2015 Minnesota State Mechanical Code MN rule chapter 1346
2012 International Mechanical Code
2012 International Fuel Gas Code

Tim Manz
Senior Training and Certification Representative
What is the objective for us today?

- Objective: Provide an overview of basic and essential requirements of the 2015 Minnesota Mechanical and Fuel Gas Codes of single family home construction and how to perform the required inspections.
What is the outcome for us today?

• Outcome: Participants will gain an understanding of what to look for when inspecting mechanical systems in single family homes.
1. Understand different categories of appliances and how they affect depressurization of the home

2. Understand the difference between makeup air, exhaust air and combustion air

3. Understand inspection and installation requirements for makeup air, exhaust air and combustion air

4. Understand evaluating make up air calculations and combustion air calculations
• Chapters 2 to 15 of the 2012 edition of the International Mechanical Code (IMC)

• Chapters 2 to 8 of the 2012 edition of the International Fuel Gas Code (IFGC)

• Minnesota Administrative Rules
  • Chapter 1346, Minnesota Mechanical and Fuel Gas Codes
• IMC chapter 5
• Exhaust air
• Make up air

• IFGC chapter 3
• Combustion air

http://www.dli.mn.gov/CCLD/codes15.asp
The Flow of Make-up Air

1. Exhaust air  
2. Make up air  
3. And combustion air
Depressurization of the home can be fatal!

- **Pascal**

  - the SI unit of pressure, equal to one newton per square meter (approximately 0.000145 pounds per square inch, or $9.9 \times 10^{-6}$ atmospheres).
Example of classification for gas burning appliances

- Heating systems with fan-powered exhaust systems can withstand higher negative pressures than natural-draft appliances. Some types of fan-powered systems are much better than others, however. In order of effectiveness, the choices are:
Example of classification for gas burning appliances

Gas-fired appliances are divided into four categories for venting purposes.
Example of classification for gas burning appliances

- **Sealed-combustion.** Also called “direct vent,” these appliances draw all combustion and dilution air from outside. These can typically tolerate negative pressures in the range from 25 to 50 Pa.

**Category IV appliance**
- Positive vent pressure
- Vent gas temp typically around 120 degrees
- Condensing appliance
Category III products are direct sidewall vented without additional apparatus. Positive pressure requires joints in flue material to be sealed. Because these 80 percent appliance flue gases are close to the dew point, and the vent material is single wall, corrosion resistant materials must be used. Drains are typically incorporated to remove flue condensation before it enters the heat exchanger. Category III has been used to solve installation problems where no appropriate flue is available.
Examples of classification for gas burning appliances and backdrafting

- Category III appliance? Read manufactures venting requirements or follow prescriptive in the 2012 IFGC chapter 4

- Operates with a positive vent static pressure
- Gas vent temperature that avoid's condensation

• **Power-vented.** These draw their makeup air from indoors and are also called fan-assisted, forced-draft, or mechanical-draft. These can typically tolerate up to 15 to 20 Pa of negative pressure.
Concentric venting system with combustion air
This is not a power vent!

Power vent system
Receives combustion air from inside of the home
Example of classification for gas burning appliances and backdrafting

- UL C-S636 venting is divided into temperature classes
- PVC is rated class A (can operate with vent gases less than or equal to 65 degrees C (149 degrees F.))
- CPVC is class B (rated to operate with vent gases less than or equal to 90 degrees C (194 degrees F.))
- Note: 2012 IFGC section 502 mandates category II and III appliances be tested to UL 1738 which requires a test at 464 degrees F on non metallic piping.
Example of classification for gas burning appliances and backdrafting

- Category II appliances
  - Category II products are no longer manufactured. Negative pressure vents with combustion gases at or below the dew point. Heavy gases at the dew point are not buoyant enough to vent with a negative pressure flue.
Example of classification for gas burning appliances and backdrafting

- **Induced-draft.** These have a small fan added for energy performance, not to overcome house depressurization. These can typically tolerate 5 to 15 Pa of negative pressure.

**Category I appliance**
- vent temperatures between 300 – 400 °F
- The heat exchanger is under a negative
- Can be connected with other natural draft appliances
Category I appliance
Example of classification for gas burning appliances and backdrafting

INSTALLATION INSTRUCTIONS
90+ Two--Stage & Two--Stage, Variable Category IV, Gas Furnace

PRODUCT DESIGN
Category I Venting (Vertical Venting)
(80% Furnaces Only)

WARNING
To prevent possible personal injury or death due to asphyxiation, non-condensing gas fired warm air furnaces must be Category I vented. Do not vent any of these furnaces using Category III venting.

Category I Venting is venting at a non-positive pressure. A furnace vented as Category I is considered a fan-assisted appliance and does not have to be "gas tight." NOTE: Single-Stage and Two-Stage gas furnaces with induced draft blowers draw products of combustion through a heat exchanger allowing in some instances common venting with natural draft appliances (i.e. water heaters).

• Should be on the appliance
Depressurization of the home can be fatal!

