ASHRAE EPIDEMIC TASK FORCE

SCHOOLS & UNIVERSITIES | Updated 5-14-2021

Introduction

Protecting the health, safety and welfare of the world's students from the spread of SARS-Cov-2 (the virus that causes COVID-19 disease) is essential to protecting the health, safety and welfare of the entire population.

ASHRAE's position is that Transmission of SARS-CoV-2 is significant and should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning [HVAC] systems, can reduce airborne exposures."

There is broad variation of complexity, flexibility, and age in HVAC equipment, systems, controls and Building Automation Systems (BAS) in educational facilities.

This guidance has been formulated to help designers retrofit and plan for the improvement of indoor air quality and to slow the transmission of viruses via the HVAC systems. The underlying effort of the designer should be to mitigate risk of airborne pathogen transmission through a combination of strategies, including increased ventilation, better filtration, improved air distribution, or use of other air cleaning or treatment technologies. Control options should be selected to provide desired exposure reduction while minimizing associated energy penalties. The designer should also be concerned with maintaining indoor comfort as defined by the design temperature and relative humidity.

This guidance should be applied to each unique climate zone, unique school building and HVAC system. All retrofits and modifications must not contradict ASHRAE 62.1 guidelines and must continue to meet or exceed the standards and codes adopted by local jurisdictions. The designer needs to work closely with the local school system to work in conjunction with new operational protocols and school operations.

The following is meant to provide practical information and checklists to school district and university campus environmental health managers, facility managers, administrators, technicians, and service providers to prepare educational buildings to resume occupancy. This information describes how the HVAC systems should be operating to help minimize the chance of spreading SARS-Cov-2 and how to practically check/verify that operation.

Epidemic Task Force Core Recommendations

ASHRAE Core Recommendations for Reducing Airborne Infectious Aerosol Exposure are available HERE.

Background and General Recommendations

Applicability and Limitations

- The focus of this guidance is to mitigate the potential for transmission of the SARS-CoV-2 virus through HVAC systems and to reduce concentrations of infectious aerosols present in occupied spaces to the extent possible. It should be clearly stated and understood that adherence to this guidance does not eliminate the potential for airborne transmission of the virus and should not serve as a replacement for other steps such as social distancing, use of masks or other face coverings, cleaning and disinfection of surfaces, etc.

- This guidance is primarily focused on HVAC systems within school and higher education facilities – many organizations are likely to have challenges outside of these facilities as well – transportation systems (primarily buses) may be an area of specific concern
  - Refer to the ASHRAE Epidemic Task Force Transportation Guidance for additional information

General Operations References

Guidance from cognizant authorities should be followed to the extent possible. Select guidance that is likely applicable for educational facilities includes:

- United States CDC Readiness and Planning Tool to Prevent the Spread of COVID-19 in K-12 Schools.
  - This reference provides recommendations for policies, general operations, response protocols, communications, etc.
- United States CDC Guidance for K-12 School Administrators on the Use of Cloth Face Coverings in Schools and Additional Considerations Table.
  - These documents provide guidance for K-12 facilities in the use of cloth face coverings.
- United States CDC Considerations for Institutions of Higher Education.
  - This reference provides general information, risk assessment guidance, and recommendations for higher education institutions.
- United States CDC Guidance for Cleaning and Disinfecting.
  - This reference provides cleaning guidance for multiple building types and should be applicable to most K-12 and higher education spaces.
- WHO Advice on the use of masks in the context of COVID-19.
  - Background for recommendations associated with masks or face coverings and recommendations for use under different circumstances.

- Harvard T.H. Chan School of Public Health – Schools For Health
  - Risk reduction strategies, guide to checking ventilation, classroom calculators.

Guidance from individual states or territories (United States):

- Johns Hopkins University eSchool+ Initiative – Analysis of Reopening Plans.
  - This reference includes basic information on state K-12 reopening plans and links to information from individual states where specific guidance and requirements can be located.

Determining Building Readiness and Operations for Existing Facilities to Reoccupy After Shut-Down due to Pandemic

These recommendations and strategies are organized in order from simple first steps, more involved next steps and then more long-term improvements

1. Create a District or Campus Health and Safety Committee that includes all stakeholders (environmental health and safety, administration, education staff, operations staff, local healthcare providers, etc.)

2. Develop policies for staff and contractor PPE requirements for completing work at facilities that follow local authority, CDC, and OSHA guidelines for the proper use of Personal Protective Equipment (PPE).

3. Where semi-annual / annual scheduled maintenance on the equipment can be performed safely, do not defer this maintenance cycle.

4. Where worker safety could be at risk, defer semi-annual/ annual maintenance on the equipment up to 60 days until worker safety can be accomplished.

5. During the summer period before occupancy perform Checklist No. 1 Summer Checklist for Fall Start of Classes.

6. Operate all HVAC in occupied mode for following minimum periods prior to resuming full occupancy:
   1. Any time staff or others are in the building.
   2. 24 hours if systems have operated during closure period.
   3. Up to one week prior to occupancy if systems have been shut down to bring temperature and humidity under control prior to occupancy.

7. During the week prior to occupancy perform Checklist No. 2 Startup Checklist for HVAC Systems Prior to Occupancy.

Checklist No. 1: Checklist for Unoccupied Buildings Prior to Occupying:

- ❑ Review design guidance for potential system modifications to comply with this guidance.
- ❑ Review air distribution conditions of existing spaces (look for covered diffusers, blocked return grilles, overly closed supply diffusers/registers and return/exhaust grilles creating short cycling, possible measurements of airflows by commissioning or balancing professionals, possible review of overall system configuration by design professional, etc.)
- ❑ Review existing Indoor Air Quality issues, if any, records of documents and investigate current status of complaint and address any deficiencies identified, if possible.
- ❑ General inspection of spaces to identify any potential concerns for water leaks or mold growth that could negatively impact occupant health.
- ❑ Check all lavatories and sinks for correct operation and ensure soap dispensers are functional and adequate supply of soap is available to allow for proper handwashing.
- ❑ Coordinate with local utilities to identify when buildings will be restarted, identify when systems will be operated (if different than prior operations) and identify that demands may increase (primarily electric but gas may apply as well for some facilities).
- ❑ Consider completing preventative and deferred maintenance projects not directly related to pandemic, but potentially improving facility IEQ:
    - ❑ Clean/disinfect building surfaces, focusing on high touch surfaces – secure spaces from access once cleaning is complete.
    - ❑ Consider asbestos abatement work if applicable.
    - ❑ Consider lead paint abatement work if applicable.
    - ❑ Consider access improvements, including repairs to walkways and ramps, ADA upgrades, handrail repairs, etc.
    - ❑ Consider grounds work including improvement of water drainage away from buildings, planting of native plants or trees to help control water penetration into ground and shading of facilities to reduce cooling load.
- ❑ Review control sequences to verify systems are operating according to this guidance to maintain required ventilation, temperature and humidity conditions to occupied areas.
- ❑ Address or clear existing alarms from Building Automation Systems/Building Management Systems to allow for recognition of new alarms that may impact building indoor air quality and consider alarm hierarchy.
- ❑ Consider completing preventative and deferred maintenance projects not directly related to pandemic, but potentially improving facility IEQ.

