Draft IESO Standard for Testing HEPA Filtered Devices

Originally Published in the January 2010 issue of "Indoor Environmental Connections"

Since their development many years ago, most users of portable air filtration devices equipped with HEPA filters had the impression that these devices filtered air at near HEPA filtration efficiency. However, in actual use, this is more an exception than actual practice.

History of the Standard

In late 1990, the National Asbestos Council in their magazine Outlook recommended the development of an in-field testing and certification method for portable air filtration devices that contain HEPA filters. Unfortunately, at that time, the cost for the testing equipment that was necessary for certifying HEPA filters was prohibitively expensive for most industries - except for clean room and hospital applications.

With the introduction of relatively low cost laser particle counters in 2000, in-field testing of portable air filtration devices became possible. After this leap in testing equipment technology, all that was needed was development of a test and certification method. However, by this time, the asbestos abatement industry had significantly decreased in size. In fact, Outlook magazine has ceased publication. Hence, there was little industry interest in pursuing an in-field testing method for portable filtration devices.

Another step had to occur beyond the asbestos industry to push the need for this standard forward. This next step was the explosive growth in the mold remediation industry in recent years. The huge growth in this industry was reflected by the establishment of the Indoor Air Quality Association in 1995 and its unification partner, the Indoor Environmental Standards Organization in 2005. Both IAQA and IESO had recognized the need for standards for the indoor air quality industry. In recognition of this need, IESO became an accredited standards organization in 2007. This set the stage for establishing industry standards that are precedent setting.

Both IAQA and IESO recognized that portable air filtration devices, equipped with HEPA filters are a fundamental tool in the industry. In fact, existing mold remediation guidelines such as IICRC S520 and asbestos abatement regulations require testing or monitoring of portable HEPA filtered exhaust devices. However, no industry standard existed for testing of portable air filtration devices as complete devices.

In October 2007, a real-world research article was published IEC that clearly established the need for testing and validation of this equipment, particularly in regard to Post Remediation Verification testing.

Consequently, in early 2008, the IESO Standards Development Committee decided to develop an ANSI accredited standard for an in-field method for testing and certifying

portable HEPA filtered air filtration devices. IESO's ANSI secretariat, Kristie Lee, published an ANSI notification that IESO intended to develop a standard for the in-field testing of portable HEPA filtered air filtration devices. This standard received the designation IESO 4310. The standard was subsequently named the Portable High Efficiency Air Filtration Device Standard or PHEAF (pronounced feef) Device Standard for short.

Brief Summary of The PHEAF Device Standard

This standard is designed to apply to all types of portable high efficiency air filtration devices. This would include vertical and horizontal portable air filter devices, movable vacuums, hand held vacuums, and other filtered suction devices used for cleaning surfaces for the purposes of removing dust, dirt, mold, asbestos, lead, condensed mercury vapor particles, radioactive particles and other undesired particulate environmental contaminants.

This equipment is subjected to significant vibration and movement during transportation, deployment, use and filter maintenance. All of these activities exert physical forces that can and will disturb and break the filter seal between the case and motor housing. This breakage or damage can result in very significant deterioration of the filtering device effectiveness. Further, filter efficiency and performance characteristics change over the useful lifetime of a filter.

The significance of this standard lies in the question of what impact these devices have on the air quality in the area they exhaust to. If a PHEAF device discharges into a hospital corridor from a remediation project, (because the hospital doesn't have windows that open or the remediation area is too remote from an outside discharge source), what the PHEAF device discharges into the air can have very serious health consequences, especially for immuno-compromised patients. The medical literature contains numerous cases of mold infections in hospital patients that were associated with construction activities.

However, even in typical home mold remediation projects, excessive particle discharges from PHEAF devices may also be of health concern. For example, the current medical literature shows an increase risk of cardiovascular disease from increased levels of 2.5 micron size particles exposure. This is a particle size that is easily inhaled into the lungs. Much of the dust removed during mold, asbestos or other clean up projects fall into this size range. PHEAF devices that do not work properly are essentially "particle pumps." They can generate excessive particle levels outside of containments with possible health impacts.