### Health effects of carbon monoxide

It doesn’t take much CO to cause problems. Below is a table outlining the general effects of carbon monoxide on healthy adults. **Individual susceptibility will vary.**

<table>
<thead>
<tr>
<th>PPM CO in air</th>
<th>Percent CO in air</th>
<th>Symptoms experienced by healthy adults</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 35 ppm</td>
<td>0.0035%</td>
<td>No effect in healthy adults</td>
<td>35 ppm is WISHA 8-hour average permissible limit</td>
</tr>
<tr>
<td>100 ppm</td>
<td>0.01%</td>
<td>Slight headache, fatigue, shortness of breath, errors in judgment</td>
<td></td>
</tr>
<tr>
<td>200 ppm</td>
<td>0.02%</td>
<td>Headache, fatigue, nausea, dizziness</td>
<td>200 ppm is the WISHA ceiling limit</td>
</tr>
<tr>
<td>400 ppm</td>
<td>0.04%</td>
<td>Severe headache, fatigue, nausea, dizziness, confusion, can be life-threatening after 3 hours of exposure</td>
<td></td>
</tr>
<tr>
<td>800 ppm</td>
<td>0.08%</td>
<td>Headache, confusion, collapse, death if exposure is prolonged</td>
<td></td>
</tr>
<tr>
<td>1500 ppm</td>
<td>0.15%</td>
<td>Headache, dizziness, nausea, convulsions, collapse, death within 1 hour</td>
<td>Levels greater than 1500 ppm are considered “immediately dangerous to life or health” (IDLH)</td>
</tr>
<tr>
<td>3000 ppm</td>
<td>0.3%</td>
<td>Death within 30 minutes</td>
<td></td>
</tr>
<tr>
<td>6000 ppm</td>
<td>0.6%</td>
<td>Death within 10-15 minutes</td>
<td></td>
</tr>
<tr>
<td>12,000 ppm</td>
<td>1.2%</td>
<td>Nearly instant death</td>
<td></td>
</tr>
</tbody>
</table>

ppm = parts per million
Natural draft and fan assist venting application

2012 IFGC section 503.10.4
• when two or more appliances connected to a common vent
• The smaller connector shall enter at the highest level
Example of classification for gas burning appliances

• By comparison, an atmospherically vented furnace can backdraft with as little as 5 Pa of negative pressure, and a gas water heater will have spillage at 2 or 3 Pa. Fireplaces can start having problems at about 3 Pa. Canadian codes limit negative pressures in homes with atmospherically vented equipment to 5 Pa. U.S. codes do not currently address the issue.

• 1 pascal is equivalent to .004015 inches of water column

• 250 pascals is equivalent to 1 inch of water column
Example of water manometer

5.5 inch water column
What is an Exhaust air system

- MN 1346.501 discharge to the exterior of the building. Not into an attic or crawl space
- MN 1346.501.4.2.2 intake
  - Needs screen minimum of ¼ inch
  - Located at least 12 inches above grade
- MN 1346.501.3 back draft damper required
- Assembly of connected ducts, plenums, fittings, registers, grilles and hoods
What is an Exhaust air system

- Domestic kitchen exhaust hoods
- Domestic kitchen and bathroom fans
- Clothes dryers
- Subslab soil exhaust systems
  - Radon systems
  - MN rule 1303.2402
  - MN rule 1303.2403
What is an Exhaust air system

Exception: Central vacuum systems can discharge into an attached garage

IRC 302.11 - #4 fill the annular space with material meeting ASTM E 136
Laundry exhaust rough in required when designated on the plan.

IMC 504.6.6 if space is provided in the plan the dryer exhaust duct work shall be installed.
Laundry exhaust installation

Clothes dryer exhaust per IMC section 504

transition duct per UL 2158A – Max 8 feet
Residential kitchen exhaust

Exception: Ductless range hoods

IMC 1346.505.1 domestic systems

Two types:

- Range hoods discharging to the exterior
- Downdraft systems discharging to the exterior
Residential kitchen exhaust
1346.505.1

Range hood discharging to the exterior of the building
Residential kitchen exhaust 1346.505.1

Downdraft exhaust
Slab on grade construction
Exception #2
Residential kitchen exhaust 1346.505.1 “downdraft”

Permitted to be PVC (schedule 40) if:
• Duct installed under the slab
• The trench is completely backfilled
• PVC duct ≤ 1 inch above the indoor slab
• PVC duct ≤ 1 inch above grade
• PVC ducts primed and glued

1346.603 table 603.4 ductwork
Schedule 40 PVC
Max 1 inch above grade
• Ductless range hoods exception #1
  • Installed per manufacturers installation instructions
  • Mechanical ventilation provided according to IMC

Note: remember clearance requirements for appliances to combustibles and bottom of hoods
2012 IFGC 623.7
2012 IMC 917
Range top clearances to combustibles

2012 IFGC section 623.7 (gas appliances)

*CNOTE: 24" (61.0 cm) minimum when bottom of wood or metal cabinet is covered by not less than 1/4" (0.64 cm) flame retardant millboard covered with not less than No. 28 MSG sheet steel, 0.015" (0.4 mm) stainless steel, 0.024" (0.6 mm) aluminum or 0.020" (0.5 mm) copper. 30" (76.2 cm) minimum clearance between the top of the cooking platform and the bottom of an uncovered wood or metal cabinet.

