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

Chinese restaurant case study of transmission via HVAC

HVAC diffusers are meant to mix the air
What do we know about Viruses?

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)*

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

For Detailed SARS/COVID guidance:
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.
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”
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.
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

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
### Target Level for Filtration for Schools

The minimum filtration level for schools is MERV 13 or higher. This ensures that indoor air quality is maintained at a high standard, protecting the health and well-being of students and staff. The table below outlines the typical applications and limitations for various filtration levels, as well as the recommended filter types.

<table>
<thead>
<tr>
<th>MERV</th>
<th>Typical Particle Size (μm)</th>
<th>Typical Applications and Limitations</th>
<th>Typical Air Filter/Cleaner Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0.3 to 1.0</td>
<td>Hospital, institutional care</td>
<td>Pleated filters</td>
</tr>
<tr>
<td>7</td>
<td>1.0 to 3.0</td>
<td>General, office, light schools</td>
<td>Box filters</td>
</tr>
<tr>
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<td>3.0 to 5.0</td>
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<td>Pleated filters</td>
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<td>5.0 to 7.0</td>
<td>Light industrial, light schools</td>
<td>Pleated filters</td>
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<td>7.0 to 10.0</td>
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<td>Pleated filters</td>
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<td>3</td>
<td>10.0 to 20.0</td>
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<td>Pleated filters</td>
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<td>20.0 to 30.0</td>
<td>Commercial, industrial</td>
<td>Pleated filters</td>
</tr>
<tr>
<td>1</td>
<td>30.0 to 40.0</td>
<td>Commercial, industrial</td>
<td>Pleated filters</td>
</tr>
</tbody>
</table>

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

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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.
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
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
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?

GET EDUCATED
BUILD A PLAN
WORK THE PLAN
Step 1: Know Where you Stand: Gather HVAC plans and System Manuals

Step 2: Speed & Cost: Establish your budget

Step 3: Prepare: With your HVAC P.E., create your statement of work plan

Step 4: Execute Phase 1: Put into place the Fast, short term interim adjustments

Step 5: Execute Phase 2: Mid to longer term projects; harden your buildings

Step 6: Audit: Engage your HVAC P.E. to audit and re-certify the building changes
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
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
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
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*
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)
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
Sixth: Develop Playbooks for Circulation

- **Entry/Circulation** - Security and Entry Protocols
  - *Phased entry, thermographic scanning, disinfection protocols, questionnaire, telepresence*

- **Operational** - Touchless Systems and Circulation
  - *Water fountains, Water Bottle Fillers, Revolving Doors, Elevators*
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

GET EDUCATED
BUILD A PLAN
WORK THE PLAN
WORK THE PLAN

**Know Where you Stand:**
Gather HVAC plans and System Manuals

**Speed & Cost:**
Establish your budget - $5,000 will get you started

**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
**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**
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
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*
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

**STEP 1**
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**STEP 2**
**Speed & Cost:**
Establish your budget

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