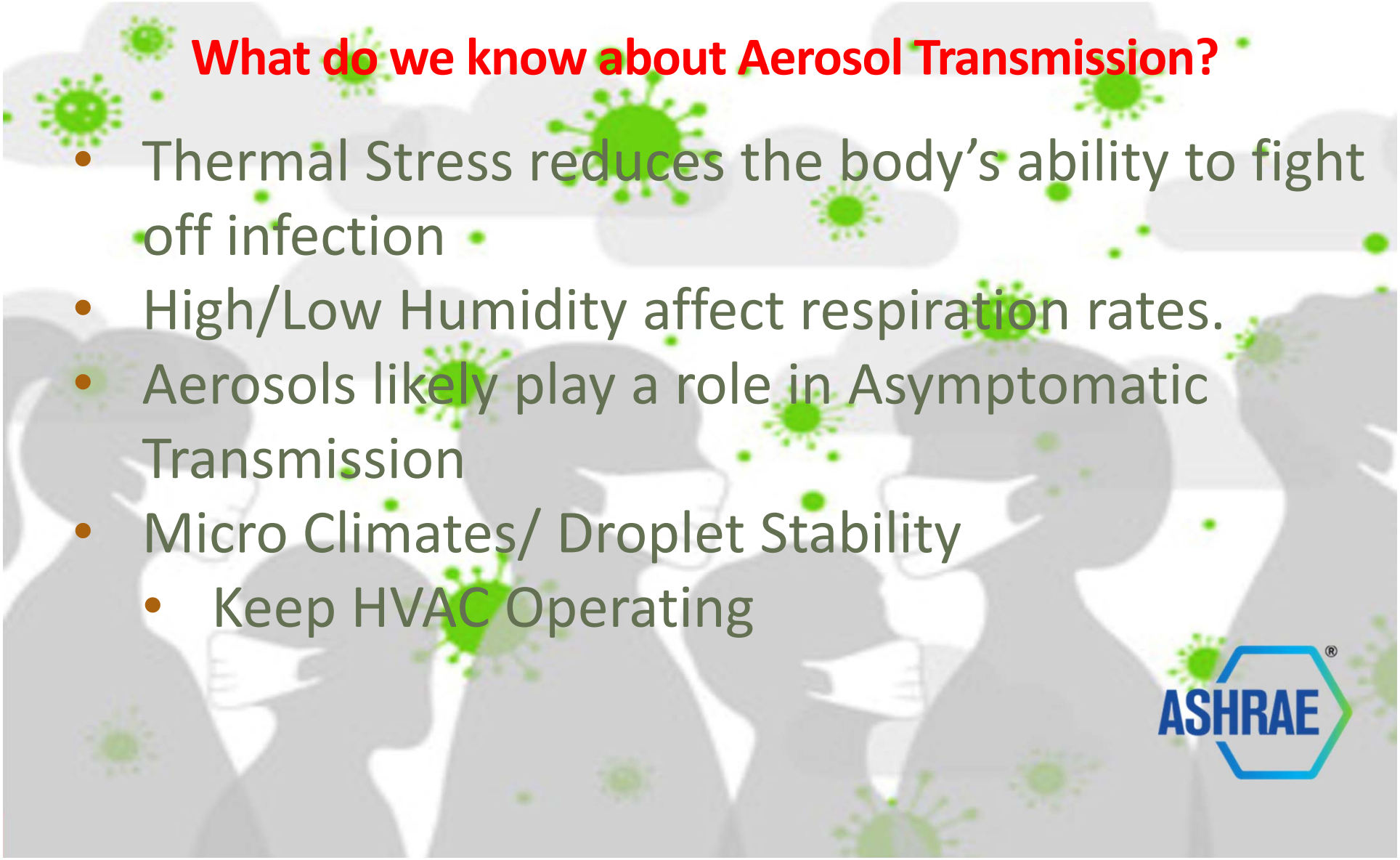
What do we know about Aerosol Transmission?