Checklist No. 2:

Startup Checklist for HVAC Systems Prior to Occupancy

- ❑ Maintain proper indoor air conditions (temperature and humidity) to maintain occupant comfort (refer to ASHRAE Standard 55), and to limit potential for mold growth in building structure and finishes
- ❑ Review potential for maintaining space relative humidity between 40% and 60%, which may reduce potential for airborne viral transmission
- ❑ Humidification during heating season in cold climates creates significant potential for condensation in/on building envelope components – addition of, or modification to, humidification in these areas should be reviewed by competent professionals before changes are incorporated
- ❑ Trend and monitor temperature and humidity levels in each space to the extent possible and within the capability of BAS, portable data loggers and handheld instruments.
- ❑ Verify proper separation between outdoor air intakes and exhaust discharge outlets to prevent/limit re-entrainment of potentially contaminated exhaust air (generally minimum of 10-foot separation - comply with local code requirements).
- ❑ Consider having airflows and building pressurization measured/balanced by a qualified Testing, Adjusting and Balancing (TAB) service provider.
- ❑ Consider having airflows and system capacities reviewed by design professionals to determine if additional ventilation can be provided without adversely impacting equipment performance and building Indoor Environmental Quality (IEQ).
- ❑ Measure building pressure relative to the outdoors. Adjust building air flows to prevent negative pressure differential.
- ❑ Verify coil velocities and coil and unit discharge air temperatures required to maintain desired indoor conditions and to avoid moisture carry over from cooling coils.
- ❑ Review outdoor airflow rates compared to the most current version of ASHRAE Standard 62.1 or current state-adopted code requirements.

Checklist No. 2 Continued:

Startup Checklist for HVAC Systems Prior to Occupancy

- **Filtration in all mechanical equipment:**
  - ❑ Verify filters are installed correctly.
  - ❑ Develop standards for frequency of filter replacement and type of filters to be utilized.
  - ❑ Select filtration levels (MERV ratings) that are maximized for equipment capabilities, use MERV 13 if equipment allows, while assuring the pressure drop is less than the fans capability. See Filtration Upgrades.

❑ **Disable Demand-Controlled Ventilation (DCV) systems using Carbon Dioxide (CO2) sensors where feasible:**
  - ❑ Either disable control sequence or adjust setpoints to be at or near ambient outdoor CO2 levels (typically between 400 and 500 ppm)
  - ❑ Trend and monitor levels continuously if controls system is capable of doing so (use portable data loggers and handheld instruments and document readings where needed to demonstrate compliance with District or Campus requirements).
  - ❑ Consider adjusting to maximize outdoor air or disabling operation of DCV if it will not adversely impact operation of overall system (Temporary recommendation while operating under infectious disease crisis).
  - ❑ Systems incorporating diversity into sizing may require DCV to maintain ventilation to occupied spaces – consideration should be given to system capabilities and outdoor air flow rates should be maximized.

❑ **Perform initial air flush of all spaces prior to occupants re-entering building:**
  - ❑ Mechanical systems should operate in occupied mode for minimum period of one week prior to students returning (may be completed at same time as teachers start returning to building) while assuring the outside air dampers are open.

❑ **Domestic water systems shall be prepared for use:**
  - ❑ Systems should be flushed to remove potential contaminants from stagnant equipment, piping, fixtures, etc.
  - ❑ Domestic cold-water systems should be flushed with all fixtures on a branch of piping opened simultaneously for a minimum period of five minutes – preferred approach is to have all building fixtures open at same time if possible – if not, care should be taken to ensure flow rate is adequate to flush piping mains and branch lines.
  - ❑ Domestic hot water systems should be flushed with all fixtures on a branch of piping opened simultaneously for a minimum period of 15 minutes – preferred approach is to have all building fixtures open at same time if possible – if not, care should be taken to ensure flow rate is adequate to flush piping mains and branch lines.
  - ❑ Reference Standard 188 and Guideline 12 (available read-only on website).

Equipment and System Specific Checks and Verifications During the Academic Year

Cleaning and Air Flush: Daily

- ❑ Flush spaces between occupied periods for a duration sufficient to reduce concentration of airborne infectious particles by 95%. For a well-mixed space, this would require 3 changes of space volume using outdoor air (or equivalent outdoor air including the effect of filtration and air cleaners). In lieu of calculating the air change rate, pre- or post-occupancy flushing periods of 2 hours may be used since this should be sufficient for most systems meeting minimum ventilation standards.

- ❑ Cleaning:
  - ❑ All areas that have been occupied after previous cleaning efforts should be re-cleaned.
  - ❑ All restrooms should be thoroughly cleaned.
  - ❑ All food preparation areas should be thoroughly cleaned.
  - ❑ Any spaces not previously cleaned should have all accessible surfaces properly cleaned.

Boilers: Monthly

- ❑ For systems with Steam Boilers, develop a schedule that provides minimum supervision on-site.

- ❑ Perform chemical testing of system water. Verify water treatment target levels are being maintained.

- ❑ For systems using fuel oil:
  - ❑ Check fuel pump for proper operation.
  - ❑ Inspect fuel filter; clean and verify proper operation.

- ❑ For systems using natural gas:
  - ❑ Check gas pressure, gas valve operation, and combustion fan operation.
  - ❑ Check for evidence of leakage of fuel supply, heat transfer fluid, and flue gas.

- ❑ Verify proper operation of safety devices per manufacturer’s recommendations.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

Chilled Water, Hot Water and Condenser Water Systems: Monthly

- ❑ Perform chemical testing of system water. Verify water treatment target levels are being maintained.
- ❑ Check the control system and devices for evidence of improper operation.
- ❑ Verify control valves operate properly.
- ❑ Check variable-frequency drives for proper operation.

Air Cooled Chillers: Monthly

- ❑ Check the refrigerant system for evidence of leaks.
- ❑ Check and clean fan blades and fan housing.
- ❑ Check coil fins and check for damage.
- ❑ Check for proper evaporator fluid flow and for fluid leaks.

Water Cooled Chillers: Monthly

- ❑ Check the refrigerant system for evidence of leaks.
- ❑ Check for proper evaporator and condenser fluid flow and for fluid leaks.
- ❑ Check compressor oil level and/or pressure on refrigerant systems having oil level and/or pressure measurement means.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

Cooling Towers and Evaporative-Cooled Devices Monthly

- ❑ Perform chemical testing of system water. Verify water treatment target levels are being maintained.
- ❑ Check chemical injector device for proper operation.
- ❑ Check conductivity and other sensors for proper readings.
- ❑ Check the water system ultraviolet lamp, replace bulbs as needed (if applicable).
- ❑ Check the control system and devices for evidence of improper operation.
- ❑ Check variable frequency drive for proper operation.
- ❑ Check for proper condenser water flow and for leaks.
- ❑ Check for proper damper operation.
- ❑ Inspect pumps and associated electrical components for leaks and normal operation.
- ❑ Verify control valves operate properly.

Steam Distribution Systems: Monthly

- ❑ Perform chemical testing of system condensate and feed water.
- ❑ Check piping for leaks.
- ❑ Check steam traps and condensate return units for proper operation.
- ❑ Check safety devices per manufacturer’s recommendations.
- ❑ Verify control valves operate properly.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

HVAC Water Distribution Systems: Monthly

- ❑ Perform chemical testing of system water. Verify water treatment target levels are being maintained.
- ❑ Check for proper fluid flow and for fluid leaks. If necessary, vent air from system high points and
- ❑ verify backflow preventers and pressure regulating valves on makeup water lines are functioning properly.
- ❑ Check expansion tanks and bladder type compression tanks have not become waterlogged.
- ❑ Verify control valves operate properly.