A. 18" (45.7 cm) upper side cabinet to countertop
B. 13" (33 cm) max. upper cabinet depth
C. 30" (76.2 cm) min. opening width
D. For minimum clearance to top of cooktop, see NOTE *.
E. 30 1/8" (76.5 cm) min. opening width
F. The shaded areas are recommended for installation of rigid gas pipe.
G. 11" (27.6 cm)
H. 17" (43.2 cm)
I. 2" (5.1 cm)
J. 4 1/2" (11.4)
K. 3" (7.6 cm) min. clearance from both sides of range to side wall or other combustible material.
L. Grounded outlet
M. Cabinet door or hinges should not extend into the cutout.
30 inches

24 inches
### Appendix C, Table C-1

#### Recommended Capacities for Domestic Kitchen Exhaust Hoods

<table>
<thead>
<tr>
<th>Hood Size</th>
<th>Equipment with Grills or Deep Fryers (Number of Exposed Sides)</th>
<th>Ranges and Ovens (Number of Exposed Sides)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Four (CFM)</td>
<td>Three (CFM)</td>
</tr>
<tr>
<td>Area (Sq. Ft.)</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>Up to 4</td>
<td>Up to 400</td>
<td>Up to 300</td>
</tr>
</tbody>
</table>
Bathroom exhaust: combination waste and vent?
Bathroom exhaust

MN 1346.501.3 exhaust needs to discharge to the exterior

IMC 603 Flexible air ducts shall be either;
- Metallic
- Non metallic
- UL 181 approved
- Know the difference between flexible duct and flexible connector
- Read Air diffusion council installation requirements for flexible ducts. (ADC)

IMC table 403.3 Bathroom exhaust
- 20 cfm continuous or,
- 50 cfm intermittent
What is a make up air system

- Replenishes the air removed from the home by exhaust air systems

Vent a hood make up air - video

https://www.youtube.com/results?search_query=make+up+air+for+range+hood
How much make up air is required in (new dwellings)

• MN 1346.501.4.1 Makeup air in new dwelling units.
  • Determined by using IMC Table 501.4.1
  • Needs to be supplied in accordance with IMC section 501.4.2
Table 501.4.1 New Dwellings
Procedure to Determine Makeup Air in Dwelling Units

<table>
<thead>
<tr>
<th></th>
<th>APPLIANCES OR NO COMBUSTION APPLIANCES(^A)</th>
<th>APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES(^B)</th>
<th>APPLIANCE OR ONE SOLID FUEL APPLIANCE(^C)</th>
<th>VENTED GAS OR OIL APPLIANCES OR SOLID FUEL APPLIANCES(^D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use the Appropriate Column to Estimate House Infiltration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) pressure factor (cfm/sf)</td>
<td>0.15</td>
<td>0.09</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>b) conditioned floor area (sf) (including unfinished basements)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Estimated House Infiltration (cfm): ([1a \times 1b])</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Exhaust Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) clothes dryer</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>b) 80% of largest exhaust rating (cfm) (not applicable if recirculating system or if powered \textit{makeup air} is electrically interlocked and matched to exhaust)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>c) 80% of next largest exhaust rating (cfm) (not applicable if recirculating system or if powered \textit{makeup air} is electrically interlocked and matched to exhaust)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total Exhaust Capacity (cfm): ([2a + 2b + 2c])</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3. Makeup Air Requirement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Total Exhaust Capacity (from above)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>b) Estimated House Infiltration (from above)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Makeup Air Quality (cfm): ([3a - 3b])</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

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B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.
C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

(if value is negative, no makeup air is needed

4. For Makeup Air Opening Sizing, refer to Table 501.4.2.)
# TABLE 501.4.2 MAKEUP AIR OPENING SIZING TABLE FOR NEW AND EXISTING DWELLING UNITS

