Dealing with Dust In The Wind
2018 EPA Guidance for Air Cleaners in the Home

Consumer Guide

Technical Summary

Lew Harriman
Mason-Grant
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Speakers

**Terry Brennan**

- Decades of experience with radon, pesticides, mold, moisture, indoor air quality, building forensics and envelope commissioning. NESEA Lifetime Achievement Award (2012)
- 2018 - Member of consulting support team for 2018 update: EPA Guidance for Air Cleaners in the Home

**Lew Harriman**

- Principal experience: humidity, moisture and related indoor air quality. Fellow, ASHRAE and IAQA Indoor Air Quality Hall of Fame
- 2018 - Member of consulting support team for 2018 update: EPA Guidance for Air Cleaners in the Home
Why we care about small particles (PM$_{2.5}$)
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About ~130,000 premature deaths in 2005 in the US were due to ozone and small particle exposure (PM$_{2.5}$)

Fann et al. 2012 Risk Analysis
Pollutants of concern - PM$_{2.5}$ tops the list

“DALYS” - Years of productive life lost per 100,000 people

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Pollutants of concern - PM$_{2.5}$ tops the list

“DALYS” - Years of productive life lost per 100,000 people

Of the indoor air pollutants of known concern, PM$_{2.5}$ is responsible for the largest number of lost years of productive life

Logue et al. 2012 Environ Health Perspectives

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It’s Because Small Particles Bypass Your Nasal Defenses and...

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Unfortunately...
The small guys are the most common particles.

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Longest exposure to OUTDOOR small particles happens INDOORS.

Chen and Zhao, 2011 *Atmos Environ*
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Chen and Zhao, *2011 Atmos Environ*

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Best way to reduce indoor PM$_{2.5}$?...
Build a **TIGHT HOUSE** so outdoor particles stay out!

Azimi et al. 2016 *Science Technol Built Environ*
Best way to reduce indoor PM$_{2.5}$?...
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![Graph showing infiltration factor comparison]

**Typical Old-School Leaky House**
20 ACH50

Azimi et al. 2016 *Science Technol Built Environ*
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Best way to reduce indoor PM$_{2.5}$?...
Build a **TIGHT HOUSE** so outdoor particles stay out!

- **About 38% of outdoor PM$_{2.5}$ comes INSIDE**

- **20% gets inside**

- **Only about 2% of outdoor PM$_{2.5}$ leaks into a tight house**

---

**Azimi et al. 2016 Science Technol Built Environ**
Indoor Sources - Cooking is the big one
Indoor Sources - Cooking is the big one
Indoor Sources - Cooking is the big one

Wallace and Ott 2011 J Expo Sci Environ Epidem
**Indoor Sources - Cooking is the big one**

![Ultra fine Particles](image)

Wallace and Ott 2011 *J Expo Sci Environ Epidem*

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Event</th>
<th>N</th>
<th>Mean emission rate ($ \times 10^{12}$) (particles/min$^{-1}$)</th>
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</thead>
<tbody>
<tr>
<td>Gas stove and toaster oven</td>
<td>Cooking</td>
<td>23</td>
<td>5.11</td>
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<tr>
<td>Gas clothes dryer</td>
<td>Drying clothes</td>
<td>6</td>
<td>4.40</td>
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<tr>
<td>Air popper</td>
<td>Popping corn</td>
<td>4</td>
<td>4.26</td>
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<tr>
<td>Electric toaster</td>
<td>Toasting</td>
<td>1</td>
<td>3.8</td>
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<tr>
<td>Match</td>
<td>Lighting candles</td>
<td>3</td>
<td>3.65</td>
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<tr>
<td>Spray cleaner</td>
<td>Housecleaning</td>
<td>6</td>
<td>2.60</td>
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<tr>
<td>Electric toaster oven</td>
<td>Cooking</td>
<td>54</td>
<td>2.11</td>
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<td>Gas stove</td>
<td>Cooking</td>
<td>95</td>
<td>1.89</td>
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<td>Electric stove</td>
<td>Cooking</td>
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<td>1.25</td>
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<td>Cigarette</td>
<td>Smoking</td>
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<tr>
<td>Electric mixer</td>
<td>Preparing food</td>
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<td>Candles</td>
<td>Burning candles</td>
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<td>Curling irons</td>
<td>Grooming</td>
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<tr>
<td>Steam iron</td>
<td>Ironing</td>
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<tr>
<td>Hair dryers</td>
<td>Grooming</td>
<td>8</td>
<td>0.23</td>
</tr>
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<td>Heating</td>
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<td>Hair straightener</td>
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<td>0.11</td>
</tr>
<tr>
<td>Laser printer</td>
<td>Printing 10 pages</td>
<td>3</td>
<td>0.06</td>
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<tr>
<td>Vacuums</td>
<td>Housecleaning</td>
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</tr>
<tr>
<td>Fireplace</td>
<td>Fire lit</td>
<td>1</td>
<td>0.003</td>
</tr>
</tbody>
</table>

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What to do?
What to do?