- Thermal Stress reduces the body's ability to fight off infection
- High/Low Humidity affect respiration rates.
- Aerosols likely play a role in Asymptomatic Transmission
- Micro Climates/ Droplet Stability
  - Keep HVAC Operating



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UV-C and UV Tech to Consider

- Electronic air filters/air cleaners
- **UV-C in ductwork and UV-C in upper-air units**
- UVGI – ultraviolet germicidal irradiation
- UV-A (400-315 nm)
- UV-V (under 200 nm) can generate ozone
- Photocatalytic Oxidation (PCO)
- Bipolar Ionization (Refer to ASHRAE position document)
- Vaporized Hydrogen Peroxide (VHP)
- Pulsed Xenon (Pulsed UV)
- 405 nm visible light (“Near UV”)
  - Virus Kill Effectiveness NOT well documented, see study “the environmental control of epidemic contagion, wells”
- Far UV (205 to 230 nm)
  - Can be harmful to people; limited effect on viruses

Watch out for Ozone

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What about energy efficiency?

There are **8760** hours in a year.

Occupancy is roughly **3000 hours** per year. Recommendations in this presentation are focused on preventing spread of airborne infections without consideration for energy impacts.

We must be energy efficient in the other 5760 hours.

Give your operators the OPTION to run their systems in a **Building Air Flush** mode

What is the game plan?

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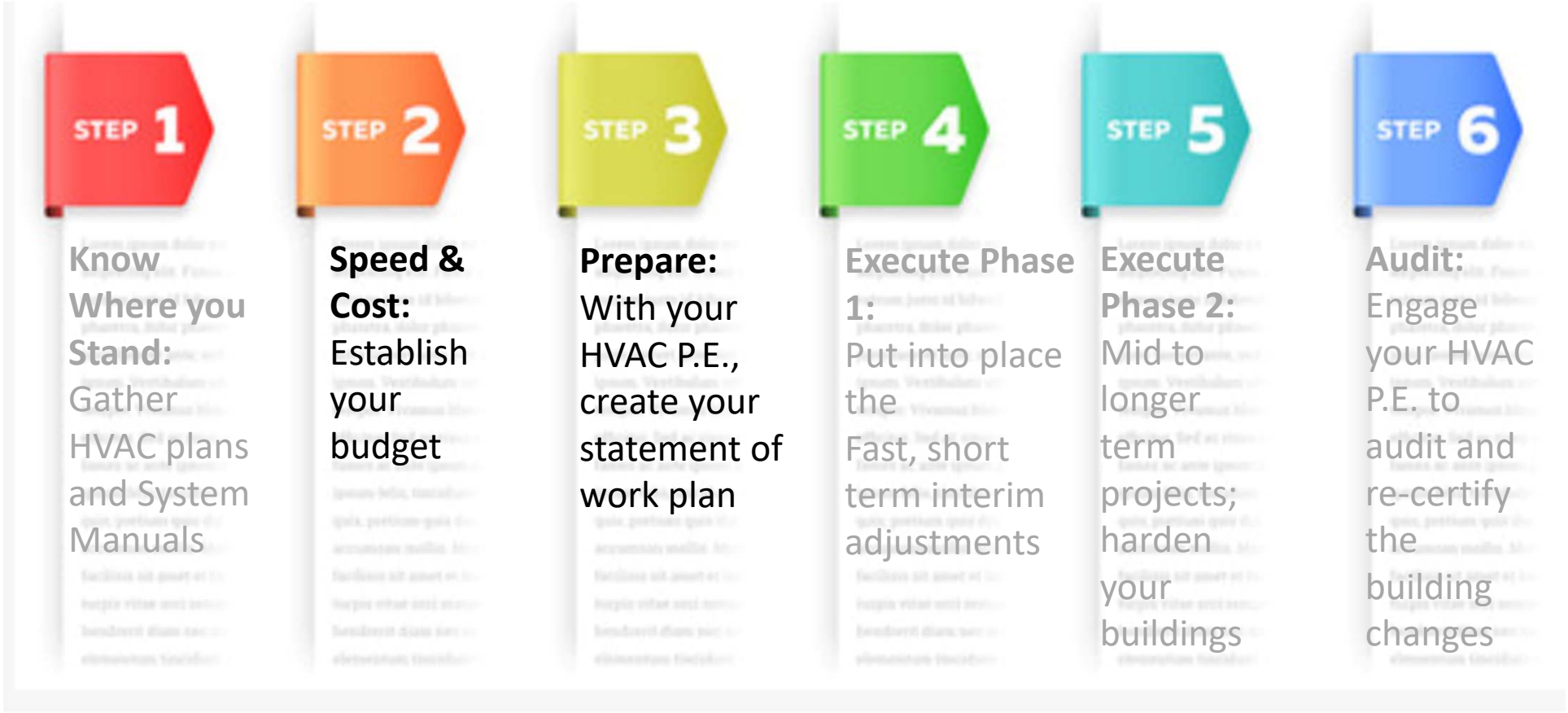
BUILD A PLAN