<table>
<thead>
<tr>
<th>TYPE OF OPENING OR SYSTEM</th>
<th>ONE OR MULTIPLE POWER VENT OR DIRECT VENT APPLIANCES OR NO COMBUSTION APPLIANCES&lt;sup&gt;A&lt;/sup&gt; (cfm)</th>
<th>ONE OR MULTIPLE FAN-ASSISTED APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES&lt;sup&gt;B&lt;/sup&gt; (cfm)</th>
<th>ONE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCE OR ONE SOLID FUEL APPLIANCE&lt;sup&gt;C&lt;/sup&gt; (cfm)</th>
<th>MULTIPLE APPLIANCES THAT ARE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCES OR SOLID FUEL APPLIANCES&lt;sup&gt;D&lt;/sup&gt; (cfm)</th>
<th>PASSIVE MAKEUP AIR OPENING DUCT DIAMETER&lt;sup&gt;E,F,G&lt;/sup&gt; (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive opening</td>
<td>1-36</td>
<td>1-22</td>
<td>1-15</td>
<td>1-9</td>
<td>3</td>
</tr>
<tr>
<td>Passive opening</td>
<td>37-66</td>
<td>23-41</td>
<td>16-28</td>
<td>10-17</td>
<td>4</td>
</tr>
<tr>
<td>Passive opening</td>
<td>110-163</td>
<td>67-100</td>
<td>47-69</td>
<td>29-42</td>
<td>6</td>
</tr>
<tr>
<td>Passive opening</td>
<td>164-232</td>
<td>101-143</td>
<td>70-99</td>
<td>43-61</td>
<td>7</td>
</tr>
<tr>
<td>Passive opening</td>
<td>233-317</td>
<td>144-195</td>
<td>100-135</td>
<td>62-83</td>
<td>8</td>
</tr>
<tr>
<td>Passive opening with motorized damper</td>
<td>318-419</td>
<td>196-258</td>
<td>136-179</td>
<td>84-110</td>
<td>9</td>
</tr>
<tr>
<td>Passive opening with motorized damper</td>
<td>420-539</td>
<td>259-332</td>
<td>180-230</td>
<td>111-142</td>
<td>10</td>
</tr>
<tr>
<td>Passive opening with motorized damper</td>
<td>540-679</td>
<td>333-419</td>
<td>231-290</td>
<td>143-179</td>
<td>11</td>
</tr>
<tr>
<td>Powered makeup air&lt;sup&gt;D&lt;/sup&gt;</td>
<td>&gt; 679</td>
<td>&gt; 419</td>
<td>&gt; 290</td>
<td>&gt; 179</td>
<td>Not applicable</td>
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</tbody>
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E. An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and ten feet for each 90-degree elbow to determine the remaining length of straight duct allowable.
F. If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.
G. Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.
H. Powered makeup air shall be electrically interlocked with the largest exhaust system.
How much make up air is required in (new dwellings)

• Exceptions
  • Testing per ASTM Standard E 1998-02
    • Specific to category I appliances (natural draft, fan assisted)
      • Need to read document waiting to receive!
  • Testing approved by the building official verifying proper operation of vented combustion appliances
• How much make up air is required in (new dwellings)

https://www.youtube.com/watch?v=et2-PW_nnos
Requirements for how make up air is supplied MN 1346.501.4.2

Three Requirements when Supplying Passive Make Up Air:
1. Sized through IMC table 501.4.2

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<tr>
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<th>ONE OR MULTIPLE POWER VENT OR DIRECT VENT APPLIANCES OR NO COMBUSTION APPLIANCES A (cfm)</th>
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H. Powered makeup air shall be electrically interlocked with the largest exhaust system.
Requirements for how make up air is supplied
MN 1346.501.4.2

2. Barometric dampers are prohibited in passive make up air openings when any atmospherically vented appliance is installed
Requirements for how make up air is supplied
MN 1346.501.4.2

A single passive opening greater than 8 inches diameter

- Requires a motorized damper
- Needs to be electrically interlocked with exhaust appliance
Requirements for how make up air is supplied MN 1346.501.4.2

- Intake needs corrosion resistant screen not less than ¼ inch mesh.
- Need to meet manufacturers' installation requirements 501.4.2.4 termination restrictions.
- Table R403.2.1 R 3.3
- 3 feet insulated
- Energy code
- "12" From grade
- http://www.gulland.ca/fhs/makeupair.htm
Requirements for how make up air is supplied
MN 1346.501.4.2

603.4 Metallic ducts.
All metallic ducts shall be constructed as specified in the SMACNA HVAC Duct Construction Standards—Metal and Flexible.

Exception: Ducts installed within a single dwelling unit shall have a minimum thickness as specified in IMC Table 603.4 as amended in this part.

Table 603.4 Duct Construction Minimum Sheet Metal Thicknesses for Single Dwelling Units

<table>
<thead>
<tr>
<th>Duct Size</th>
<th>Galvanized</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum thickness (in.)</td>
<td>Equivalent galvanized gage no.</td>
</tr>
<tr>
<td>Round ducts and enclosed rectangular ducts</td>
<td>0.013</td>
<td>30</td>
</tr>
<tr>
<td>14 inches or less</td>
<td>0.016</td>
<td>28</td>
</tr>
<tr>
<td>Over 14 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed rectangular ducts</td>
<td>0.016</td>
<td>28</td>
</tr>
<tr>
<td>14 inches or less</td>
<td>0.019</td>
<td>26</td>
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<tr>
<td>Over 14 inches</td>
<td></td>
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For SI: 1 inch = 25.4 mm, 1 inch water gage = 249 Pa.
When is Power make up air required

- If single or multiple openings exceed 11 inches in diameter per...
Requirements for how make up air is supplied MN 1346.501.4.2

• Electrically interlocked with the largest exhaust system
  • Example
    • Kitchen hood