Further, PHEAF devices such as HEPA vacuums or air scrubbers that do not work properly will constantly circulate mold spores and other particles inside of a containment. Even though the surfaces may have been adequately remediated and cleaned, a malfunctioning PHEAF device will continue to circulate excessive mold spores, recontaminating the containment air and depositing mold spores on cleaned areas.

In view of the different situations where PHEAF devices are used, the PHEAF Device Standard defines 5 classes of PHEAF devices. These classes reflect both the intended use of the PHEAF device as well as its filtration effectiveness.

The PHEAF device classes use similar particle removal efficiency ranges as described in ASHRAE Standard 52.2 -2007 for rating air filters. This is the same standard that defines the MERV rating of air filters. The PHEAF Standard is based on a simple comparison of particle counts using a laser particle counter of the air entering the device to the particle counts of the discharge air from the air filtration device at various particle sizes.

Table 1 below shows the PHEAF device classifications and the similar MERV rating, where appropriate. One will note that there is no MERV rating for a filter that is 99% efficient across all tested particle ranges. This is a Class 4 PHEAF device. One will also note that most PHEAF device classes do not approach a level of filtration as efficient as that of a HEPA filter.

Table 1 : PHEAF Device Classification by Percent Reduction of Incoming Versus Discharge Particle Counts by Particle Size

Classification	Class 5	Class 4	Class 3	Class 2	Class 1	Class 0
MERV* Rating	17	NA	16	15	14	13
Particle size (in microns)	MINIMUM MEASURED PERCENT FILTER EFFICIENCY					
0.3	99.97	99	95	85	75	75
0.5	99.97	99	95	90	80	75
0.7	99.97	99	95	90	85	75
1.0	99.97	99	95	90	90	80
2.0	99.97	99	95	90	90	85
3.0	99.97	99	95	90	90	90
5.0	99.97	99	99	90	90	90
10.0	99.97	99	99	90	90	90

*minimum efficiency reporting value

Testing of both new and older equipment has shown that many portable devices do not meet the Merv 17 (HEPA) rating. However, this does not mean that these devices can not still be used. The PHEAF standard defines situations and conditions where less efficient devices should be used. The PHEAF device classes and their recommended limitations are list below:

Class 5 device - A portable high efficiency air filtration device that operates as a fully

effective and functional air filtration devices, meeting all the filtration efficiency requirements of a HEPA filter. This class of PHEAF device shall be required for all work in hospitals or in other environments where the PHEAF device discharges into the general air space of the building.

Class 4 device - A portable high efficiency air filtration device that operates at a level equivalent to a 99% efficient filter. This class of PHEAF device shall be required for all work in commercial buildings or in other environments where the unit discharges into the air space of the building.

Class 3 device - A portable high efficiency air filtration device that operates at a level equivalent to a MERV 16 filter. This class of PHEAF device can be used for environmental contaminant filtering and/or air scrubbing within a containment, provided the containment is under negative pressure and discharges to the outside air.

Class 2 device - A portable high efficiency air filtration device that operates at a level equivalent to a MERV 15 filter. This class of PHEAF device can be used for environmental filtering / air scrubbing, within a containment, provided the containment is under negative pressure and discharges to the outdoor air.

Class 1 device - A portable high efficiency air filtration device that operates at a level equivalent to a MERV 14 filter. This class of PHEAF device can be used for environmental filtering / air scrubbing, within a containment, provided the containment is under negative pressure and discharges to the outdoor air.

Class 0 device - A portable high efficiency air filtration device that operates at a level equivalent to a MERV 13 filter. This class of PHEAF device can be used to provide general exhaust or negative pressure for a contained area when it discharges to the outdoor air. This class of portable hand vacuums can discharge into a contained area that is under negative pressure and from which the air is exhausted to outdoor air.