WORK THE PLAN

BUILD A PLAN


STEP 1
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Execute Phase 1: Put into place the Fast, short term interim adjustments
STEP 5
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STEP 6
Audit: Engage your HVAC P.E. to audit and re-certify the building changes

BUILD A PLAN

Guiding Principles

Do No Harm and Stay informed with correct information

ASHRAE Infectious Aerosols Position Document

ASHRAE Environmental Health COVID-19 Emerging Issues Brief

ASHRAE COVID-19 Preparedness Resource Website

Use your Resources, Education and Experience

Climate conditions

School Policies on occupancy

BUILD A PLAN

First: 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
- Review existing maintenance and operations policies and procedures:
  - Custodial Operations
  - Preventative Maintenance
  - Deferred Maintenance

BUILD A PLAN

Second: Facilities/Maintenance PPE

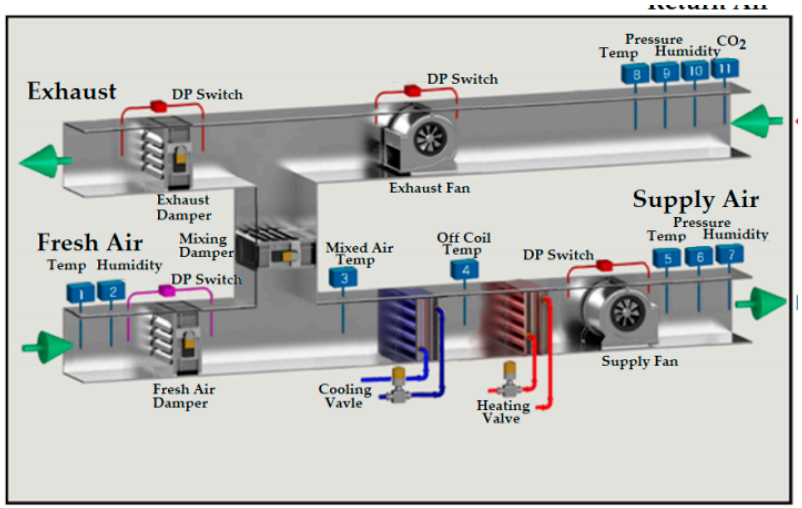
- Eye Protection and Masks
  - **Surgical or cloth mask respiration** filtering
  - Safety glasses (side shields preferred)
  - Face shields
- Disposable Gloves
  - Can be vinyl, rubber, or nitrile
  - Double gloves reduces likelihood of cuts/punctures
  - Can be worn under work gloves if necessary
- 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

BUILD A PLAN

Third: Get Organized

- Baseline/Indoor Air Quality – Professional Engineer
  - *Check Temps and Humidity – find out how much OA you have*
- Maintenance - Prioritize HVAC backlog – Building Engineer
  - *Ex: Outside Air Dampers, building management systems*



BUILD A PLAN

Fourth: HVAC Pre-Assessment

Gather Information- Administrative Phase

Consult **original design** and construction teams and professionals when available

Gather **Manuals** and maintenance information on systems in place

Review **Filter Order** information for existing MERV 13 or higher

Work with contract service providers – verify contract roles and responsibilities and response times. Review Force Majeure clauses with legal counsel before an event occurs.

