Unlisted Hood Calculation based on UMC!

Exhaust ventilation rate based on 100 cfm per square foot of hood face area.

Example:
4 ft. x 4 ft. x 100 cfm/ft² = 1600 cfm
Which hood needs more exhaust?

UMC specifies:

- 1600 cfm
- 2000 cfm
# Minimum CFM for Unlisted Hoods
(per 2001 International Mechanical Code)

<table>
<thead>
<tr>
<th>Type of Hood</th>
<th>Light Duty Equipment</th>
<th>Medium Duty Equipment</th>
<th>Heavy Duty Equipment</th>
<th>Extra Heavy Duty Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted canopy</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>Single island canopy</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Double island canopy</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>250</td>
<td>250</td>
<td>not allowed</td>
<td>not allowed</td>
</tr>
<tr>
<td>Backshelf/Passover</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>not allowed</td>
</tr>
</tbody>
</table>

* Conversion from cfm per ft\(^2\) to cfm per lin. ft. assumed a 4 ft. deep canopy hood
Light Duty Appliances
(ASHRAE Standard 154 & IMC)

- Gas and electric ovens (including standard, bake, roasting, revolving, rethermal, convection, combination convection/steamer, conveyor, deck or deck-style pizza, and pastry)
- Electric and gas steam-jacketed kettles
- Electric and gas compartment steamers (both pressure and atmospheric)
- Electric and gas cheesemelters.
- Electric and gas rethermalizers
## Medium Duty Appliances

**Medium Duty Appliances**

(ASHRAE Standard 154 & IMC)

- Electric discrete element ranges (with or without oven)
- Electric and gas hot-top ranges
- Electric and gas griddles
- Electric and gas double-sided griddles
- Electric and gas fryers (including open deep-fat fryers, donut fryers, kettle fryers, and pressure fryers)
- Electric and gas pasta cookers
- Electric and gas conveyor (pizza) ovens
- Electric and gas tilting skillets/braising pans
- Electric and gas rotisseries
Heavy Duty Appliances
(ASHRAE Standard 154 & IMC)

- Electric and gas underfired broilers
- Electric and gas chain (conveyor) broilers
- Gas open-burner ranges (with or without oven)
- Electric and gas wok ranges
- Electric and gas overfired (upright) broilers
- Salamanders
Extra-Heavy Duty Appliances
(ASHRAE Standard 154 & IMC)

- Appliances using solid fuel such as wood, charcoal, briquettes, and mesquite to provide all or part of the heat source for cooking.
Exemption (both IMC and UMC):

Listed exhaust hoods are to be installed in accordance with the terms of their listing and the manufacture’s installation instructions.
**Underwriters Laboratories (UL) Standard 710**

*Exhaust hoods for commercial cooking equipment.*

Part of this UL Standard is a “cooking smoke and flare up” test. This test is essentially a capture and containment (C&C) test where “no evidence of smoke or flame escaping outside the exhaust hood” must be observed.

Hoods bearing a recognized laboratory mark are called listed hoods, while those constructed to the prescriptive requirements of the building code are called unlisted hoods. Generally, a listed hood can be operated at a lower exhaust rate than an unlisted hood of comparable style and size over the same cook line.

UL clearly states that under the application of UL 710 “air flow rates are established under draft free laboratory conditions with the appliance cooking surface temperatures as noted. Greater exhaust and/or lesser supply air flow rates may be required for each specific installation to obtain complete vapor and smoke removal.”
Typical Minimum Exhaust Flow Rates for Listed Hoods by Cooking Equipment Type*

<table>
<thead>
<tr>
<th>Type of Hood</th>
<th>Minimum Exhaust Flow Rate (cfm per linear foot of hood)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light Duty Equipment</td>
</tr>
<tr>
<td>Wall-mounted canopy</td>
<td>150 - 200</td>
</tr>
<tr>
<td>Single island canopy</td>
<td>250 - 300</td>
</tr>
<tr>
<td>Double island canopy</td>
<td>150 - 200</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Backshelf/Passover</td>
<td>100 - 200</td>
</tr>
</tbody>
</table>