Exhaust at the source
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Exhaust at the source

Remove by filtration

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Air Cleaner Alternatives
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Air Cleaner Alternatives

Furnace Filter

Portable Air Cleaner

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Central system air filters: EPA Recommends **MERV 13**
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**MERV = Minimum Efficiency Reporting Value**
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No Pleats—No MERV Rating
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**MERV** = **Minimum Efficiency Reporting Value**

- **No Pleats—No MERV Rating**
- **Probably a MERV 4 or 6**
Central system air filters: EPA Recommends **MERV 13**

**MERV = Minimum Efficiency Reporting Value**

**MERV 13**
Many deep pleats

No Pleats—No MERV Rating

Probably a MERV 4 or 6

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Central filtration can reduce indoor PM$_{2.5}$...

BUT... furnaces and AC systems don’t run much!

Monte Carlo model simulating removal of 1-3μ particles from a home, based on a range of air leakage rates from outdoors. Upper boundaries model effectiveness of a perfectly-installed system and filter in a tight house. Lower boundaries represent modeled effectiveness in a leaky house.

Model, analysis and graph courtesy of Marianne Touchie and Jeff Siegel - U. Toronto

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Given that typical run-times are less than 20% of annual hours, MERV 13 is a more effective filter choice.

Model, analysis and graph courtesy of Marianne Touchie and Jeff Siegel - U. Toronto
Portable Air Cleaners: EPA Recommends **High CADR**

**CADR**: Clean Air Delivery Rate - The AHAM certification

![Portable Air Cleaner](image)

**AHAM VERIFIDÉ**: Independently Tested. Consumer Trusted.

**AIR CLEANER SUGGESTED CLOSED ROOM SIZE**

**450 SQUARE FEET**

**CLEAN AIR DELIVERY RATE TESTED**

The higher the CADR numbers, the faster the units clean the air

- **TOBACCO SMOKE**: 298
- **DUST**: >291
- **POLLEN**: >343

Portable air cleaners are most effective in rooms where all doors and windows are closed.

www.ahamverifide.org
Portable Air Cleaners: EPA Recommends **High CADR**

**CADR:** *Clean Air Delivery Rate* - The AHAM certification

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Portables can provide useful **mitigation of wildfire PM$_{2.5}$**
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PM$_{2.5}$ concentration - Santa Barbara, CA - 2017
Source: EPA
(Google search: “EPA Outdoor Air Quality Data”)
Portables can provide useful **mitigation of wildfire PM$_{2.5}$**

Less than 12 $\mu$m/m$^3$

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PM$_{2.5}$ concentration - Santa Barbara, CA - 2017  
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(Google search: “EPA Outdoor Air Quality Data”)

- Less than 12 μm/m$^3$
- 12 - 35 μm/m$^3$
- More than 150 μm/m$^3$
Portables can provide improvements for homes with **ductless min-splits** and VRF equipment.
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**Generally speaking...**
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- Minisplit filters protect equipment, seldom (if ever) rated for PM$_{2.5}$ removal
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**Generally speaking...**

- Minisplit filters protect equipment, seldom (if ever) rated for PM$_{2.5}$ removal
- Efficient houses may not need much cooling/heating air flow (**less air flow** = **less air filtration**)

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Bedroom (sleeping) represents many hours of exposure
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Portables can provide economical protection for vulnerable populations...
Bedroom (sleeping) represents many hours of exposure

Portables can provide economical protection for vulnerable populations...

...especially for children who live next to sources of PM$_{2.5}$ like highways and farms
Filtration can indeed be helpful
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Intervention studies show improvements in health markers
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Intervention studies show improvements in health markers
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Table 4
Asthma
Filtration can indeed be helpful

Intervention studies show improvements in health markers

Table 4
Asthma

Table 5
Cardiovascular Functions
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For new homes: **Indoor airPLUS**
Comprehensive specifics - **Branded certainty for builders**
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Principal Take Aways...
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1. **PM 2.5** is *the* pollutant of best-documented health concern
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Principal Take Aways...


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2. Filter: **MERV 13** or higher for central systems
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Principal Take Aways...


1. PM \textit{2.5} is \textit{the} pollutant of best-documented health concern

2. Filter: MERV \textbf{13} or higher for central systems

3. Portable air cleaners: High CADR... the higher the better