Work with vendors and procurement officers to make sure supplies will not be interrupted

Understand your **Building Management System (BMS)**

BUILD A PLAN

Assess existing systems and equipment

- Break into simple modifications and systems not requiring significant changes

Document all deficiencies

Engage External Resources as needed to Complete assessments where time or technical resources are limited

Develop a repair plan facility by facility and on equipment level

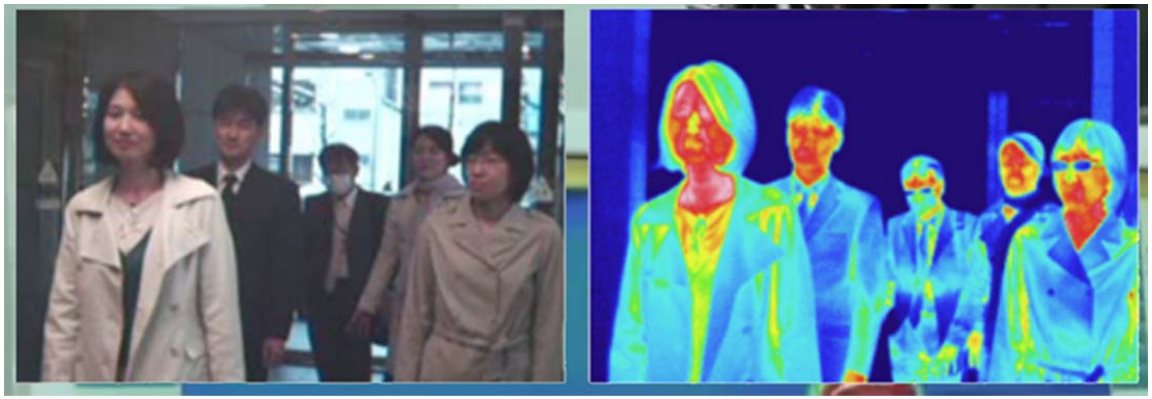
Develop sequences of Operation for

- Normal Occupied Mode
- Normal Unoccupied Mode
- Emergency shutdown
- Partial shutdown
- Starting back up after an event – re-occupancy

BUILD A PLAN

Sixth: Develop Playbooks for Circulation

- Entry/Circulation - Security and Entry Protocols
  - *Phased entry, thermographic scanning, disinfection protocols, questionnaire, teleprescence*
- Operational - Touchless Systems and Circulation
  - *Water fountains, Water Bottle Fillers, Revolving Doors, Elevators*