• The fan needs to match the airflow of the largest exhaust system
  • Example
    • Kitchen hood – 200 cfm
    • Dryer exhaust – 135 cfm
    • 2 Bathroom fan – 50 cfm = 100 total cfm
<table>
<thead>
<tr>
<th>ONE OR MULTIPLE POWER VENT OR DIRECT VENT APPLIANCES OR NO COMBUSTION APPLIANCES^A</th>
<th>ONE OR MULTIPLE FAN-ASSISTED APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES^B</th>
<th>ONE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCE OR ONE SOLID FUEL APPLIANCE^C</th>
<th>THAT ARE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCES OR SOLID FUEL APPLIANCES^D</th>
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<tr>
<td>1. Use the Appropriate Column to Estimate House Infiltration</td>
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<tr>
<td>a) pressure factor (cfm/sf)</td>
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<tr>
<td>b) conditioned floor area (sf)</td>
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<td></td>
<td></td>
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<tr>
<td>(including unfinished basements)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Estimated House Infiltration (cfm): [1a \times 1b]</td>
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</tr>
<tr>
<td>2. Exhaust Capacity</td>
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<td>a) clothes dryer</td>
<td>135</td>
<td>135</td>
<td>135</td>
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<tr>
<td>b) 80% of largest exhaust rating (cfm):</td>
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<tr>
<td>(not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) 80% of next largest exhaust rating (cfm):</td>
<td>not applicable</td>
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<tr>
<td>(not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)</td>
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<td></td>
<td></td>
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<tr>
<td>Total Exhaust Capacity (cfm): [2a+2b+2c]</td>
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<td>3. Makeup Air Requirement</td>
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<td>a) Total Exhaust Capacity (from above)</td>
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<tr>
<td>b) Estimated House Infiltration (from above)</td>
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<tr>
<td>c) Makeup Air Quality (cfm): [3a - 3b]</td>
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<tr>
<td>(if value is negative, no makeup air is needed)</td>
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<td>4. For Makeup Air Opening Sizing, refer to Table 501.4.2.</td>
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<td>TYPE OF OPENING OR SYSTEM</td>
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<td>ONE OR MULTIPLE FAN-ASSISTED APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES&lt;sup&gt;B&lt;/sup&gt;</td>
<td>ONE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCE OR ONE SOLID FUEL APPLIANCE&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Passive opening</td>
<td>(cfm)</td>
<td>(cfm)</td>
<td>(cfm)</td>
</tr>
<tr>
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<td>1-36</td>
<td>1-22</td>
<td>1-15</td>
</tr>
<tr>
<td>Passive opening</td>
<td>37-66</td>
<td>23-41</td>
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<tr>
<td>Passive opening</td>
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<td>101-143</td>
<td>43-125</td>
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<td>Passive opening</td>
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<td>100-135</td>
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<tr>
<td>Passive opening with motorized damper</td>
<td>318-419</td>
<td>196-258</td>
<td>136-179</td>
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<td>Passive opening with motorized damper</td>
<td>420-539</td>
<td>259-332</td>
<td>180-230</td>
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<tr>
<td>Passive opening with motorized damper</td>
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<td>333-419</td>
<td>231-290</td>
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<td>Powered makeup air&lt;sup&gt;H&lt;/sup&gt;</td>
<td>&gt; 679</td>
<td>&gt; 419</td>
<td>&gt; 290</td>
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</tbody>
</table>

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliance.
B. Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliance.
C. Use this column if there is one atmospherically vented appliance per venting system. A single appliance.
D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliances.

E. An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and ten feet for each 90-degree elbow to determine the remaining length of straight duct allowable.
F. If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.
G. Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.
H. Powered makeup air shall be electrically interlocked with the largest exhaust system.

Power makeup required 263 cfm
Requirements for how make up air is supplied
MN 1346.501.4.2

• What else is required when we have makeup air of 175 cfm

263 cfm of make up air required for hood
Requirements for how make up air is supplied
MN 1346.501.4.2

MN 1346.501.4.2.3
Make up air location ≥ 175 cfm. You need to meet one of the following:

• In the space of vented combustion appliances
• In the space of the exhaust system
• In the space that freely communicates with the exhaust system and
  • Approved by the B.O.
MN 1346.501.4.3 additions, alterations, or installation of mechanical system

- Dwelling constructed after 2003
- Use tables 501.4.1 (infiltration calc) and 501.4.2 (passive/mechanical)
- When installing or replacing vented gas or solid fuel appliance
- When installing or replacing an exhaust system
- Exception:
  - Powered makeup interlocked
MN 1346.501.4.3 additions, alterations, or installation of mechanical system

- Dwelling constructed after 1999 using MN energy code 7672
- Use tables 501.41 (infiltration calc) and 501.4.2 (passive/mechanical)
- When installing or replacing vented gas or solid fuel appliance
- When installing or replacing an exhaust system
- Exception:
  - Powered makeup interlocked
• When a solid fuel appliance is being installed
• Dwelling constructed during or after 1994 using MN energy code 7670
• Use tables 501.41 (infiltration calc) and 501.4.2 (passive/mechanical)
• Exception
  • Sealed combustion
MN 1346.501.4.3 additions, alterations, or installation of mechanical system

- When exhaust is installed greater than 300 cfm
- Dwelling is constructed during or after 1994 using MN energy code 7670
- Use tables 501.4.1 (infiltration calc) and 501.4.2 (passive/mechanical)
- Exception
  - Powered makeup interlocked
MN 1346.501.4.3 additions, alterations, or installation of mechanical system

- When exhaust is installed greater than 300 cfm
- Dwelling is constructed prior to 1994
- Use tables 501.4.3(2)-(infiltration calc) and 501.4.2 (passive and mechanical)
- Exception
  - Power makeup air interlocked
MN 1346.501.4.3 additions, alterations, or installation of mechanical system