Pumps: Annually

- ❑ Inspect pumps and associated electrical components for proper operation.
- ❑ Check variable-frequency drive for proper operation.
- ❑ Check the control system and devices for evidence of improper operation.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

Air Handling Units: Monthly

- ❑ Check for particulate accumulation on filters, replace filter as needed.
- ❑ Check ultraviolet lamp, replace bulbs as needed (if applicable).
- ❑ Check P-trap on drain pan.
- ❑ Check the control system and devices for evidence of improper operation.
- ❑ Check variable-frequency drive for proper operation.
- ❑ Check drain pans for cleanliness and proper slope.
- ❑ Verify control dampers operate properly.
- ❑ Confirm AHU is bringing in outdoor air and removing exhaust air as intended.
- ❑ Verify filters are installed correctly.
- ❑ Follow filter replacement policy.
- ❑ Review condition of cooling coils in air handling equipment – if issues with condensate drainage are identified or biological growth is identified, corrective action should be taken to clean or repair.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

Roof Top Units: Monthly

- ❑ Check for particulate accumulation on outside air intake screens and filters. Replace filter as needed.
- ❑ Check ultraviolet lamp, replace bulbs as needed (if applicable).
- ❑ Check P-trap.
- ❑ Check drain pans for cleanliness and proper slope.
- ❑ Check the control system and devices for evidence of improper operation.
- ❑ Check variable frequency drive for proper operation.
- ❑ Check refrigerant system for leaks.
- ❑ Check for evidence of leaks on gas heat section heat-exchanger surfaces.
- ❑ For fans with belt drives, inspect belts and adjust as necessary.
- ❑ Verify control dampers operate properly.

Equipment and System Specific Checks and Verifications During the Academic Year Continued

Unitary and Single Zone Equipment (For example: Wall Hung Units, Unit Ventilators, Mini-Splits, Packaged Terminal Air Conditioners, Water-Source Heat Pumps, Fan Coil Units)**:**

Monthly

- ❑ Check for particulate accumulation on filters, replace filter as needed.
- ❑ Check P-trap.
- ❑ Check drain pans for cleanliness and proper slope.
- ❑ Check the control system and devices for evidence of improper operation.
- ❑ Verify control dampers operate properly.

New/Modified Facility Design Recommendations

Introduction

This guidance has been formulated to help designers retrofit and plan for the improvement of indoor air quality and to slow the transmission of viruses via the HVAC systems. The underlying effort of the designer should be to increase outside air to the spaces, treat return air and or supply air to spaces via mechanical filtration and maintain indoor comfort as defined by the design temperature and relative humidity.

This guidance should be applied to each unique climate zone, unique school building and HVAC system. All retrofits and modifications must not contradict ASHRAE 62.1 guidelines and must continue to meet or exceed applicable codes and standards. The designer needs to work closely with the local school system to work in conjunctions with new operational protocols and school operations.

Nurse office suite design should follow health care facilities design practices as described in standards such as ASHRAE Standard 170 and other applicable guidelines and design information.

Designer Guidelines – General School

Temperature and Humidity Design Criteria

1. **Winter classroom design guidelines 72 F/40- 50% RH**
   - 40- 50% RH in winter is primary guidance via humidifiers/active humidification (central or local, depending on the classroom/space system). The humidity minimum, humidifier, and sensor location should be made after consultation with your ASHRAE professional regarding the envelope design due to the potential for condensation within the building envelope.
2. **Summer classroom design guidelines 75 F/50%-60% RH**
   Designing to 50% RH in summer is primary guidance, depending on the classroom system.

Ventilation Design Criteria/Guideline

- Follow current ASHRAE 62 standard or local ventilation standards for minimum outside air requirements.
  - Consider increasing outside air capacities beyond code minimum based on analysis completed by a qualified HVAC professional.
- For retrofitting or replacing an existing AHU, verify equipment provides required minimum outside air to all occupied spaces.
- For Dedicated Outdoor Air Systems (DOAS) that are being replaced, size unit with the following in mind:
  - Consider increasing capacities beyond code minimum for ventilation
  - Consider impact to operation and equipment sizing associated with failure of energy recovery systems or filter loading.
- During the Pandemic, disable any Demand Control Ventilation (DCV) and introduce the design outside airflow to occupied spaces until further notice (including DOAS).
- Apply and utilize outdoor air quality sensors or reliable web-based data for outdoor pollution information as part of the new ventilation operation.

Designer Guidelines – General School Continued

Filtration Design Criteria/ Guideline

1. Follow 2019 ASHRAE- Applications Handbook, chapter 8, table 7 for minimum Filtration Efficiency

- Apply the highest Minimum Efficiency Reporting Value (MERV) filter for the HVAC units (local, central and DOAS) given limitations with increase pressure drop. MERV 13 is the recommended minimum, MERV 14 is preferred per Filtration and Disinfection Guidance consider HEPA filters in critical areas.

2. Introduce terminal or portable, all electric HEPA/UV Machines in each classroom

- Target highest achievable air change rate for units that will not generate excessive noise or negatively impact space air distribution
- Ensure flow patterns maximize mixing of air in classrooms

Operation and Scheduling Guideline for Existing HVAC Systems during the Pandemic

1. Cooling and Heating equipment- Change the start of operation hours (e.g. change 6 am start to 4 am) and run DOAS

- Cooling and Heating systems (Local, central)- Goal is to create a thermal lag and minimize HVAC operations when occupied
- DOAS Systems - Run DOAS units two hours before and after occupancy.

2. Exhaust fans- Turn on when DOAS is running

- Only applies to school days not weekend operations
- Goal is to flush the building with OA and positively pressurize the building

3. Dedicated Outdoor Air Systems (DOAS) – Create "Minimum Transmission Sequence of Operation"

- DOAS Systems – Operate in occupied mode (including normal or peak outside air rate introduced to each space) to achieve minimum of three air changes of equivalent clean air supply. In cases where calculations cannot readily be completed, operate systems as described above for minimum period of 2 hours prior to occupants re-entering building.
- For DOAS units equipped with active, thermally operated desiccant dehumidifier, consult the manufacturer for safe operation.
- For new installations, designer should designate a "Purge/Flush" mode for operations to minimize the virus transmission via HVAC systems.

4. Energy Recovery Systems

- Many air handling system types (central air handling units, DOAS units, terminal systems, etc.) include Energy Recovery Ventilation (ERV) systems (these can include energy recovery wheels, plate-type heat exchangers, heat pipes, run around loops, etc.)
- Some types or configurations for energy recovery systems allow for exhaust air transfer from the exhaust airstream to the supply airstream, while others do not – depending on system configuration this may be cause for concern
  - For DOAS equipment with potential for cross contamination from exhaust air stream to outdoor air stream, verify MERV-13 filtration filters any air that may be recirculated (may be in exhaust intake position for some units).
- A document focused on operational considerations for energy recovery systems for many system types and configurations is available here.

