TIP NO. 98-124-0820

CONSIDERATIONS FOR THE USE OF PORTABLE HIGH-EFFICIENCY PARTICULATE AIR (HEPA) FILTRATION UNITS

INTRODUCTION

Portable high-efficiency particulate air (HEPA) and ultra-low particulate air (ULPA) filtration units may range in size; they generally consist of a pre-filter and a HEPA/ULPA filter along with a fan and airflow controls in a housing with an inlet ("dirty") and outlet ("clean"). Add-ons or other equipment may include, among other items, carbon adsorption units, antimicrobial HEPA/ULPA filters, differential pressure gauges, ultraviolet light chamber, photocatalytic oxidation filters, and inlet and outlet ductwork. Portable HEPA/ULPA filtration units are used to augment existing airflow in spaces, to provide airflow in spaces without airflow, and to increase filtration effectiveness in the space. These units recirculate air within the room but do not provide outdoor air to satisfy indoor air quality requirements. They may also be used to provide space pressurization but must be specifically set up to do so.

HEPA AND ULPA FILTRATION

HEPA filtration consists of filters that remove at least 99.97% of dust, pollen, mold, bacteria, and any airborne particles at 0.3 microns (µm) in size.[1] The 0.3-µm particles are the worst-case or most penetrating particle size (MPPS) at this efficiency range. Particle sizes greater than and less than 0.3 µm are trapped with more efficiency.[1] ULPA filtration consists of filters that remove at least 99.999% of dust, pollen, mold, bacteria, and any airborne particles at 0.12 µm in size with a MPPS of 0.12 µm. Recommended testing practices for HEPA and ULPA filters are published in Institute of Environmental Sciences and Technology (IEST) RP-CC001.6, IEST RP-CC007.3, UL 29463, and European Standard EN 1822.[2,3,4,5] Minimum Efficiency Reporting Value (MERV) filter values 17 through 20 are no longer used by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE®) since the ASHRAE Standard 52.2 test methods do not address these levels of filtration. A method for testing portable HEPA and ULPA filter units is also discussed in the Minnesota Department of Health document, Airborne Infectious Disease Management Methods for Temporary Negative Pressure Isolation.[6] The HEPA/ULPA filters in a portable filtration unit must be well sealed with proper fitting frames to prevent air bypassing the filter. A pre-filter and proper maintenance increases the life of the HEPA/ULPA filter. HEPA and ULPA filtration is not effective for filtration of gases and vapors.

AIRFLOW VOLUME

Effectiveness of portable HEPA/ULPA filtration units for room air filtration depends on recirculating as much room air as possible through the unit. Portable HEPA/ULPA filtration units should ideally be capable of recirculating all air in the room. Select the correct size of portable HEPA/ULPA filtration unit by calculating the desired air exchange rate for the individual room or area. For example, if 12 air changes per hour (ACH) is desired and the room size is 20 feet (ft) x15 ft x10 ft or 3000 cubic feet (ft^3), the airflow volume should be calculated as follows: 12 ACH ÷ 60 minutes x 3000 cubic feet (ft^3) or 600 cubic feet per minute (cfm). Note that filtration

(including HEPA and ULPA) adds increased resistance (pressure drop) to the system as it becomes dirty (loaded); this may affect the airflow rate and velocity. Verify dirty filter airflow conditions with the manufacturer to ensure the airflow volume will meet the desired rate when filters are dirty. Verify that if lower speed settings of the unit will be used they will meet the necessary requirements.

NEGATIVE PRESSURE

Portable HEPA/ULPA filtration units alone do not provide negative pressure in a room. If negative pressure is desired, the units must be connected to an exhaust to the exterior, to an adjacent space or corridor, or to the room return air grille(s).[6,7,8,9] Consider the effect on heating, ventilating and air conditioning (HVAC) equipment and also on the existing and adjacent room ventilation when ducting the portable HEPA/ULPA unit to an adjacent room or to a return air duct.[6,8,9] Additional information on portable HEPA/ULPA filtration for creating negative pressure environments can be found in the U.S. Army Public Health Center (APHC) TIP No. 98-109-0420, (Improvising Negative Pressure Isolation Areas)[7] and in the Minnesota Department of Health document, Airborne Infectious Disease Management Methods for Temporary Negative Pressure Isolation.[6]

CLEAN AIR DELIVERY RATE (CADR)

Note that the CADR, which is specified for portable household electric room air cleaners, is a performance comparison tool that measures an air cleaner's delivery of relatively clean air at the highest fan setting. It is generally derived from testing using the Association of Home Appliance Manufacturers (AHAM®) protocol[10] for specific contaminants that represent fine, medium and large particles like tobacco smoke (0.10-1.0 µm), dust (0.5-3 µm), and pollen (5-11 µm). Ensure you know the basis for CADR rating (fine, medium, or large particles). The CADR relates to filter efficiency in that it is the product of the filter efficiency and the airflow volume (cubic feet per minute) of the unit (Filter efficiency x airflow volume (cfm) = CADR (cfm)). For example, an air purifier with an airflow volume of 200 cfm with a filter tested to remove 90% of particles will have a CADR of 180 cfm. Using the smoke CADR, a room measuring 300 ft^2 in area will be divided by 1.55 (assuming an 8 ft ceiling or see the AHAM AC-1-2013) resulting in a value of 194. The CADR must be 194 cfm or higher for this room using the smoke CADR. The AHAM also recommends appliances be submitted for inspection and listing per UL 867, Standard for Electrostatic Air Cleaners, and UL 507, Standard for Fans.[10] Additional testing information can be found through AHAM at AHAM.org.

