The 2018 Ventilation Extravaganza

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Residential Energy Dynamics
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Topics

- Multifamily
- Manufactured homes
- Equipment options
- Controls
- Ducting
- Low-cost strategies
- Best practices
Multifamily
Multifamily Buildings - What’s Different from Detached Units?

- Smaller dwelling units
- Connections to other units
  - Cooking odors, smoking, etc.
- Less connection to outdoors
- Fewer options for ventilation
- Centralized systems
  - Ventilation
  - Space conditioning
- Non-residential spaces (corridors, etc.)
What MF does 62.2-2016 apply to?

- Anything MF building
  - A duplex qualifies as multifamily
  - A 50-story building qualifies

- 62.1 addresses non-residential spaces in multifamily buildings
MF Infiltration Credit

• Allows for an infiltration credit to be taken for horizontally-attached multifamily homes, which includes common walls, subject to a reduction factor.
Multifamily Infiltration Credit

• Implication:
  – For the first time SOME multifamily units can get an infiltration credit.

• How it is calculated:
  – Do a blower door test of the unit.
  – Calculate the fraction of enclosure area (6-sides) that is NOT attached to other units or garages.
  – Multiply infiltration estimate from blower door test by this fraction.

\[ Q_{\text{fan}} = Q_{\text{tot}} - (Q_{\text{inf}} \times A_{\text{ext}}) \]

\[ A_{\text{ext}} = \frac{\text{exterior surface}}{\text{total envelope surface}} \]
Blower Door Tests in MF

• If there is no infiltration credit, is there any value to blower door tests in multifamily?

  • Yes
    – Helps identify leakage locations
    – Helps evaluate air sealing implementation
    – Can help identify pathways between units (IAQ) (compartamentalization)
62.2 - MF Requirements

• Requirement for compartmentalization
  – Suggested maximum leakage rate of 0.3 CFM\textsubscript{50} per ft\textsuperscript{2} of enclosure area
  • Note: enclosure area is 6 sides, not just floor area
Multifamily

• Exhaust fans
  – Single in-line can serve multiple units
  – Individual unit fans cannot share a duct
  – Concerns about exhaust fans?

• Supply fans
  – Single fan can serve multiple units if it is continuous or has a backdraft damper to prevent cross-contamination
Multifamily Ventilation Issues

- Concerns about exhaust fans?
  - Contamination from adjacent units and corridors
  - Compartmentalization issues
- If central exhaust system, use Constant Air Regulator (CAR) dampers.
- Challenging fan termination issues in MF
  - Terminating outdoors
  - Wall fans rather than ceiling fans?
Topics

• Multifamily
• Manufactured homes
• Equipment options
• Controls
• Ducting
• Low-cost strategies
• Best practices
Manufactured Homes

• The standard does cover manufactured homes
  – No special requirements or compliance paths for mobile homes

• Common issues:
  – Where to put the fan(s)
  – Fitting a fan in a ceiling (often low-profile fan is needed) or in a wall
  – Depressurization caused by fan(s)
Panasonic WhisperFit

Panasonic WhisperFit Low Profile
80 or 110 CFM
3 or 4 inch duct
10 ¼ x 10 ¼ x 5 5/8
0.8 or 1.5 sones
3.3 or 3.3 CFM/Watt at 0.1" static
24.5 or 33.5 Watts at 0.1" static
3-year warranty
Models: FV-08VF2 or FV-11VF2
Panasonic WhisperWall

70 CFM
8 inch duct
10 1/8 grille size
1.1 sones
3.9 CFM/Watt at 0.1” static
18 Watts at 0.03” static
Model: FV-08WQ1
NuTone LoProfile

80 CFM
3 or 4 inch duct
10 1/8 grille size
1.1 sones
3.9 CFM/Watt at 0.1” static
25.7 Watts at 0.1” static
Ceiling or wall installation
Model: LPN80
Depressurization

- Depressurization in a manufactured home must be addressed just as in a site-built dwelling.
  - Often a more frequent issue in manufactured homes because of the smaller volume.
Topics

• Multifamily
• Manufactured homes
• **Equipment options**
• Controls
• Ducting
• Low-cost strategies
• Best practices
Equipment

• HVI testing: Home Ventilating Institute 920 Product Performance Certification Procedure Including Verification and Challenge

• HVI 915 Procedure for Loudness Rating of Residential Fan Products
Select the Equipment
Local Exhaust Ventilation - Kitchen

Range hoods

Exterior
mounted fan
System Choices – Exhaust fans

Bath fans. Should be certified by HVI for both air flow and sound.