Designer Guidelines – General School Continued

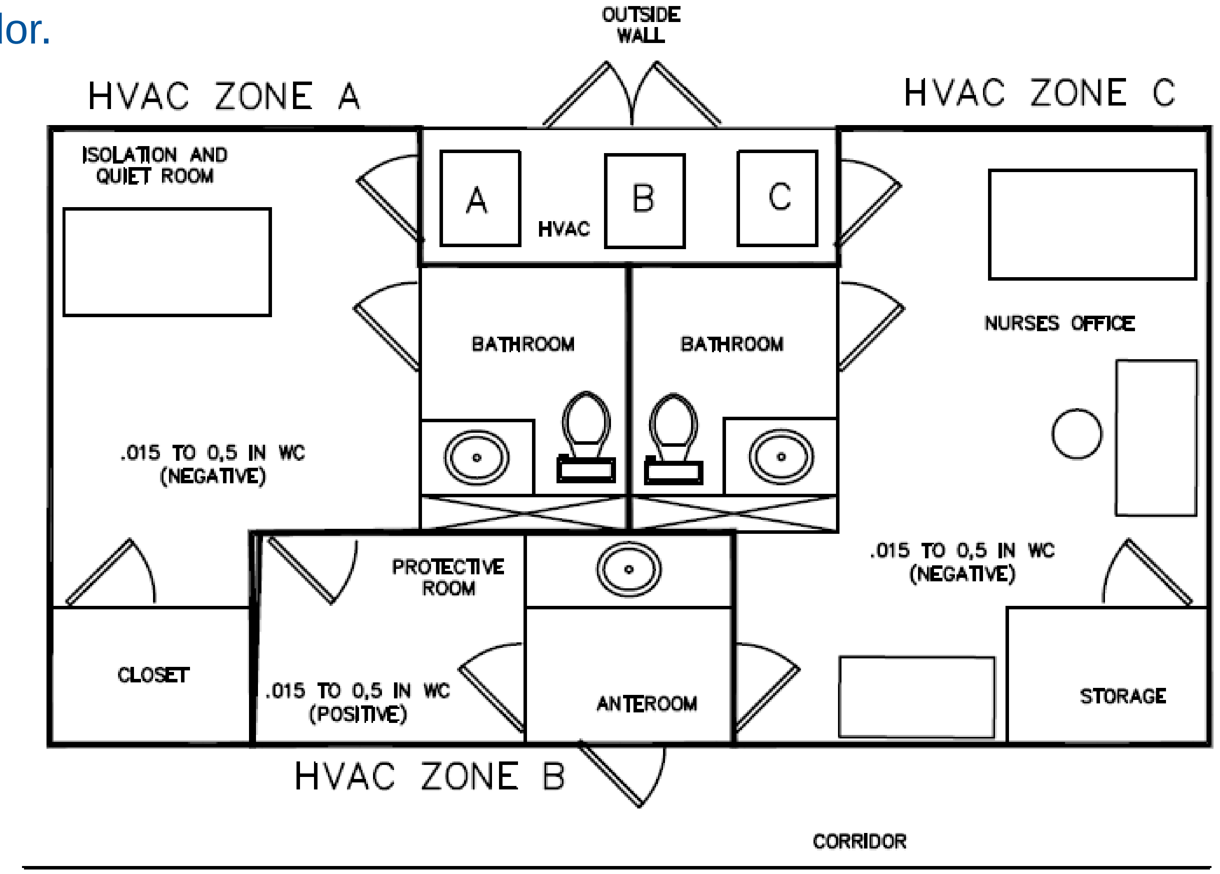
5. **AHU's (SZ and VAV) and Packaged Rooftop units (PSZ, PVAV)**
    - During the Pandemic, increase Filtration to that recommended in the Filtration Upgrade section below.
    - For existing units, an increase in filtration efficiency may reduce airflow capacity. Compensate for loss of capacity in winter with portable plug in elec. Heaters or higher discharge temps.
    - Compensate for loss of capacity in summer with lower discharge temps off of AHU – recommend 52 F (this is mainly for VAV units where supply air temperature is controlled and due to additional pressure drop associated with higher efficiency filters).
    - Check and fix economizer dampers and controls and maximize the economizer operation when possible (favorable outdoor conditions and outdoor air pollution).
    - Check, fix and modify control sequences in VAV systems to avoid outdoor air flow /minimum OA air flow shortage.
    - In VAV systems maximize the total supply air flow in each VAV terminal when the system is in full economizer mode.
    - Minimize the unit air recirculation to minimize zones cross contamination thru the return air system.
    - Consider air treatment technology to kill/disable airborne infectious aerosols (refer to the Building Readiness Document for additional guidance).
    - Consider installing Humidifiers in AHUs and Packaged rooftop units if feasible. Consideration must be given to climate zone and building envelope to avoid mold growth or IAQ problems.
    - Install duct mounted humidifiers at classrooms as an alternate.

6. **Local HVAC units (Fan Coils, WSHP, GSHP, Mini Split, VRF, Unit Ventilators, Radiators/baseboards)**
    - Increase Filtration to the maximum efficiency (highest MERV rating) recommended by the manufacturer.
    - Compensate for loss of capacity in winter with portable plug in electric heaters or higher discharge temps.
    - Hydronic /Electric radiators / baseboard should remain operational.
    - Check unit ventilators for proper amounts of OA and operation.
    - Consider installing portable humidifiers in each classroom for local humidity control if feasible. Consideration must be given to climate zone and building envelope to avoid mold growth or IAQ problems.

7. **Space Air Flow**
    - Where directional airflow is not required or recommended, verify air distribution promotes mixing of space air without creating strong air currents that increase direct transmission from person-to-person.
    - Recommended guidance is to provide lowest possible particulate concentration anywhere in the space.
    - Consider upper air UV-C treatment for select spaces. Work with a reputable ventilation engineer or UV system designer.

Nurses Office – General Requirements

- Treat as Isolation rooms – 1 bed per building – follow [ASHRAE 170 and 2019 ASHRAE Handbook Chapter 9]().
- If retrofits are not possible recommend temporary nurse's station trailers.
- Dedicated bathrooms.
- The nurse station will include Anteroom/Protective Equipment Room.
- Normal non-isolation nursing office.
- Provisions for Biohazard waste.
- Two (2) modes of operation, (1) "Isolation Mode and (2) "Normal Mode"
- For "Isolation mode" design Dedicated HVAC system.
- For the "Normal Mode" the HVAC system can be (supplementary) standard HVAC system (VRF +DOAS, Fan coils, WSHP/GSHP, DOAS etc) with current design practices (ASHRAE 62.1, ASHRAE 90.1and local codes etc).
- The HVAC operation will be "Isolation mode" OR "Normal Mode".
- Follow CDC guidelines for supply air return air paths, do not mix isolation room air with any other spaces. Directly exhaust isolation rooms. Follow design guidelines for location of OA intakes and exhaust air from exhaust fans.
- Recommend locations of nurse's office HVAC on an exterior wall.
- Maintain pressure relationship for room, ante room and corridor.



Note: Systems A, B, and C are the Dedicated "Isolation Mode "systems, each system is individually operated and controlled. The Supplementary HVAC systems for "Normal mode" are not shown.

Nurses Office – General Requirements Continued

Temperature and Humidity Design Criteria- Isolation Mode

- Winter Nurse Station design guidelines 72 F/50-55% RH
- Summer Nurse Station design guidelines 72 F/50%-60% RH

Ventilation Design Criteria/Guideline- Isolation Mode

- 100 % OA system
- Design for a maximum of 10 Air Changes per Hour (ACH), can operate at 6 ACH

Filtration Design Criteria/ Guideline- Isolation Mode

- Follow ASHRAE 170, table 6.4 – Protective Environment (PE) room filter guidelines
  - Two filter banks, MERV 7 and HEPA (MERV 14 for existing HVAC that is unable to support HEPA)

Space Pressurization Design Criteria/ Guideline- Isolation Mode

- Follow ASHRAE 170, section 7.2 and other related sections for space pressure requirements
  - Isolation Room and Nurse office will be Negative Pressure (- 0.015" to – 0.05" W.C)
  - Protective Room will be Positive Pressure ((+ 0.015" to + 0.05" W.C)
  - Given the small size of the systems serving the Nurse Station in Isolation Mode, it is suggested considering Constant Volume, hard balanced air system.

Space Air Distribution/Diffusion Design Criteria/ Guideline- Isolation Mode

- Follow ASHRAE 170, Table 6.7.2 – PE Group E non-aspirating (for additional information refer to 2017 ASHRAE – Fundamentals, chapter 20).