BUILD A PLAN

Financial Budgeting

As you establish a budget include the four main factors

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

Easy to Implement Recommendations – Short & Long Term

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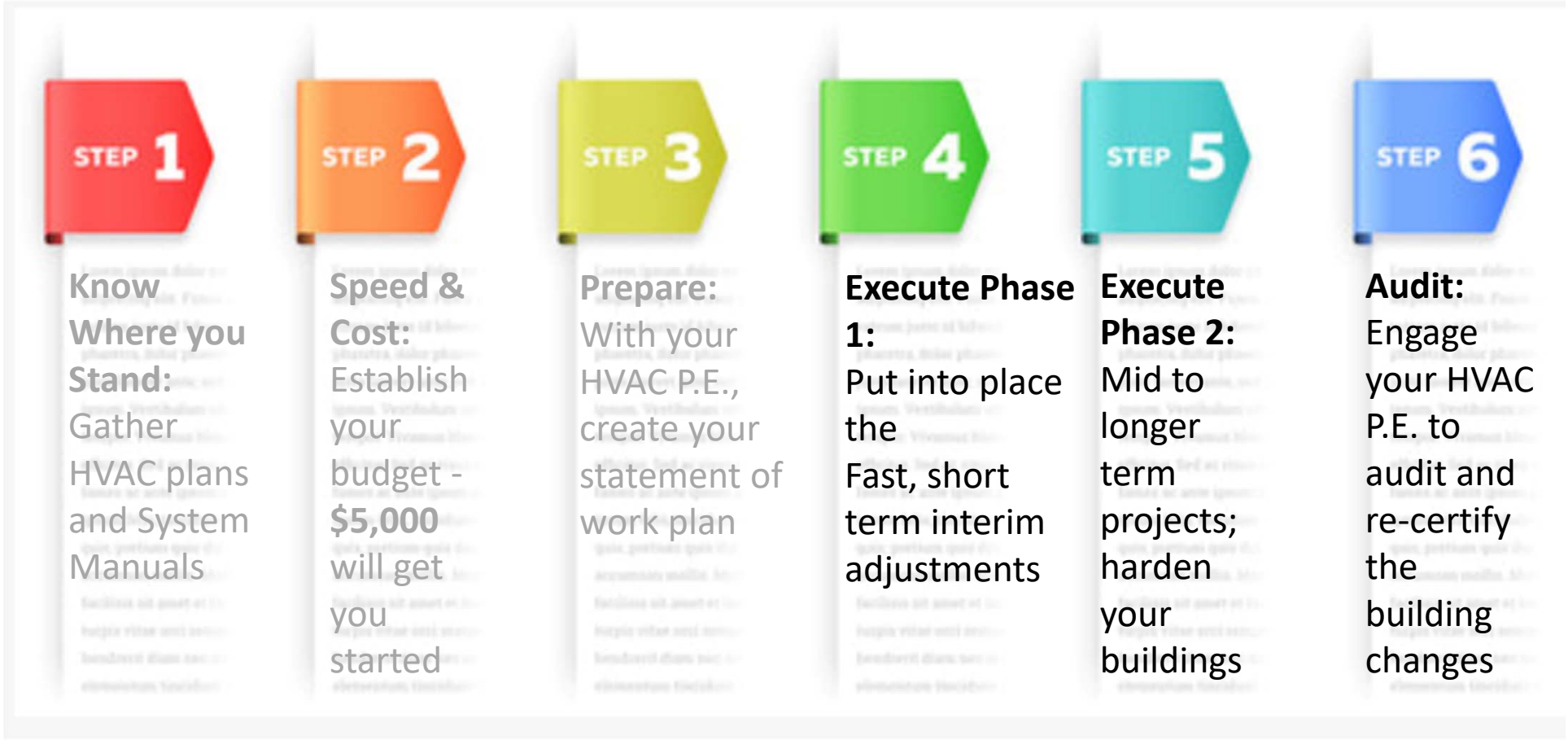
BUILD A PLAN

WORK THE PLAN

WORK THE PLAN



WORK THE PLAN.

Roll Out

Distribute the plan to all stakeholders

Walk the facility with all stakeholders

Consult insurers, legal counsel as necessary

Consult local, state and federal regulators, as necessary

Collaborate with stakeholders to plan for modifications to operations

Organize pricing of the plans and schedule

Continue routine and scheduled maintenance

Keep good records!