EFFECTIVENESS AND OTHER CONSIDERATIONS FOR USE

- Other considerations to effectiveness of the units, according to the Centers for Disease Control and Prevention (CDC), are: room configuration, furniture and people in the room, placement of units relative to room layout, and location of supply and exhaust grilles.[2,14] See Location section for additional information.

- Use of the units in excessively moist or humid conditions for significant time periods may result in filter performance deterioration over time if the filters and housing are not designed for such conditions. Antimicrobial treatments are intended to reduce microbial

growth on filters rather than to clean the air of microbes.[11] ASHRAE studies have found that under normal use, air filters were unlikely to be a source of microbial contamination to the space, and treatment with antimicrobial products did not increase the filter efficiency for bioaerosols[11]. Antimicrobial products used in air filters must meet the U.S. Environmental Protection Agency (EPA) guidelines[12].

- Performance should be verified for longer time periods than those from just the AHAM test, which is approximately 10 to 20 minutes (what is the efficiency after 8 hours? 4 weeks? etc.). The ASHRAE states that filtration and air cleaners should be tested for extended durations to examine the possible change of performance in time of operation and the minimum period at which regular performance checks should be made.[12]

- Any claims specific to viruses or bacteria require testing information beyond the CADR.

- Testing should show reduction of intended contaminant in a room environment similar to that in which the unit will be operated.

- Local exhaust ventilation (LEV) units or extractors with HEPA/ULPA filtration should demonstrate effectiveness at capturing the contaminant for a similar time period required and at practical distances from the source. Local exhaust hoods must be placed as close to the source of contamination as possible and should cause minimum interference with the work being performed. Cross-drafts may reduce the effectiveness of local exhaust ventilation and should be considered when selecting an effective capture velocity for the generated contaminant. Hoods should pull air away from and not across the breathing zone of the worker. The CDC Tuberculosis Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings, 2005, state that LEV should maintain 200 fpm capture velocity at the breath zone to capture droplet nuclei (<5 µm).

ULTRAVIOLET GERMICIDAL IRRADIATION (UVGI)

The EPA states that it is likely that the effective destruction of airborne viruses and fungal and bacterial spores requires much higher ultraviolet (UV) exposures than a typical residential UVGI air-cleaning unit provides.[1] The ASHRAE states that research should quantify rates of airborne removal by filtration and inactivation by UVGI strategies specific to individual microorganisms and should field-validate in real facilities the effectiveness of these interventions in preventing transmissions.[13] The CDC states that the use of UV lamps and HEPA filtration in a single unit offers only minimal infection-control benefits over those provided by the use of a HEPA filter alone.[14]

Moveable room air cleaners with HEPA filtration should be able to capture contaminants and UVGI use may be redundant. If an air purifier includes a UV lamp, the U.S. Food and Drug Administration (FDA) recommends the manufacturer evaluate its product for time, dose, and intensity with validation of cleaning and disinfection procedures.[8] Additional information on UV can be found in APHC's Considerations for the Use of Ultraviolet Germicidal Irradiation (UVGI), the Illuminating Engineering Society (IES) CR-2-20-V1 Germicidal Ultraviolet (GUV) – Frequently Asked Questions[15], and APHC TIP No. 24-103-0320 (Effectiveness and Safety of Ultraviolet Germicidal Irradiation Lamps Used for Air and Surface Disinfection).[16]

Ozone may be produced as a by-product of some electrical air-cleaning technologies. According to ASHRAE, any ozone emission beyond a trivial amount may have a negative effect on indoor air quality, and ozone-generating air-cleaners should therefore be used with caution.[12]

LOCATION

Portable HEPA/ULPA filtration units must be located to avoid blocking egress per the Life Safety Code® and local requirements. Follow manufacturer's instructions for placement of the unit. Units should be placed to allow for proper recirculation (avoid placing them adjacent to corners, doorways, curtains, walls or furniture; ideally approximately 3 feet away from obstructions). Air cleaners for general room use should provide filtered air in the area of the occupants breathing zone.[17] Units used for source contaminant control should be as close as possible to the source (patient) and should not pull contaminated air past other (or healthcare) workers. Avoid directing clean airflow onto patients or staff to avoid discomfort.[14]

NOISE

Noise is a concern, and staff may reduce the unit speed to reduce noise. Unit ratings, like the CADR, are at the highest speed, and therefore, the highest noise level. Ensure the sound level (decibels (dBA)) generated (especially on high speed) will not exceed local building codes or regulations for the intended space.[18]

ELECTRICAL AND EES

Cords should be heavy duty with a hospital-grade plug[18] and should not create a tripping hazard. Consider electrical requirements for the filtration unit, and consult safety personnel for the use of extension cords. Also, consider if the unit is required to connect to the Essential Electrical System (EES).

MAINTENANCE

- Ensure preventive maintenance for the units and appropriate personal protection equipment (PPE) for workers performing maintenance on the units.
- Ensure a sufficient supply of the correct filters needed for change-out of both the pre-filter and HEPA/ULPA filter.
- Obtain from the portable HEPA/ULPA unit manufacturer the correct maintenance and filter change requirements (both for the pre-filter and the HEPA/ULPA filter). Ensure staff are aware of these requirements.
- Verify pressure drop periodically to ensure compliance with manufacturer's instruction on filter changes and to ensure the unit is not leaking.[7]
- Ensure good fit of filters in the frame and no leakage of air around the filter unit.

PREVIOUSLY USED HEPA/ULPA UNITS

Clean and disinfect any portable HEPA/ULPA units that have been used previously; follow manufacturer's instructions and guidance for installation of new pre-filters and, if necessary, HEPA/ULPA filters. Portable HEPA/ULPA filtration units should be performance-tested before use. (See Appendix G of Airborne Infectious Disease Management Methods for Temporary Negative Pressure Isolation).[6]

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