- When a solid fuel appliance is installed
- Dwelling constructed prior to 1994
- Use tables 501.4.3(3)-(infiltration calc) and 501.4.2 (passive and mechanical)
- Exception
  - Sealed combustion
ASTM E1998

1. Scope
1.1 This guide describes and compares different methods for assessing the potential for, or existence of, depressurization-induced backdrafting and spillage from vented residential combustion appliances.
1.2 Assessment of depressurization-induced backdrafting and spillage is conducted under either induced depressurization or natural conditions.
1.3 Residential vented combustion appliances addressed in this guide include hot water heaters and furnace. The guide also is applicable to boilers.
1.4 The methods given in this guide are applicable to Category I (draft-hood- and induced-fan-equipped) furnaces. The guide does not apply to Category III (power-vent-equipped) or Category IV (direct-vent) furnaces.
1.5 The methods in this guide are not intended to identify backdrafting or spillage due to vent blockage or heat-exchanger leakage.
1.6 This guide is not intended to provide a basis for determining compliance with code requirements on appliance and venting installation, but does include a visual assessment of the installation. This assessment may indicate the need for a thorough inspection by a qualified technician.
1.7 Users of the methods in this guide should be familiar with combustion appliance operation and with making house-tightness measurements using a blower door. Some methods described in this guide require familiarity with differential-pressure measurements and use of computer-based data-logging equipment.
1.8 This guide does not purport to address all safety concerns, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use. Carbon monoxide (CO) exposure or flame roll-out may occur when performing certain procedures given in this guide. See Section 4 for precautions that must be taken in conducting such procedures.

MN 1346.501.4.3 additions, alterations, or installation of mechanical system
Testing according to ASTM standard E1998-02
Testing approved by the Building Official
What is Combustion Air?

• Air necessary for complete combustion of a fuel, including theoretical air and excess air

How do we know when we have enough combustion air?
How do we apply combustion air to a residential home in Minnesota?

- IFGC MN rule 1346.5304.1 combustion, Ventilation and dilution air
- IFGC Appendix E for worksheet E-1, residential combustion air calculation method
How do we apply combustion air to a residential home in Minnesota?

- IFGC MN rule 1346.5304.1 combustion, Ventilation and dilution air
- 1346.6012 - residential combustion air required volume
Step 1: Complete vented combustion appliance information.

Furnace/Boiler:

- Draft Hood
- Fan Assisted
- Direct Vent
- Input:

Water Heater:

- Draft Hood
- Fan Assisted
- Direct Vent
- Input:

Step 2: Calculate the volume of the Combustion Appliance Space (CAS) containing combustion appliances.

The CAS includes all spaces connected to one another by code compliant openings.

CAS volume: _______ ft³

Step 3: Determine Air Changes per Hour (ACH)¹

Default ACH values have been incorporated into Table E-1 for use with Method 4b (KAIR Method). If the year of construction or ACH is not known, use method 4a (Standard Method).

Step 4: Determine Required Volume for Combustion Air.

4a. Standard Method

Total Btu/hr input of all combustion appliances (DO NOT COUNT DIRECT VENT APPLIANCES)

Input: _________________ Btu/hr

Use Standard Method column in Table E-1 to find Total Required Volume (TRV)

TRV: _________________ ft³

If CAS Volume (from Step 2) is greater than TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) is less than TRV then go to STEP 5.

4b. Known Air Infiltration Rate (KAIR) Method
Residential Combustion Air Calculation Method

**Total Btu/hr input of all fan-assisted and power vent appliances (DO NOT COUNT DIRECT VENT APPLIANCES)**

Use Fan-Assisted Appliances column in Table E-1 to find Required Volume Fan Assisted (RVFA)

Total Btu/hr input of all non-fan-assisted appliances

Use Non-Fan-Assisted Appliances column in Table E-1 to find Required Volume Non-Assisted (RVNFA)

Total Required Volume (TRV) = RVFA + RVNFA

\[ \text{RV} = \frac{\text{Input}}{3} + \frac{\text{Input}}{3} = \frac{\text{Input}}{3} \text{ ft} \]

If CAS Volume (from Step 2) is greater than TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) is less than TRV then go to STEP 5.

**Step 5:** Calculate the ratio of available interior volume to the total required volume.

Ratio = CAS Volume (from Step 2) divided by TRV (from Step 4a or Step 4b)

**Step 6:** Calculate Reduction Factor (RF).

RF = 1 minus Ratio

**Step 7:** Calculate single outdoor opening as if all combustion air is from outside.

Total Btu/hr input of all Combustion Appliances in the same CAS (EXCEPT DIRECT VENT)

Combustion Air Opening Area (CAOA):

Total Btu/hr divided by 3000 Btu/hr per in²

\[ \text{CAOA} = \frac{\text{Input}}{3000 \text{ Btu/hr per in}^2} = \frac{\text{Input}}{3000} \text{ in} \]

**Step 8:** Calculate Minimum CAOA.

Minimum CAOA = CAOA multiplied by RF

IFGC Appendix E, Worksheet E-1

Residential Combustion Air Calculation Method
Step 9: Calculate Combustion Air Opening Diameter (CAOD)

\[
\text{CAOD} = 1.13 \times \sqrt{\text{Minimum CAOA}}
\]

\[
\text{CAOD} = 1.13 \times \text{Minimum CAOA} = \text{______________________ in}
\]