Ceiling insert

Through wall
System Choices Exhaust Only

Panasonic

Six WhisperGreen Select Base Models:
- FV-05-11VKSL: 130 to 110 CFM integrated multi-speed + LED Light
- FV-05-11VKL1: 50-80-110 CFM single speed + LED Light
- FV-05-11VKS1: 30 to 110 CFM integrated multi-speed
- FV-05-11VK1: 50-80-110 CFM single speed
- FV-11-15VK1: 110-130-150 CFM single speed
- FV-11-15VKL1: 110-130-150 CFM single speed + LED Light
  • Customizable, all-in-one fan and fan/LED light combinations
  • Pick-A-Flow speed selector satisfies designed air flow
  • Plug ‘N Play technology provides up to three value added features
  • Revolutionary DC motor with SmartFlow™ technology
System Choices Exhaust Only
Broan/NuTone

110 CFM
ULTRASense™ H, Humidity Sensing Technology fans react to a quick rise in humidity to turn the fan on;
ULTRASilent™ Sound Technology less than 0.3 Sones;

NuTone Ultra Series SB110H
Power: 8.3 Watts
System Choices Exhaust Only

Air King

- Model ESVD;
- 2 set up speeds;
  - Low 30, 40, 50, 60, 70, 90, 100, 120
  - High: 80, 110, 130, & 150
- Optional 26w night light;
- Optional motion sensor;
- Optional humidity sensor;
- All airflow below 130 cfm < 0.3 sones
System Choices Exhaust Only
Delta Breez

CFM: 50 to 124
Sones < 0.3
Power: 5.6 to 20 watts
Humidity control
System Choices Exhaust Only
Fantech

FQ80L
Sones: 0.4
Power: 30 watts
Light: 26/4

FQ80
Sones: < 0.3
Power: 25 watts
System Choices Exhaust Only
Kitchen Range Exhaust Hoods

Air King ECQ
Continuous: 30, 50, 70, 90 CFM @ 0.3 sones
High speed: 250 CFM @ 3.5 sones
Fan power: 75 Watts, max.
Light: 26 Watts
Ducting: Horizontal or vertical

Air King ECV
Continuous: 30, 50, 70, 90 CFM @ 0.3 sones
High speed: 250 CFM @ 3.5 sones
Fan power: 75 Watts, max.
Light: 26 Watts
Ducting: Horizontal or vertical
Kitchen Exhaust Fan

Broan QP330WW range hood with 100 CFM low speed (0.3 sones) and 450 CFM high speed (5 sones).
System Choices - In-Line Fans
In-Line Exhaust Fans

Photos courtesy of Wisconsin Weatherization Program
Supply-Only Dedicated Systems

Supply air systems including duct connections and filters and flow regulators
Supplement Ventilation to Furnace Return Air

- Ducts should be tight (or they can bring in bad air);
- Should have good motorized damper;
- Must be controlled to run even if no heat is needed;
- Furnace fan energy use can be high;
- Intake must be kept clean of yard debris and other outdoor stuff.
Supply Ventilation to Furnace Return Air

Supply-Only Furnace Return

Outside air supplied to return side of the air handler

Aldes CAR
Constant Airflow Regulation

AirCycler

Field Controls Damper
Balanced Ventilation

• Exhaust and supply ventilation should have equal cfm.
  – Balanced without recovery
  – Heat Recovery Ventilator (HRV)
    • unit transfers sensible heat only with no humidity transfer.
  – Energy Recovery Ventilator (ERV)
    • Unit transfers sensible heat and humidity.
HRV or ERV?

- For a small, tight house in a cold climate — especially a house with a large family — choose an HRV.
- For a large house in a cold climate — especially a house with few occupants — choose an ERV.
- In a hot, humid, climate, an ERV will cost a little less to operate during the summer than an HRV.
- In mixed climates, choose either appliance.

Source: Green Building Advisor 2010
Heat Recovery Ventilators (HRV)

Venmar HRV, inside view
Heat Recovery Ventilators (HRV)

Must be installed in an accessible place for service. Should be inside the conditioned space for maximum efficiency.
Single Room ERV by Panasonic

WhisperComfort
40 CFM
Topics

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62.2-2016 Controls
Dwelling-Unit Ventilation

• Readily accessible manual ON-OFF control, including but not limited to a fan switch or a dedicated branch-circuit over-current device
  – Allows for maintenance

• Controls shall include text or an icon indicating the system’s function.
Controls

Dwelling-Unit Ventilation

Control alternatives:

- Appropriately labeled
- Readily accessible
- Both of these controls require circuit breaker or system override to shut off.