Nurses Office – General Requirements Continued

General Design Parameters- Isolation Mode

- Follow ASHRAE 170, Table 7-1
  - Treat as PE anteroom and combination AII/PE.
  - ACH = 10.
  - Exhaust directly to outdoors
  - No air re-circulation
  - All should be under negative pressure.
  - PE rooms with respective to adjacent rooms should be under positive pressure.
- Follow ASHRAE 170, section 7.2.1.
  - Infection Control Risk Assessment (ICRA) is to be performed for new construction and renovations of nurse facilities.
  - Refer to guidance on ICRA for renovations and creating a CX plan and well as phasing the construction.
- Follow ASHRAE 170, Section 6.8.2 which refers to energy recovery.
  - No energy recovery for airborne infectious isolation rooms.
  - Refer to section 6.8.2 exception for cases where Energy Recovery can be applied.

Operation and Scheduling Guideline

- **Isolation Mode (Dedicated 100 % OA systems)**
  - Cooling, Heating, Humidification, Dehumidification, Ventilation – run 2 hours before and after occupancy
  - Exhaust fans – run when ventilation is on
- **Normal Mode (Supplementary HVAC systems)**
  - Cooling, Heating, Ventilation - per normal school schedule(occupied/unoccupied)
  - Exhaust fans - per normal school schedule (occupied/unoccupied), might be **OFF** during unoccupied hours

Filtration Upgrades

Introduction

The focus of this section is to provide instructions for educational facility managers to increase their filtration efficiency in existing air systems on a temporary basis during the pandemic. The presentation focuses on filtration basics for a facility manager, an information gathering phase, a data analytics and review phase and lastly a series of implementation and considerations an educational facility manager may address. Refer to the section on Filtration/Disinfection under the COVID-19 resources from the ASHRAE Epidemic task Force.

This guidance has been formulated to help designers and facility managers to retrofit and plan for the improvement of indoor air quality and to slow the transmission of virus via the HVAC systems. The underlying effort of the designer should be to increase outside air to the spaces, treat return air and or supply air to spaces via mechanical filtration or treating the air and maintain indoor comfort as defined by temperature and relative humidity.

The guidance should be applied to each unique climate zone, unique school building and HVAC system. All retrofits and modifications must not contradict ASHRAE 62.1 guidelines and must continue to meet code. The designer needs to work closely with the local school system to work in conjunctions with new operational protocols and school operations.

Filtration Basics

Key Terminology for Filtration

- **MERV Rating** - Minimum Efficiency Reporting Values, or MERVs, report a filter's ability to capture particles between 0.3 and 10 microns (µm).
  - For filters with enhanced performance using static charge, consider MERV-A ratings to understand performance of filter if charge has been removed or dissipated.

- Particle Size Range – This is the composite particle size efficiency percentage within a range of particle size. The three ranges used in Std 52.2 are E1 - (0.3-1.0 µm), E2 - (1.0-3.0 µm), and E3 – (3.0-10.0 µm).

Mechanical Air Filters

- Consist of media with porous structures of fibers or stretched membrane material to remove particles from airstreams. Filters range in size but the typical depths of filters are 1”, 2”, 4” and 12-15”.
- Some filters have a static electrical charge applied to the media to increase particle removal.
- The fraction of particles removed from air passing through a filter is termed “filter efficiency” and is provided by the Minimum Efficiency Reporting Value (MERV) under standard conditions.
  - MERV ranges from 1 to 16; higher MERV = higher efficiency
  - MERV ≥13 (or ISO equivalent) are efficient at capturing airborne viruses
- Generally, particles with an aerodynamic diameter around 0.3 µm are most penetrating; efficiency increases above and below this particle size.
- Overall effectiveness of reducing particle concentrations depends on several factors:
  - Filter efficiency
  - Airflow rate through the filter
  - Size of the particles
  - Location of the filter in the HVAC system or room air cleaner

Filtration Basics Continued

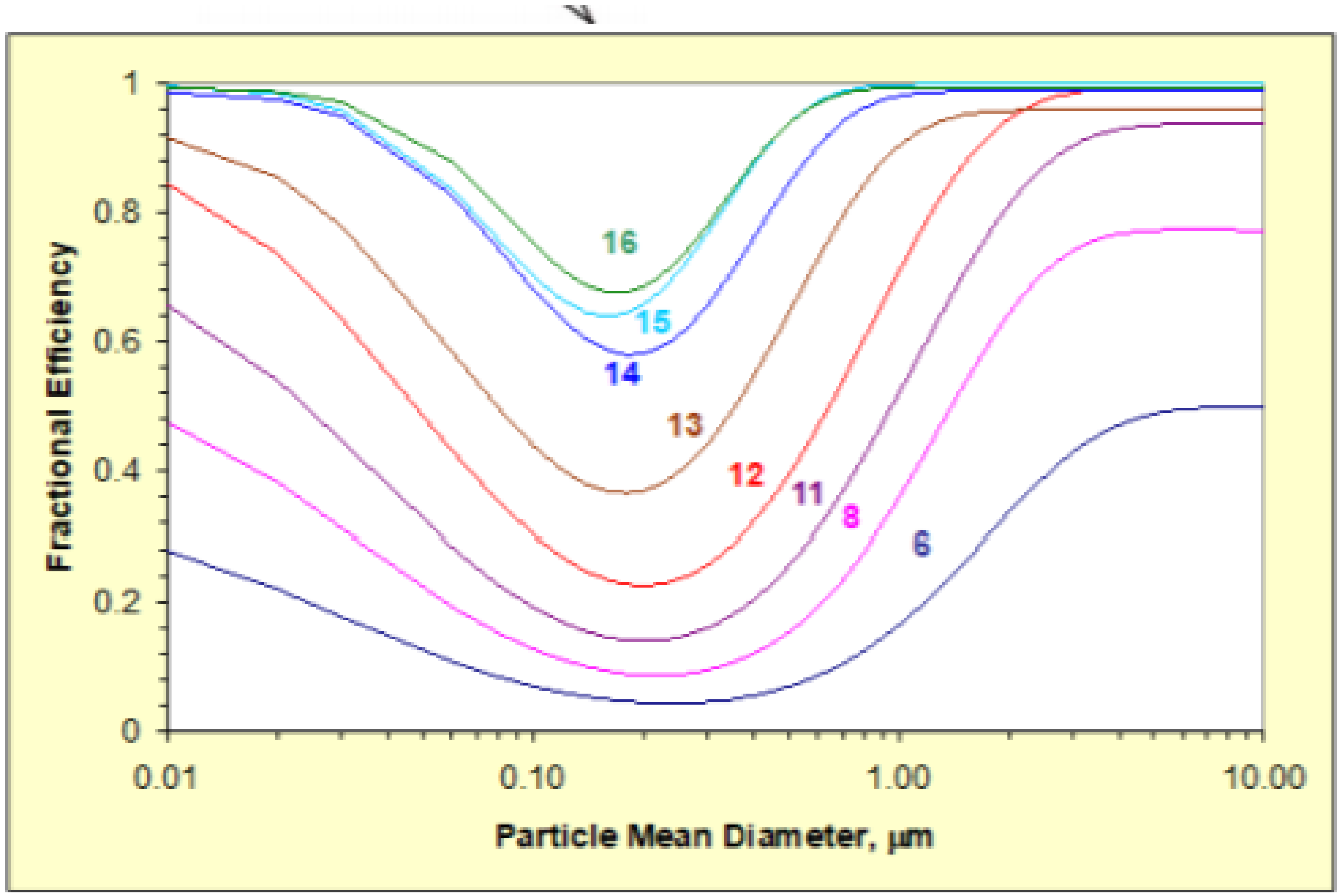
ASHRAE Standard 52.2-2017 -- Minimum Efficiency Reporting Value (MERV)