WORK THE PLAN

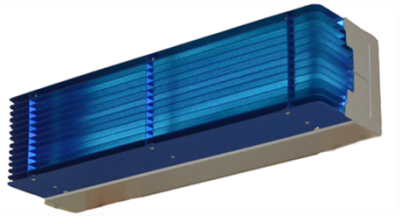
Easy to Implement Sample Recommendations – *Short Run*

- Add **HEPA or MERV13/14 filters** to 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**
- Consider temperature readings for everyone entering building
- PPE storage cabinet
- Test operations of **Heat Wheels**
- ***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***

WORK THE PLAN

Recommendations – *Future Strategies to the Plan*

- Ability to keep classrooms and corridors under either positive or negative pressure
  - Ducted return no plenum return in areas of high risk
- Evaluate by climate zone, **DOAS** with energy recovery per ASHRAE 90.1
- Convert all AHU's to operate with **MERV 13/14 or HEPA**
- Assess for all AHU's to include UV-C
- All AHU's to have humidifiers to maintain 40% RH
- Operator to switch to **"Building Air Flush"** Mode
- Disinfectant **Mats** at all entrances
- Mailroom and Loading isolation
- Consider airflow paths, **supply high/return low**
- Upgrade Restrooms Exhaust to minimize transmission
- Have filtration strategies for systems reviewed by HVAC Professional