Honeywell will require reprogramming after shut down.
Controls
Dwelling-Unit Ventilation

- Complies with 62.2-2016
- Appropriately labeled
- Readily accessible
- But if installed in an obvious place, is likely to be turned off.

Controls
Dwelling-Unit Ventilation

- Intermittent operation requires a timer or other automatic control
- A new section in standard provides algorithm for real-time controllers
Controls
Local Exhaust Ventilation

- Readily accessible manual ON-OFF control shall be provided for demand-controlled devices.

- Control devices . . . are permissible provided they do not impede occupant control;
  - Shut off timers;
  - Occupancy sensors;
  - Multiple speed fans;
  - Combined switching;
  - IAQ sensors.
Controls
Local Exhaust Ventilation

- Standard wall switch
- Delay timer
- Crank timer
- Motion detector
- IAQ control

Humidity Control
Delay Timer
Motion Detector
IAQ Control
Controls

Tamarack Technologies, Inc.

Fantech

Panasonic
Topics

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Ductwork

Rigid, galvanized ducting: crimped end should be pointed away from the fan

White, vinyl ducting - don’t use this stuff

White, pvc drain pipe - smooth, long lengths
Ductwork

The effects of duct length on airflow performance in more detail.

*Actual length* is the actual, physical length of the duct run (how far is it from A to B);

*Equivalent length* is equivalent resistance to the airflow generated by the fittings;

*Effective length* is the sum of the Actual and Equivalent lengths.

\[
\text{Actual length} + \text{Equivalent length} = \text{Effective length}
\]
Example: 60 cfm fan installed in the ceiling. Duct will run for 2 feet before turning up through two 45° elbows running straight up 4 feet to the roof, connecting to a low profile roof cap with backdraft damper and bird screen. 

Two 45° elbows have an *equivalent* length of 10 feet (5 + 5 using metal elbows) 

Roof cap has an *equivalent* length of 60 feet. 

Actual flexible ducting = 12 feet (doubled 6 for flexible ducting) 

*Effective* length using flexible ducting and a metal elbow

$$12 + 60 + 10 = 82 \text{ feet.}$$
Ductwork

- Elbows, ‘T’s, Wyes, etc. are points of resistance;
- Joints that are factory made are tighter than joints that are made in the field. Seal the field joints first.
- HRV & ERV duct design is the same as designing and HVAC system.
## Ductwork

<table>
<thead>
<tr>
<th>Description</th>
<th>Equivalent Length (Ft) for rigid ducting</th>
</tr>
</thead>
<tbody>
<tr>
<td>45° adjustable elbow, 2-piece</td>
<td>5</td>
</tr>
<tr>
<td>90° adjustable elbow, 4-piece</td>
<td>10</td>
</tr>
<tr>
<td>Wye, equal sizes</td>
<td>10</td>
</tr>
<tr>
<td>Tee, take-off</td>
<td>50</td>
</tr>
<tr>
<td>Tapered increaser/reducer</td>
<td>4</td>
</tr>
<tr>
<td>Hard increaser/reducer</td>
<td>8</td>
</tr>
</tbody>
</table>

From Residential Ventilation Handbook
<table>
<thead>
<tr>
<th>Description</th>
<th>Equivalent Length (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangular wall cap for round duct with backdraft damper &amp; bird screen</td>
<td>60</td>
</tr>
<tr>
<td>Triangular wall cap for round duct with bird screen, without backdraft damper</td>
<td>35</td>
</tr>
<tr>
<td>Rounded wall cap for round duct with backdraft damper &amp; bird screen</td>
<td>40</td>
</tr>
<tr>
<td>Louvered wall cap</td>
<td>40</td>
</tr>
<tr>
<td>Low profile soffit vent with backdraft damper and bird screen</td>
<td>60</td>
</tr>
<tr>
<td>Roof cap, low-profile for round duct with backdraft damper &amp; bird screen</td>
<td>60</td>
</tr>
<tr>
<td>Roof cap, ‘goose-neck’, for round duct with backdraft damper &amp; bird screen</td>
<td>35</td>
</tr>
</tbody>
</table>
Ducting

- Ducting must conform to the following table (5.3):

<table>
<thead>
<tr>
<th>Duct Type</th>
<th>Flex Duct</th>
<th>Smooth Duct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Rating</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Diameter</td>
<td>Maximum Length</td>
<td></td>
</tr>
<tr>
<td>3”</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4”</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>5”</td>
<td>NL</td>
<td>81</td>
</tr>
<tr>
<td>6”</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>7” &amp; more</td>
<td>NL</td>
<td>NL</td>
</tr>
</tbody>
</table>

This table assumes no elbows. Deduct 15 feet (5 m) of allowable duct length for each elbow.
NL = no limit on duct length of this size.
X = not allowed, any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.