Table 12-1 Minimum Efficiency Reporting Value (MERV) Parameters

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, µm			
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0	Average Arrestance, %
1	N/A	N/A	$E_3 < 20$	$A_{avg} < 65$
2	N/A	N/A	$E_3 < 20$	$65 \le A_{avg}$
3	N/A	N/A	$E_3 < 20$	$70 \le A_{avg}$
4	N/A	N/A	$E_3 < 20$	$75 \le A_{avg}$
5	N/A	N/A	$20 \le E_3$	N/A
6	N/A	N/A	$35 \le E_3$	N/A
7	N/A	N/A	$50 \le E_3$	N/A
8	N/A	$20 \le E_2$	$70 \le E_3$	N/A
9	N/A	$35 \le E_2$	$75 \le E_3$	N/A
10	N/A	$50 \le E_2$	$80 \le E_3$	N/A
11	$20 \le E_1$	$65 \le E_2$	$85 \le E_3$	N/A
12	$35 \le E_1$	$80 \le E_2$	$90 \le E_3$	N/A
13	$50 \le E_1$	$85 \le E_2$	$90 \le E_3$	N/A
14	$75 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
15	$85 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
16	$95 \le E_1$	$95 \le E_2$	$95 \le E_3$	N/A

Filtration Target Level

Target Level for Filtration for Schools is MERV 13 or higher.
Significant improvement in removal when compared to MERV 8.



Filtration Upgrades: Information Gathering Stage

Data Collection Stage – Can be done by any staff

- Determine if the Building was CHPS Certified.
- Determine the current size, depth and quantity of filters in equipment. Make a list by piece of equipment.
- Determine if there are one or two filter banks.
- Document MERV rating of existing filters installed. May need to review previous filter orders.
- Determine the area of filter banks. This can also be determined by quantity of filters broken down by size of filter.
- Collect Original Design Drawings if available.
- Gather equipment shop drawings or Operation and Maintenance Manuals.
- Record the Model or Serial number of the air handling equipment.
- Determine the type of motor that is used in the equipment.
- Determine if the equipment served from a Variable Frequency Drive.

Record all Data Collected

Filtration Upgrades: Data Analysis & Review

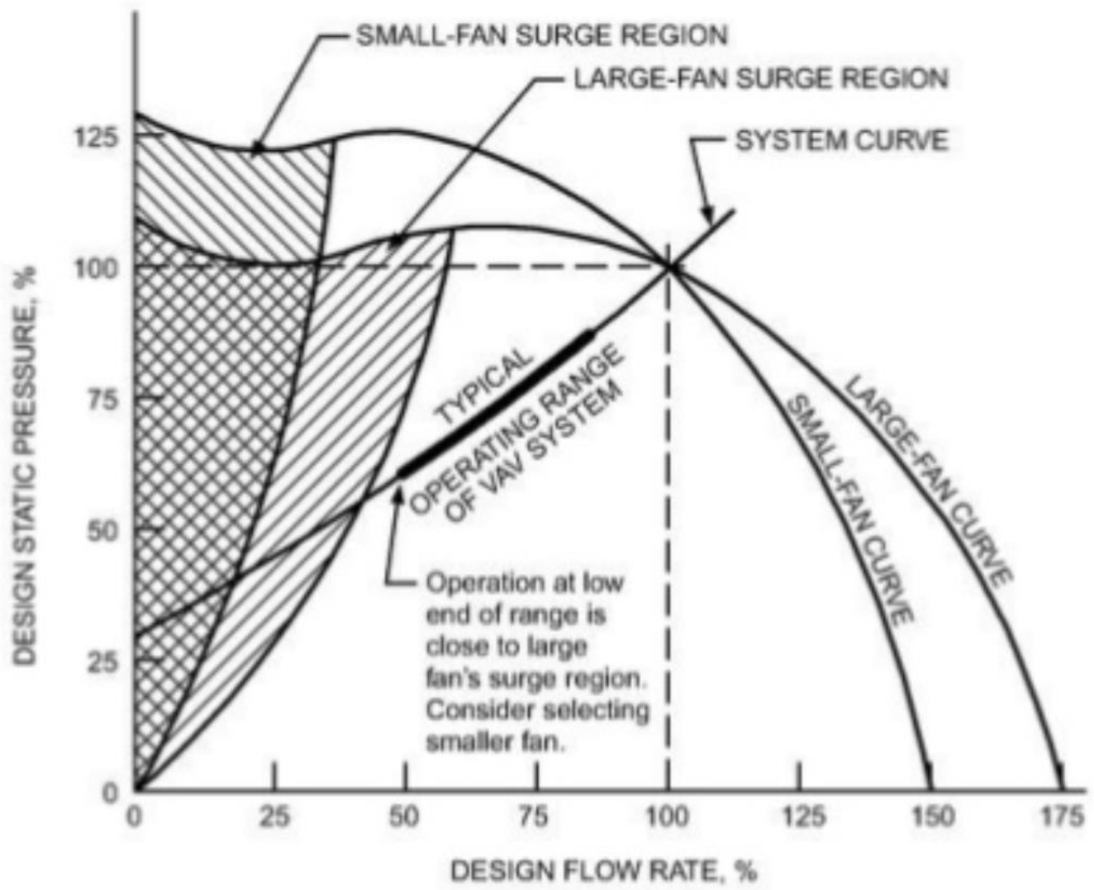
The following are steps for Data Analysis:

- If the system is designed for MERV 13 filters and MERV 13 filters are not in place, change filters to MERV 13.
- If the existing filters and filter bank are 2” or thicker install a MERV 13 Filter. Determine if a 1” rack can be refitted with a larger rack.
- If filter racks can accept a minimum MERV 13 filter but were not part of the original design, the following analysis can be completed by internal staff or a consulting engineer:
  - Provide Information previously gathered in the Gathering Stage to individual completing additional analysis.
  - Calculate the velocity of the existing filter bank to determine existing filter pressure drop when clean.
  - Typical Velocity is between 300-500 fpm.
  - Determine the initial and final pressure drop for the filters in the original system design.
  - Calculate the increase in filter pressure drop after installing the new MERV 13 filters. Remember the final pressure drop of any filter is an operational choice.
  - Review the original design and equipment shop drawings to determine available External Static Pressure for equipment.
  - Determine the effect of additional external static pressure on the fan.

Filtration Upgrades:
Data Analysis & Review Continued

Motors and Fan Curves

- Determine if the fan speed can be increased to compensate for the additional pressure drop while maintaining the required airflow.
- Determine if the speed increase exceeds the fan maximum tip speed.
- Determine if the speed increase exceeds the maximum motor power.
- Fan airflow is reduced with increase in filter restriction. This may lead to DX low suction pressures which causes faults in cooling or DX high pressure trips in heating with HP's. Electric heat elements must have sufficient airflow to operate.
- A constant cfm ECM fan will be noisier with restriction. Could increase noise in space and have a negative impact to the acoustics of the space.
- Be aware of fan surge under increased static pressure and low flow rate.



Filtration Upgrades:
Data Analysis & Review Continued

Fan laws are relatively straightforward:

Q = FLOW
P = PRESSURE
PWR = HORSEPOWER
RPM = FAN SPEED

$$Q_2 = Q_1 \frac{RPM_2}{RPM_1}$$

$$P_2 = P_1 \left(\frac{RPM_2}{RPM_1} \right)^2$$

$$PWR_2 = PWR_1 \left(\frac{RPM_2}{RPM_1} \right)^3$$

Fan performance

Minimum CFM

Table 8: Standard PSC static motor

Unit Size	Speed	Factory Wired	Nominal cfm	External Static Pressure (in. w.c.)													
				0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75
007	High	Yes	300	410	400	390	380	360	350	330	320	310	290	270	250		
009	High	Yes	300	410	400	390	380	360	350	330	320	310	290	270	250		

Filtration Upgrades: Implementation & Considerations

What are the next steps?