1 If desired, ACH can be determined using ASHRAE calculation or blower door test. Follow procedures in Section G304.
<table>
<thead>
<tr>
<th>Input Rating (Btu/hr)</th>
<th>Standard Method (ft³)</th>
<th>Fan Assisted 1994¹ to Present</th>
<th>Pre 1994²</th>
<th>1994¹ to Present</th>
<th>Pre 1994²</th>
</tr>
</thead>
<tbody>
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<td>250</td>
<td>375</td>
<td>188</td>
<td>525</td>
<td>263</td>
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<td>1,125</td>
<td>563</td>
<td>1,575</td>
<td>788</td>
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<td>750</td>
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<td>1,050</td>
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<td>938</td>
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<td>1,313</td>
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</table>
IFGC Appendix E, Table E-1

Residential Combustion Air Required Volume

(Required Interior Volume Based on Input Rating of Appliances)

<table>
<thead>
<tr>
<th>Input Rating (Btu/hr)</th>
<th>Standard Method (ft³)</th>
<th>Fan Assisted 1994¹ to Present</th>
<th>Non-Fan-Assisted Pre 1994²</th>
<th>Non-Fan-Assisted 1994¹ to Present</th>
<th>Non-Fan-Assisted Pre 1994²</th>
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<td>12,000</td>
<td>6,000</td>
<td>16,800</td>
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<td>8,250</td>
<td>23,100</td>
<td>11,550</td>
</tr>
<tr>
<td>225,000</td>
<td>11,250</td>
<td>16,875</td>
<td>8,438</td>
<td>23,625</td>
<td>11,813</td>
</tr>
<tr>
<td>230,000</td>
<td>11,500</td>
<td>17,250</td>
<td>8,625</td>
<td>24,150</td>
<td>12,075</td>
</tr>
</tbody>
</table>

¹The 1994 date refers to dwellings constructed under the 1994 Minnesota Energy Code. The default KAIR used in this section of the table is 0.20 ACH.

²This section of the table is to be used for dwellings constructed prior to 1994. The default KAIR used in this section of the table is 0.40 ACH.
How do we apply combustion air to a residential home in Minnesota?

• Exceptions:
  • Direct vent appliances
  • Type 1 clothes dryers
  • Replacement of appliances
    • Input rating < 30k above the original appliance
    • Combustion air meets code at the time of appliance installation
    • Does not make the system unsafe, hazardous, or overloaded
How do we apply combustion air to a residential home in Minnesota?

MN 1346.304.1 General

- Exceptions #4
- Combustion air can be determined by Table 304.1
- One opening
- Discharging within 12 inches of the floor

12 inches above the floor
### Combustion Air Requirements for Gas-Fired Appliances When the Combined Input is Up to and Including 400,000 Btu/hr

<table>
<thead>
<tr>
<th>Total input of appliances(^1), thousands of Btu/hr (kW)</th>
<th>Required free area of air-supply opening or duct, square inches (sq mm)</th>
<th>Acceptable approximate round duct equivalent diameter(^2), inch (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 (8)</td>
<td>7 (4,500)</td>
<td>3 (75)</td>
</tr>
<tr>
<td>50 (15)</td>
<td>7 (4,500)</td>
<td>3 (75)</td>
</tr>
<tr>
<td>75 (23)</td>
<td>11 (7,000)</td>
<td>4 (100)</td>
</tr>
<tr>
<td>100 (30)</td>
<td>14 (9,000)</td>
<td>4 (100)</td>
</tr>
<tr>
<td>125 (37)</td>
<td>18 (12,000)</td>
<td>5 (125)</td>
</tr>
<tr>
<td>150 (45)</td>
<td>22 (14,000)</td>
<td>5 (125)</td>
</tr>
<tr>
<td>175 (53)</td>
<td>25 (16,000)</td>
<td>6 (150)</td>
</tr>
<tr>
<td>200 (60)</td>
<td>29 (19,000)</td>
<td>6 (150)</td>
</tr>
<tr>
<td>225 (68)</td>
<td>32 (21,000)</td>
<td>6 (150)</td>
</tr>
<tr>
<td>250 (75)</td>
<td>36 (23,000)</td>
<td>7 (175)</td>
</tr>
<tr>
<td>275 (83)</td>
<td>40 (26,000)</td>
<td>7 (175)</td>
</tr>
<tr>
<td>300 (90)</td>
<td>43 (28,000)</td>
<td>7 (175)</td>
</tr>
<tr>
<td>325 (98)</td>
<td>47 (30,000)</td>
<td>8 (200)</td>
</tr>
<tr>
<td>350 (105)</td>
<td>50 (32,000)</td>
<td>8 (200)</td>
</tr>
<tr>
<td>375 (113)</td>
<td>54 (35,000)</td>
<td>8 (200)</td>
</tr>
<tr>
<td>400 (120)</td>
<td>58 (37,000)</td>
<td>9 (225)</td>
</tr>
</tbody>
</table>

\(^1\) For total inputs falling between listed capacities, use next largest listed input.