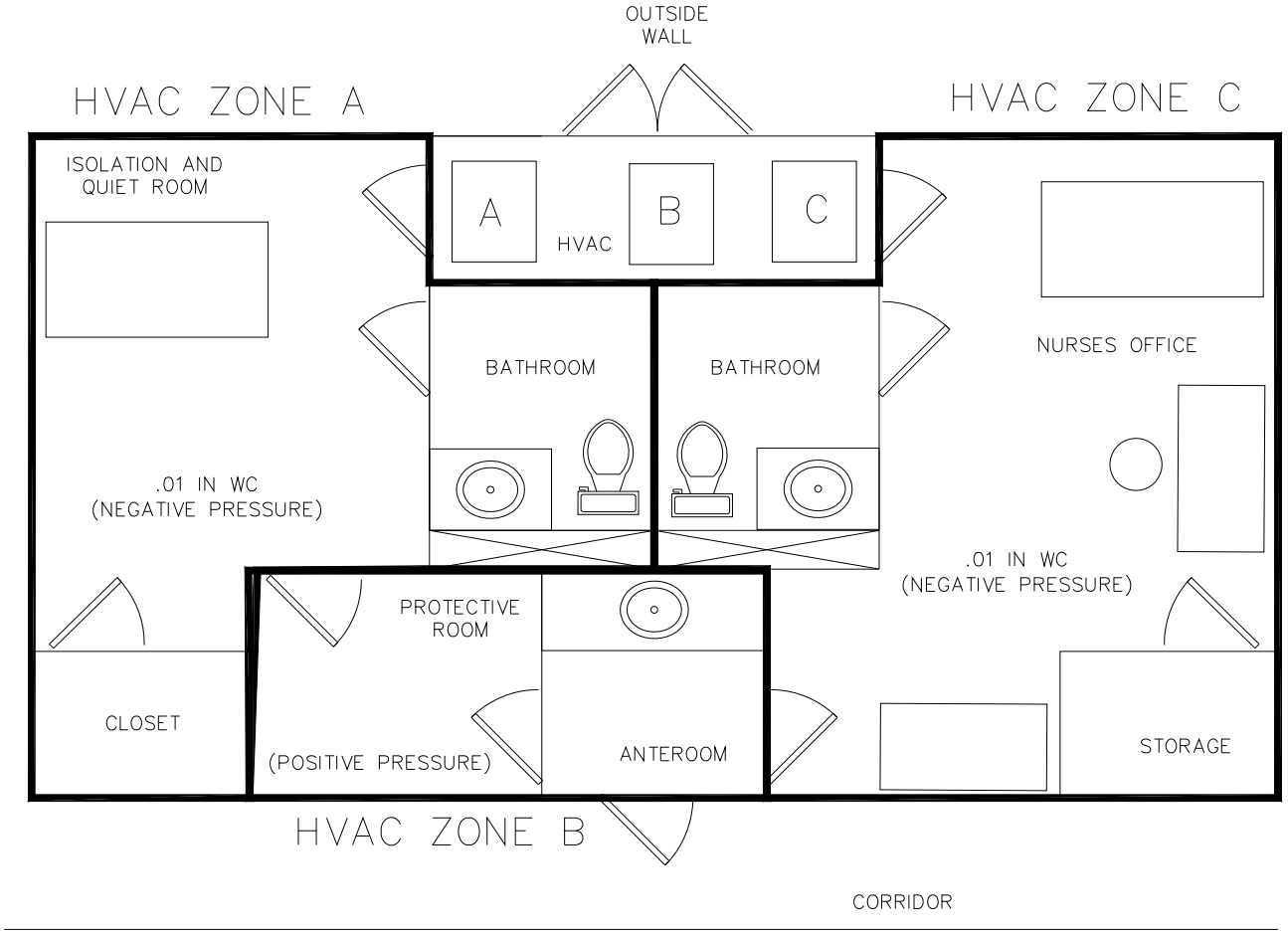
WORK THE PLAN

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

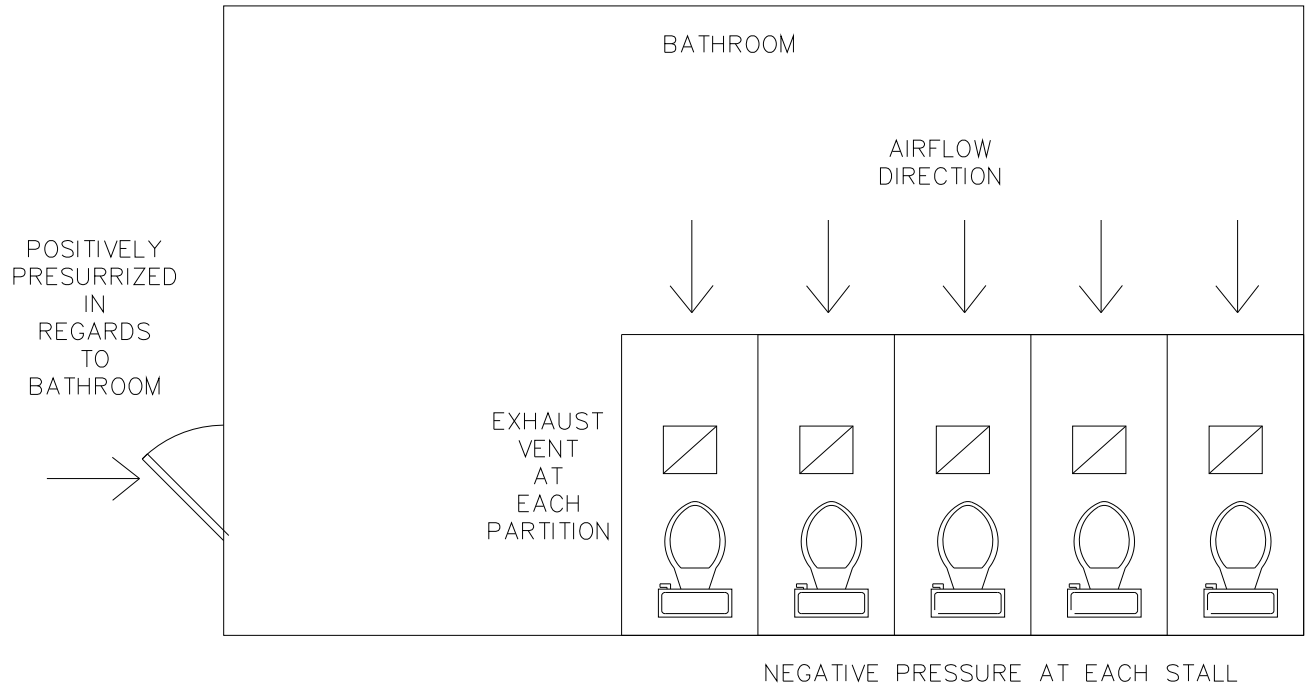
WORK THE PLAN

Recommendations – *Long Run – specialized areas*