- If MERV 13 filters are installed in the existing equipment then order additional filters for future filter changes.
- Filter Rack Maintenance and Replacement:
  - If filter rack is damaged then repair rack,
  - Ensure filter rack is sealed to prevent bypass of unfiltered air,
  - Review seal installation procedures with maintenance and operations staff,
  - Replace and Upgrade Rack if possible, to accept a filter with a higher MERV rating.
- Consider changing out motor to increase static pressure available, but this may require significant electrical modifications.
- Adjust the Variable Frequency Drives to address increase in static pressure for filters.

Filtration Upgrades: Implementation & Considerations Continued

If MERV 13 Filters cannot be installed, consider the following:

- Increase the filtration in the unit to the maximum available
- Provide a recirculation fan filtration unit and duct into the return of units
- Provide a HEPA filtration unit which re-circulates air within the space
- Consider additional treatment technology to kill/disable airborne infectious aerosols (refer to Building Readiness Document for additional guidance)
- Refer to ASHRAE Filtration and Disinfection system section for additional information
- Consider alternate filter locations in return duct or grille but consider static pressure drop implications and relationship with outside air dampers

Additional Considerations:

- Install a pressure gauge on units to assist in determining filter change frequency
- Document motor amperages before and after filter changes, alarm points in BAS may need to be updated
- Filter change frequency may increase due to seasonal and atmospheric considerations at different sites (such as Pollen Season)
- There will be an increase in fan energy used to overcome additional pressure drop from filters
- With an increase pressure drop for filtration there will be less airflow to heat and cool the spaces during peak design days
- Additional supplementary heaters or cooling devices may be required

Filtration Upgrades: Implementation & Considerations Continued

HVAC System Maintenance and Filter Replacement during the COVID-19 Pandemic:

- For HVAC systems suspected to be contaminated with SARS-CoV-2, it is not necessary to suspend HVAC system maintenance, including filter changes but additional safety precautions are warranted
- The risks associated with handling filters contaminated with coronaviruses in ventilation systems under field-use conditions have not been evaluated
- Workers performing maintenance and/or replacing filters on any ventilation system with the potential for viral contamination should wear appropriate personal protective equipment (PPE)
- When feasible, filters can be disinfected with a 10% bleach solution or another appropriate disinfectant, approved for use against SARS-CoV-2, before removal. Filters (disinfected or not) can be bagged and disposed of in regular trash, or applicable local health and safety standards
- When maintenance tasks are completed, maintenance personnel should immediately wash their hands with soap and water or use an alcohol-based hand sanitizer.

Operation of Occupied Facilities

1. Measure/Trend all information possible, including temperature (dry bulb), relative humidity, carbon dioxide concentration, zone population, etc. - may be done with central Building Automation System (BAS) if available - mobile/handheld devices may be used if central monitoring not available.
2. Follow up on temperature control, humidity control or elevated carbon dioxide concentration issues observed to address cause(s).
3. Document any unusual observations other than those that can be recorded by control systems.
4. Share pertinent information between all appropriate groups: Maintenance, Energy, Environmental Health & Safety, Building Managers, Administration, etc.
5. Create reporting methodology for tracking and reporting of critical infections. Develop policies for use of drinking fountains/water coolers.
6. Develop policies for lockers or storage spaces.
7. Develop maintenance policies for new/added equipment such as local air cleaners, humidifiers, additional filtration in mechanical equipment, etc.

Controlling Infection Outbreaks in School Facilities

1. Identify symptoms in Student.
2. Provide PPE and remove suspect individual – relocate to nursing or isolation space.
3. **a.** A K-12 Facility should develop a policy to isolate the student near the nurse's office in a room described in this guidance, inform parents and release symptomatic student according to that policy.
   b. Higher education facilities should isolate that student at the Student Health Facility in a room described in this guidance until that student can either safely travel home or be transported to a medical facility, if necessary.
4. Notify appropriate individuals (either parents or students) about possible contact.
5. Develop protocol to handle quarantine of other individuals who may have been exposed, wash/sanitize belongings and impacted spaces, look at potential for spread to adjacent spaces or other building areas through mechanical systems or other means.
6. Develop protocol to handle air cleaning for space prior to re-occupying.
7. Report/track incident through defined policies.

Higher Education Facilities

Student Health Facilities

Screen patients entering clinic in waiting area

- ❑ Establish physical barrier in waiting room for screening
- ❑ Require face mask and hand sanitation from a sanitizer dispenser
- ❑ Increase ventilation rate six ACH clean air
- ❑ Create at least one isolation exam room in waiting area (can be temporary)
- ❑ Add non-woven fabrics for seating
- ❑ Use laminate or solid surface casework to improve cleaning
- ❑ Remove carpet for flooring

Student Health Facilities

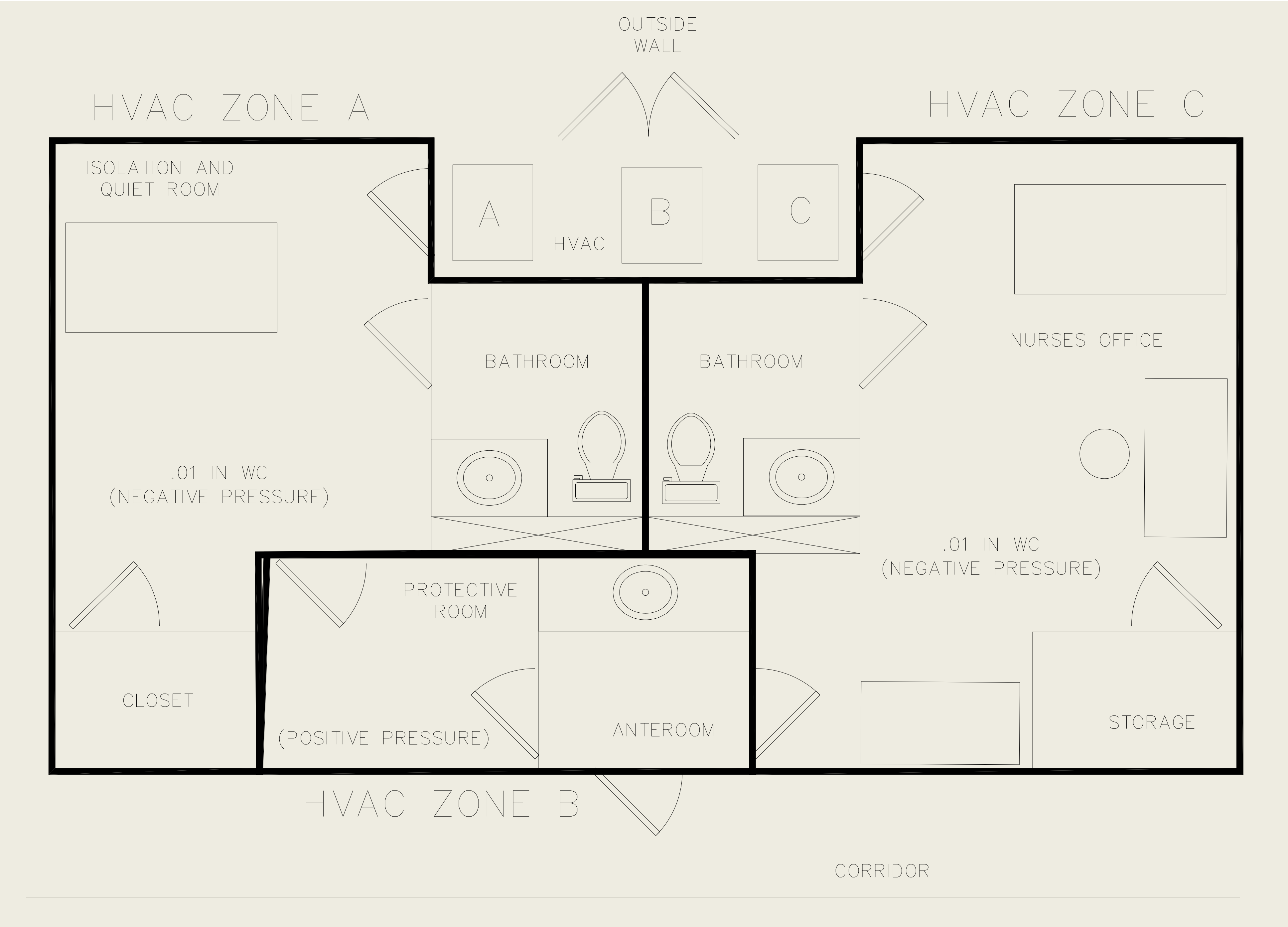
Temporary Isolation Rooms during Pandemic in addition to waiting room