* ASHRAE Applications Handbook

Note: many hood manufacturers have software tools to select an appropriate exhaust rate for a given cook line!
Real-World Hood Selection & Sizing

- Casual dining/short-order style appliance line
- Appliance located approx. 6 in. off the back wall

Hood Type? ____________  Hood features? ______________
Min. Hood length? ________  Design Exhaust rate? ________
Unlisted Wall Mounted Canopy Hood

per IMC for Heavy Duty Equipment:
19 ft. x 400 cfm/ft. = 7600 cfm

per UMC for high temperature:
19 ft x 4 ft x 100 cfm/ft² = 7600 cfm
Smaller Unlisted Wall Canopy Hood

per IMC for Heavy Duty Equipment:
18 ft. x 400 cfm/ft. = 7200 cfm

per UMC for high temperature:
18 ft x 4 ft x 100 cfm/ft² = 7200 cfm
2 Unlisted Hoods with Rearranged Line

Hood over broiler & range:
9 ft. x 400 cfm/ft. = 3600 cfm

Hood over griddle & fryer:
9 ft. x 300 cfm/ft = 2700 cfm

Total = 6300 cfm
2 Unequal Length Listed Hoods

Hood over griddle & fryers:
10.25 ft. x 250 cfm/ft. = 2560 cfm

Hood over broiler & range:
5.5 ft x 400 cfm/ft = 2200 cfm

Total = 4760 cfm
Proximity hood over griddle & fryers:
11 ft. x 150 cfm/ft. = 1650 cfm

Canopy hood w/side panels over broiler & range:
5.5 ft x 300 cfm/ft = 1650 cfm

Total = 3300 cfm
Design Strategy Comparison:

19 ft. unlisted hood = 7600 cfm
18 ft. unlisted hood = 7200 cfm
2 unlisted hood sections = 6300 cfm
(with rearranged line)
2 Listed Hood Sections = 4760 cfm
(with rearranged line)
Custom Backshelf/Canopy = 3300 cfm
Another path to exhaust hood performance...
Lab-Based Hood Design
Food Service Technology Center
affiliated with the
Commercial Kitchen Ventilation Lab
Wood Dale, IL
Manager: Rich Swierczyna
Architectural Energy Corp.
Ph: 630-860-1439

Lab Originally Designed by McDonald’s for Optimizing Hood Performance
... recently used to develop test method for Exhaust Hoods

Scope of ASTM F1704-99:

The performance evaluation of exhaust hoods with commercial cooking appliances and associated replacement air configuration

– Capture & Containment (C&C)

– Heat Gain to Space (Energy Balance Protocol)
Schlieren Flow Visualization

Hood
Range Top
(side view)
Capture and Containment at 220 cfm/lf

Hood
Range Top
(side view)
Spillage of Plume at 165cfm/lf

Hood
Capture and Containment at 220 cfm/lf

Range Top
(side view)

Range Top
(side view)
What the Eye Sees!

8-Ft Wall Mounted Canopy Hood
What the Camera Sees!

Hood Does Not Capture & Contain
Makeup Air Introduced at Low Velocity

Capture & Containment (C&C) @ 1400 CFM
The Mechanical Design Disconnect!
Hoods do not like high velocity…
Replacement (Makeup) Air Options

- Transfer air (e.g., from dining room)
- Displacement diffusers (floor or wall)
- Ceiling diffusers (2-way, 3-way, 4-way)
- Slot diffusers (ceiling)
- Ceiling diffusers with perforated face
- Integrated hood plenum including...
• Short circuit (internal supply)

• Air curtain supply

• Front face supply

• Perforated perimeter supply

• Backwall supply (rear discharge)

