Building Science

Adventures In Building Science

www.buildingscience.com
Ventilation In Houses
Build Tight - Ventilate Right
Build Tight - Ventilate Right
How Tight?
What’s Right?
Air Barrier Metrics

Material  0.02 l/(s-m2) @ 75 Pa
Assembly  0.20 l/(s-m2) @ 75 Pa
Enclosure 2.00 l/(s-m2) @ 75 Pa

0.25 cfm/ft2 @ 50 Pa
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting rid of big holes</td>
<td>3 ach@50</td>
</tr>
<tr>
<td>Getting rid of smaller holes</td>
<td>1.5 ach@50</td>
</tr>
<tr>
<td>Getting German</td>
<td>0.6 ach@50</td>
</tr>
</tbody>
</table>
Best

As Tight as Possible - with -
Balanced Ventilation
Energy Recovery
Distribution and Mixing
Source Control - Spot exhaust ventilation
Filtration
Material selection
Worst

Leaky - with – Nothing
Spot Ventilation in Bathroom/Kitchen
Exhaust Ventilation – with – No Distribution
and No Mixing
Three Types of Controlled Ventilation Systems

Exhaust Ventilation
Supply Ventilation
Balanced Ventilation
Induced exfiltration
Ventilation Rates Are Based on Odor Control
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Health Science Basis for Ventilation Rates is Extremely Limited
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Almost Nothing Cited Applies to Housing
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Almost Nothing Cited Applies to Housing
The Applicable Studies Focus on Dampness
Figure 1: Minimum ventilating rate history.
House

2,000 ft$^2$
3 bedrooms
8 ft. ceiling
Volume: 16,000 ft$^3$

<table>
<thead>
<tr>
<th>Ventilation Rate (ach)</th>
<th>Cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
<td>93</td>
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<tr>
<td>0.30</td>
<td>80</td>
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<tr>
<td>0.25</td>
<td>67</td>
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<tr>
<td>0.20</td>
<td>53</td>
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<tr>
<td>0.15</td>
<td>40</td>
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</tbody>
</table>
House

- 2,000 ft²
- 3 bedrooms
- 8 ft. ceiling
- Volume: 16,000 ft³

### Ventilation Rates

| .35 ach | 93 cfm | 62 - 73 | 5 cfm/person | 20 cfm |
| .30 ach | 80 cfm | 62 - 89 | 15 cfm/person | 60 cfm |
| .25 ach | 67 cfm | 62.2 - 2010 | 7.5 cfm/person | 50 cfm |
| .20 ach | 53 cfm | + 0.01 | 7.5 cfm/person | 90 cfm |
| .15 ach | 40 cfm | 62.2 - 2013 | 7.5 cfm/person | 90 cfm |
Aubin, D., Won, D.Y., Schleibinger, H., 2010
Formaldehyde sample concentration versus PFT measured outside air exchange rate over the test day

Formaldehyde concentration (ug/m³)

Outside air exchange rate over 24 h test day (ach)
ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.03 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one
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Occupancy is deemed to be the number of bedrooms plus one

Outcome is often bad – part load humidity problems, dryness problems, energy problems
IRC 2015 and 2018 calls for 7.5 cfm per person plus 0.01 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one
3 Bedroom House – 2,000 ft²
30 cfm plus 60 cfm
90 cfm
3 Bedroom House – 2,000 ft²
30 cfm plus 20 cfm
50 cfm
The Cult of The Blower Door
Blower Door Can’t Get You The True ACH On A Short Term Basis – Hour, Day, Week
Don’t Know Where The Holes Are
Don’t Know The Type of Holes
Don’t Know The Pressure Across The Holes
ELA = C \times \frac{\text{Rate of flow}}{\sqrt{\text{Pressure difference}}}

(Meters)^2 \approx \frac{1}{780} \times \frac{\text{Litres per second}}{\sqrt{\text{Pascals}}}

Building Science Corporation

Joseph Lstiburek 38
Dilution Is Not The Solution To Indoor Pollution
Source Control
Dilution For People
Source Control For The Building
Recommended Range of Relative Humidity
Above 25 percent during winter
Below 70 percent during summer
Kitchen Exhaust Hoods
Move cabinets farther apart

Hood wider than cook top and extended outboard past head space

Move hood up to provide headroom

Interlocked make-up air
Clothes Dryers
Fireplaces
Figure 3.12  
**Ductwork and Air Handlers in Basements**  
- No air pressure differences result in a house with an air handler and ductwork located in a basement if there are no leaks in the supply ducts, the return ducts or the air handler and if the amount of air delivered to each room equals the amount removed.
**Figure 3.13**  
**Ductwork and Air Handlers in Vented Attics**

- No air pressure differences result in a house with an air handler and ductwork located in a vented attic if there are no leaks in the supply ducts, the return ducts or the air handler and if the amount of air delivered to each room equals the amount removed.
Figure 3.15

**Leaky Ductwork and Air Handlers in Vented Attics**

- Supply ductwork and air handler leakage is typically 20% or more of the flow through the system.
Duct Leakage Should Be Less Than 5% of Rated Flow As Tested By Pressurization To 25 Pascals
Note: Colored shading depicts the building’s thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.
Figure 3.16
Leaky Supply Ductwork in Vented Crawl Space
- Air pressurization pattern with mechanical system ducts in the crawl space
Figure 3.14

**Leaky Ductwork and Air Handlers in Basements**

- Air pressurization patterns in a house with leaky ductwork in the basement
Figure 3.18

**Insufficient Return Air Paths**

- Pressurization of bedrooms often occurs if insufficient return pathways are provided; undercutting bedroom doors is usually insufficient; transfer grilles, jump ducts or fully ducted returns may be necessary to prevent pressurization of bedrooms.

- Master bedroom suites are often the most pressurized as they typically receive the most supply air.

- When bedrooms pressurized, common areas depressurize; this can have serious consequences when fireplaces are located in common areas and subsequently backdraft.
Grille located high in wall on bedroom side to avoid blockage by furniture.

Cavity is sealed tight, drywall glued to studs and plates on both sides.

Grille located low in wall on hallway side.