- Isolation rooms – Follow ANSI/ASHRAE/ASHE Standard 170
  - Negative Pressure to 0.01 inches of water
  - Twelve air changes (HEPA recirculation allowed)
  - All air exhausted to outdoors (exhaust grill above exam table)
- Provide minimum two isolation rooms (conduct risk assessment)
- Dedicated HVAC capable of 100% OA
- Anteroom/Protective Equipment Room
- Normal non-isolation nurses office can become iso-room
- Include Biohazard waste storage in anteroom and iso-room for PPE

Student Health Facilities

Temporary Isolation Rooms during Pandemic in addition to waiting room: Design Concepts

See layout suggestion here, can be modified as needed



Laboratories

Education Facilities contain a wide range of laboratory spaces with different functions and operational requirements

- ❑ Refer to [Laboratory Guidance] from ASHRAE Epidemic Task Force for specific space recommendations

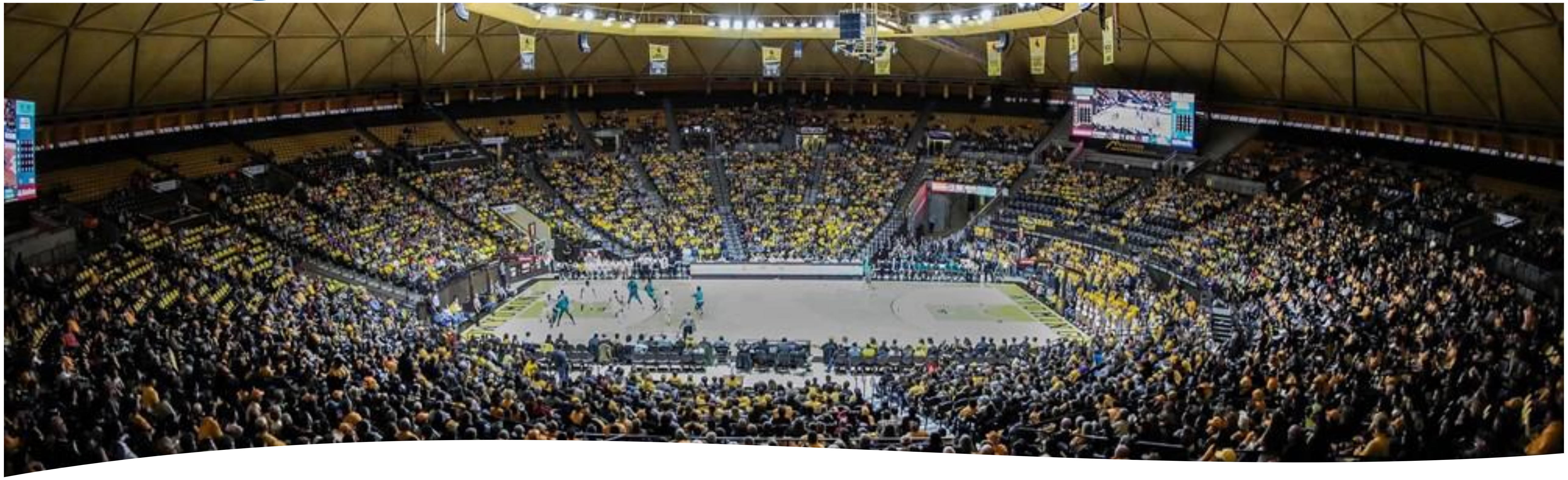
Athletics Facilities

- Move activities outdoors if possible
- Limit occupancy to maintain social distancing guidelines and avoid unnecessary occupants
  - Follow current ANSI/ASHRAE 62.1 standard or local ventilation standards for minimum outside air requirements.
  - Consider increasing outside air capacities beyond code minimum based on analysis completed by a qualified HVAC professional.
  - During the Pandemic, disable any Demand Control Ventilation (DCV) and introduce the design outside air flow to occupied spaces until further notice.
  - Where directional airflow is not required or recommended, verify air distribution promotes mixing of space air without creating strong air currents that increase direct transmission from person-to-person.
- Maintain minimal comfort conditions
- Avoid use of locker rooms but if necessary, increase airflow in locker rooms and keep negative
- Verify all locker room exhaust flows exceed ANSI/ASHRAE Standard 62.1

Residence Halls

- ❑ Consider reducing occupancy in rooms, suites and common areas
- ❑ Consider HEPA/UVC in-room air cleaners
- ❑ Install hand sanitizer dispenser in common areas
- ❑ Use non-woven fabrics for seating
- ❑ Use laminate or solid surface casework
- ❑ Cover or remove carpet for flooring
- ❑ Verify exhaust air flow in all restrooms and laundries
    - ❑ Minimum 1.0 cfm/sf
- ❑ Verify all outdoor air flows are well distributed (> 0.16 cfm/sf)
- ❑ Replace filters with MERV 13 or higher where ever possible
- ❑ Refer to [the Filtration and Disinfection Guidance]
- ❑ This guidance assumes no COVID-19 cases are housed

Large Assemblies, Lecture, Theater



- ❑ Limit occupancy to maintain social distancing guidelines
- ❑ Follow current ANSI/ASHRAE 62.1 standard or local ventilation standards for minimum outside air requirements
  - ❑ Consider increasing outside air capacities beyond code minimum based on analysis completed by a qualified HVAC professional
- ❑ During the Pandemic, disable any Demand Control Ventilation (DCV) and introduce the design outside air flow to occupied spaces until further notice.
- ❑ Replace all filters with MERV 13 or higher
- ❑ Verify exhaust airflows in all toilets and locker rooms
  - ❑ Minimum 1.0 cfm/sf
- ❑ Verify exhaust airflows from all concession stands
  - ❑ Minimum 0.7 cfm/sf
- ❑ Consider providing terminal filtration units in rehearsal rooms and green rooms

Disclaimer

This ASHRAE guidance document is based on the evidence and knowledge available to ASHRAE as of the date of this document. Knowledge regarding transmission of COVID-19 is rapidly evolving. This guidance should be read in conjunction with the relevant government guidance and available research. This material is not a substitute for the advice of a qualified professional. By adopting these recommendations for use, each adopter agrees to accept full responsibility for any personal injury, death, loss, damage or delay arising out of or in connection with their use by or on behalf of such adopter irrespective of the cause or reason therefore and agrees to defend, indemnify and hold harmless ASHRAE, the authors, and others involved in their publication from any and all liability arising out of or in connection with such use as aforesaid and irrespective of any negligence on the part of those indemnified.