Sampling and Testing of PHEAF Devices

Testing should be done using a 5 or 6 range particle counter placed in the differential counting mode. The flow rate is typically 0.1 cfm for such devices. The recommended sampling volume is 1 liter or a 21 second sample.

The testing process is initiated by taking three particle count samples of the incoming air within the room where the test will take place. This should be done before the air filtration device is turned on. The three test results should be averaged for each particle size range.

After the particulate levels in the incoming air data has been recorded, the PHEAF device should be turned on and operated at normal flow conditions for at least 1 minute until discharge particle levels are fairly constant. The particle counter should then be directed to sample the exhaust air stream of the PHEAF device. The location of the exhaust air

stream varies by device. It can be at the bottom, top or side. The sampling head of the particle counter should be placed in parallel with the discharge air direction. In this way, particles in the air being sampled will be traveling in the same direction as the air flow into the particle sampler. The three test results should be averaged for each particle size range.

Determining Efficiency Class

The average values for each particle size range measured are then placed in the equation below to determine the device's percent reduction efficiency for each particle size range.

$$1 - \frac{\text{Discharge particle concentration}}{\text{Incoming particle concentration}} \times 100 = \text{\% reduction in particle size concentration}$$

The percent efficiency for each particle size range is compared to the percent removal efficiencies in Table 1. A data point that falls between two classes should be rounded down to the lower class. The lowest class recorded for all the size ranges measured is the designated efficiency class for the unit.

What to do if you PHEAF Device Performs Poorly?

The most obvious reason a PHEAF device performs poorly during this testing is because air is leaking around the filter edges. Some people apply a coating of silicone grease at the edges to get a better seal. However, on used PHEAF devices, just the lack of cleanliness of the device can produce lower test results. Thorough cleaning of the device during filter changing is essential. Unfortunately, many PHEAF devices do not lend themselves to easy cleaning.

HEPA vacuuming and damp wiping should be the first steps in cleaning a unit when replacing the HEPA filter. Then the unit can be cleaned using compressed air to remove dirt and debris in poor accessible areas. This can be done out of doors with proper PPE, including a respirator or in a negatively pressurized, contained cleaning area.

Once the unit is thoroughly clean, inspect the sealing surfaces for the HEPA filter. Make sure they are intact and function properly. Install the new HEPA filter according to the manufacturer's recommendations. Use a silicone grease to increase seal effective.

Lastly, not all filters rated as HEPA filters perform adequately. The Department of Energy tests all their HEPA filters prior to allowing them to be used for replacement on their units. DOE testing has shown up to 20% of replacement HEPA filters do not pass their HEPA filter testing procedure. What this means is that HEPA testing and rating can be highly variable. So if your PHEAF device does not calculate to 99.97% effective using this particle counter test method, don't be surprised. Actual experience has shown than only about 2% of PHEAF devices actually perform as HEPA filters using this test

method.

According to ANSI procedures, all questions and comments must be responded to. Filling out the "Reviewer and Commenter" contact on the IESO website information pages on the IESO website will greatly facilitate this process and make sure your questions and comments are addressed.

Robert C. Brandys, PhD, MPH, PE, CIH, CSP, CMR is President of Occupational and Environmental Health Consulting Services, Inc. located in Hinsdale, Illinois. **OEHCS** is a full service safety and environmental consulting firm serving clients throughout the United States and Internationally. He has over 30 years of experience dealing with microbial contamination in the pharmaceutical, medical device, biosafety, clean room and mold remediation industries. His most recent books deal with:

Mold and Bacteria Exposure Standards-8th Edition
Post Remediation Testing and Verification -3rd Edition
Global Occupational Exposure Limits for over 6,500 chemicals-2nd Edition
International Indoor Air Quality Exposure Standards for over 2,000 Chemicals and Biological Substances.

Bob can be reached at (630) 325-2083 or by email at bobb@safety-epa.com.