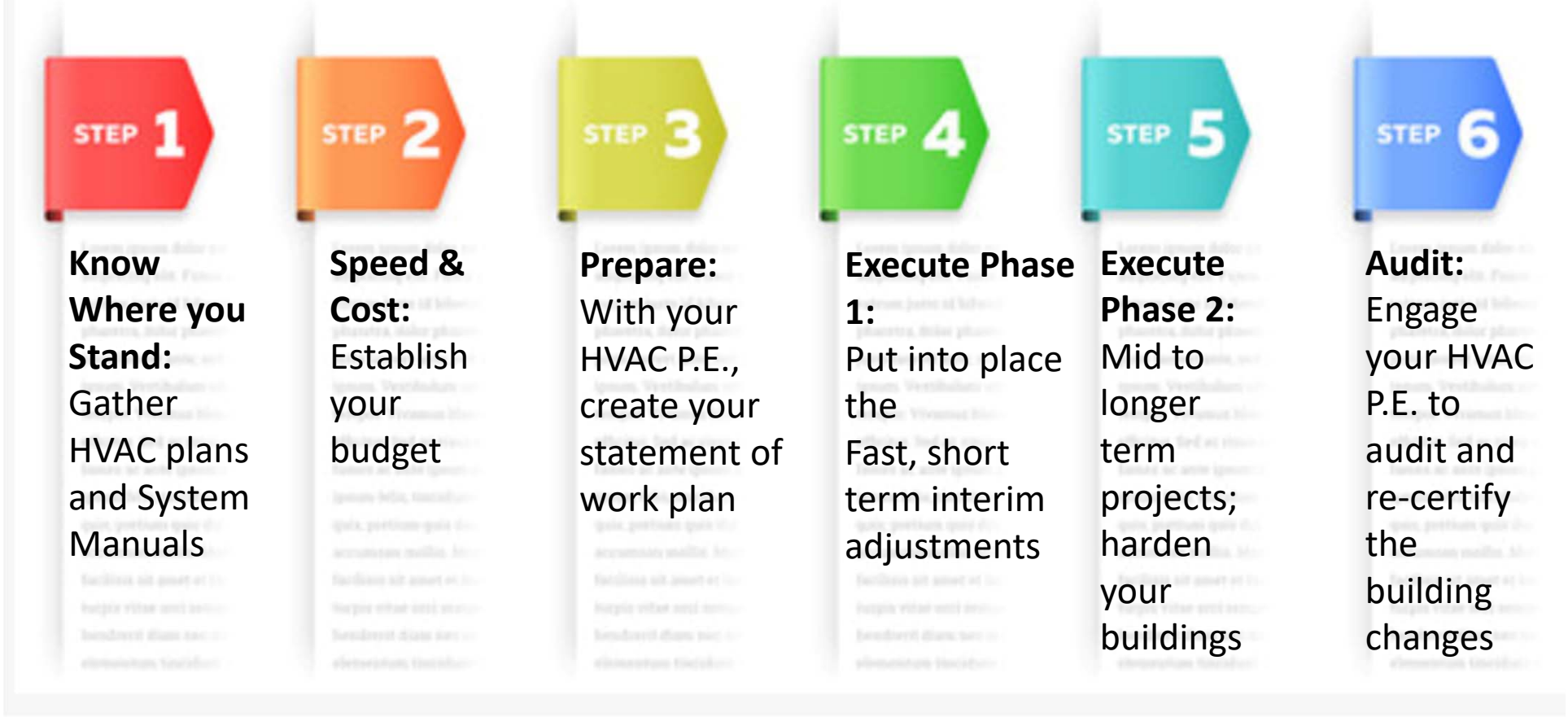
WORK THE PLAN

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



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

WORK THE PLAN



Questions?

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