\(^2\) If flexible duct is used, increase the duct diameter by one inch.*

*Flexible duct shall be stretched with minimal sags.
How do we apply combustion air to a residential home in Minnesota?

- 1346.0304.6.2 One permanent opening
- 12 inches from the floor
- When natural draft appliances are installed
- 1 inch²/3,000 Btu/hr
How do we apply combustion air to a residential home in Minnesota?

1346.0304.6.2 One permanent opening
12 inches from the top of room
Power vent
Fan assisted?
1 inch²/3,000 Btu/hr
How do we apply combustion air to a residential home in Minnesota?

• MN 1346.0304.11 Combustion air ducts.

• There are 11 criteria to comply with when looking at the installation of combustion air ducts.
How do we apply combustion air to a residential home in Minnesota? #1

#1. Ducts constructed per chapter 6 of the IMC

603.4 Metallic ducts.
All metallic ducts shall be constructed as specified in the SMACNA HVAC Duct Construction Standards—Metal and Flexible.

Exception: Ducts installed within a single dwelling unit shall have a minimum thickness as specified in IMC Table 603.4 as amended in this part.

TABLE 603.4 DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESSES FOR SINGLE DWELLING UNITS

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>GALVANIZED</th>
<th>ALUMINUM</th>
<th>ALUMINUM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum thickness (in.)</td>
<td>Equivalent galvanized gage no.</td>
<td>MINIMUM THICKNESS (gauge)</td>
</tr>
<tr>
<td>Round ducts and enclosed rectangular ducts</td>
<td>0.013</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>Over 14 inches</td>
<td>0.016</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>Exposed rectangular ducts</td>
<td>0.016</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>Over 14 inches</td>
<td>0.019</td>
<td>26</td>
<td>22</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 inch water gage = 249 Pa.
How do we apply combustion air to a residential home in Minnesota?

- #2. Ducts shall terminate to allow movement of combustion air to the appliance
How do we apply combustion air to a residential home in Minnesota?

- #3. Ducts shall serve a single space

- #4. Disregard two opening method. This has been repealed (deleted in Minnesota)
How do we apply combustion air to a residential home in Minnesota?

• #5. Ducts shall not terminate into an attic.
How do we apply combustion air to a residential home in Minnesota?

- #6. The remaining space surrounding a chimney liner or similar cannot be used for combustion air

Exception

- Gas fired appliances designed for installation in a solid fuel-burning fireplace
- Installed with listing and manufacturer’s instructions
How do we apply combustion air to a residential home in Minnesota? #7

- #7. Vertical ducts cannot extend through two or more stories
- Exception
  - Approval from the building official
- Note: you need to reference IMC chapter 6, section 607.6.3 non fire resistance rated floor assemblies.
How do we apply combustion air to a residential home in Minnesota?

• #8. Combustion air shall not terminate into return air plenums
• Unless
  • Installed per manufacture installation requirements.
• Mixed air calculation
  • \[ \text{MAT} = (\text{CFM OA} \times \text{T OA}^\circ\text{F}) + (\text{CFM RA} \times \text{T RA}) \]

MAT = Mixed air temperature °F
CFM OA = Outside air CFM
CFM RA = Return air CFM
T OA = Outside air temperature °F
Combustion air duct connected to return plenum

supply plenum

Furnace

register just above furnace supplies combustion air to this room

interior

combustion air duct

return plenum

exterior

combustion air inlet

air flow
How do we apply combustion air to a residential home in Minnesota?

- #9. Combustion air intakes shall be located to avoid intake of exhaust air in accordance with IMC Section 401.5 (intake opening protection)
- IMC Section 401.5 (intake opening protection)
- IFGC Section 503.8 (Venting system termination location)

---

**TABLE 401.5 OPENING SIZES IN LOUVERS, GRILLES AND SCREENS PROTECTING AIR INTAKE OPENINGS**

<table>
<thead>
<tr>
<th>OUTDOOR OPENING TYPE</th>
<th>MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake openings in residential occupancies</td>
<td>Not &lt; (\frac{1}{4}) inch and not &gt; (\frac{1}{2}) inch</td>
</tr>
<tr>
<td>Intake openings in other than residential occupancies</td>
<td>(&gt;\frac{1}{4}) inch and not &gt; 1 inch</td>
</tr>
</tbody>
</table>
For SI: 1 inch = 25.4 mm 1 foot = 304.8 mm 1 British thermal unit per hour = 0.2931 W.

APPENDIX C EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS
How do we apply combustion air to a residential home in Minnesota?

10. Intake openings shall be at least 12 inches above grade
How do we apply combustion air to a residential home in Minnesota?

• #11. Do not combine make up air and combustion air openings
  • Exception:
    • Unless approved by the Building Official!
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Link</th>
<th>Date</th>
<th>Retrieved from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic kitchen hood exhausting to exterior</td>
<td><a href="https://upload.wikimedia.org/wikipedia/commons/0/00/Kitchen_fan.jpg">https://upload.wikimedia.org/wikipedia/commons/0/00/Kitchen_fan.jpg</a></td>
<td>11/2/2017</td>
<td>Google Images</td>
</tr>
</tbody>
</table>
THANK YOU FOR YOUR ATTENTION

https://www.youtube.com/watch?v=0YjJhn2UkEk