- Can’t use 4” flex ducting for larger than 56 cfm
Ductwork

Water reduces the diameter of the duct;

Air flowing across water creates waves, increasing the resistance.
Terminations Gone Wrong

Don’t do this!
Results of Bad Terminations

Different attics
Topics

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Local/Dwelling-Unit Combination

• Use high quality DC-motor fan to serve as local bathroom (or kitchen) ventilation and dwelling-unit ventilation (double-duty fan).
  – Best if bathroom (kitchen) is centrally located.
  – Bathroom door must remain open most of the time.
  – Provide pressure relief for some communication when door is closed.
  – Not best practice, but complies with 62.2-2016.
Broan Fan Upgrade Kit

690 Bath Fan Upgrade Kit

The BROAN bath fan upgrade kit lets you convert your old bath fan to a brand new unit in just 10 minutes. Improve performance, reduce the sound level, and upgrade the appearance of your economy fan in minutes.

<table>
<thead>
<tr>
<th>Models</th>
<th>Duct Size</th>
<th>Sones</th>
<th>CFM @ 0.10&quot;</th>
<th>Compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>690</td>
<td>3&quot;</td>
<td>3.0</td>
<td>60</td>
<td>Add</td>
</tr>
</tbody>
</table>

Use existing fan housing and avoid the high cost of an electrician, however alteration or control might require an Electrician (complies with local exhaust requirements only)
Add control

• If there is a decent existing fan on a wall switch, can add a control that runs the fan on a schedule without requiring a new fan

• Consider
  – Age of existing fan
  – Whether AC- or DC-powered fan
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Local Ventilation

• Install demand-controlled in full baths and kitchen, 50 and 100 CFM.

• If use occupancy sensor, beware of “line of sight”.

• In full bath, consider 80 CFM for purging room of shower moisture.

• Consider pressure across closed bathroom door.
  – 3 pascals or less.
  – Proper flow when bathroom door is closed.
Local Ventilation

• In kitchen, use a range hood with a high capture efficiency.
Other Local Ventilation

• Toilet rooms (not required by 62.2)
  – 50 CFM demand-controlled fan.

• Consider other rooms with high potential contaminant sources.
Local Kitchen Ventilation

This is not best practice!
Dwelling-Unit Ventilation

• First choice, balanced ventilation?
  – Is dwelling tightness an issue?
  – Life-cycle cost?

• As second choice, exhaust-only in cold climates, supply-only in warm climates.

• Do not use Alternative Compliance Path.

• Install so well mixed, central location.

• Do not combine with local fan, but if do...
  – Install in central location.
Dwelling-Unit Ventilation

• Duct supply and exhaust air to/from appropriate locations:
  − Supply to bedrooms and living areas
  − Exhaust from bathrooms and other contaminant-producing areas.
  − Use caution when exhausting from kitchen.

• No fans in basement if not lived in.
Controls for Dwelling-Unit Vent.

• Ensure controls have flash memory.

• Label controls.

• Use controls that are easy to install and setup.

• Use controls that are easy for homeowner.
Filtration

• If possible, install filter.
  – Minimum MERV = 6
  – Better practice is MERV = 11 or higher
  – Need to consider duct static pressure
Ductwork

- Minimize length and fittings.
- Minimize collection of internal condensate.
- Minimize external duct condensate.
- Use smooth material.
- Use proper diameter.
- Insulate duct outside of conditioned space.
Termination

• Always terminate outdoors.
• Don’t terminate in soffit.
• Terminate in gable end or through roof.
• Use bird and insect screen.
• Utilize backdraft damper in system.
Health and Safety

• Consider source control of pollutants.
• CO alarm(s).
• Basement and crawlspace moisture.
• Consider pollutants from adjacent spaces.
• Encourage use of ventilation system.
• Combustion safety testing.
Fan Use and Maintenance

• User’s manual
  – When and how to operate.
  – Maintenance schedule.
  – When to service.
  – Who to call.