• Combinations of the above
Focused on minimizing the effect that makeup air supply can have on the performance of exhaust hoods
Hypothesis:

IF the local makeup air strategy were to have no effect on hood performance (i.e., equivalent to the displacement base-case condition),

THEN it would be possible to replace 100% of the air exhausted through the makeup air configuration being investigated.
Short-Circuit Challenges Capture & Containment!
Wall Mounted Short Circuit Canopy Hood
Two Charbroilers Idling -- 3375 cfm Exhaust
2100 cfm (62%) Internal Makeup Air
Air Curtain (Perimeter) Discharge
Two Broilers Simulated Cooking -- Spillage at 4100 cfm
Exhaust 1200 cfm (29%) Air Curtain Supply
Air Curtain, Real World

Don’t go there!
4-Way Diffuser Set-up
8-Ft Wall Mounted Canopy Hood
1400 SCFM to 4 Way
Even Worse with Island Canopy Hood

No Back Wall
Front Face Discharge
Front Face #1:
Plenum with no Baffling
Two Charbroilers Idling -- Spillage at 3600 cfm Exhaust
1200 cfm (33%) MUA through Front Face Diffusers
Front Face #1:
Plenum with no Baffling

- 8" Diameter Supply Collar
- Perforated Front Face
- 25.75" High x 32" Wide
- Solid Baffle 67°
Rear Plenum Discharge
Two Charbroilers, Simulated Cooking -- C&C 3500 cfm Exhaust
2000 cfm MUA (57%) through Rear Discharge
Perforated Perimeter Supply

Performance similar to the back supply when velocities are minimized by maximizing perforated area
Displacement Ventilation
DuctSox Testing
4-Way & DuctSox Diffusers
Pressure versus Airflow

- 4-Way, Single 2x2
- KitchenSox™, Single 2x2
- KitchenSox™, Single 2x4
- KitchenSox™, D-Shape, 2x10

Static Pressure of Diffuser [in. of water] versus Airflow through Diffuser [CFM]
Capture and Containment Results

Capture and Containment Exhaust Rate [CFM]

- Displacement w/ side panels
- 4-Way, Single 2x2 500 cfm
- 4-Way, Single 2x2 1000 cfm
- KitchenSox™, Single 2x2 500 cfm
- KitchenSox™, Single 2x2 1000 cfm
- KitchenSox™, Single 2x4 1500 cfm
- KitchenSox™ D-Shape 2x10 2000 cfm
- KitchenSox™ D-Shape 2 by 10-ft 1500 cfm
- KitchenSox™ D-Shape 2 by 10-ft 1000 cfm

Values:
- 2300
- 2200
- 3300
- > 3600
- 3000
- 2800
- 3500
- 2600
- 3100
- 3300
Perforated Supply Plenum (PSP)
Perforated Supply Plenum (PSP) & Island Hood Testing
Capture and Containment Results

- Fryer/Broiler/Oven Line w/o Side Panels
  Front & Rear Displacement
  - 4500 CFM

- Fryer/Broiler/Oven Line w/o Side Panels
  4 Side PPS  80 cfm/ft of PPS (2,880 cfm)
  - 3200 CFM

- Fryer/Broiler/Oven Line w/o Side Panels
  4 Side PPS  160 cfm/ft of PPS (5,760 cfm)
  - 8200 CFM

- Fryer/Broiler/Oven Line w/o Side Panels
  Front & Side 4-Way Diffuser  2000 cfm (1000 cfm each)
  - 7400 CFM
Recommendations

• Do not use short-circuit hoods
• Avoid air curtain strategies
• Do not spec 4-way diffusers near hoods
• Minimize MUA velocity near hood
• Maximize transfer air – minimize local MUA
Regardless of strategy…

Try to limit dedicated makeup air through any one pathway to 60% of the total exhaust rate, minimizing velocity of air around the hood perimeter.

[this is our experience; not standard practice]
No 4-Way Diffusers Near Hood!