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DEPARTMENT OF ENVIRONMENTAL HEALTH
CONSUMER PROTECTION DIVISION
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TO: FOOD OPERATORS, CONTRACTORS, and DESIGNERS

FROM: PLAN REVIEW AND CONSTRUCTION UNIT
CONSUMER PROTECTION DIVISION
DEPARTMENT OF ENVIRONMENTAL HEALTH

DATE: OCTOBER 1, 2002

SUBJECT: KITCHEN EXHAUST SYSTEM DESIGN

Mechanical local exhaust ventilation is required for cooking and dishwashing equipment to remove odors, smoke, steam, grease, heat, vapors, fumes and gases. (See Uniform Mechanical Code for construction details.) The following information is furnished to aid in the development of plans for kitchen exhaust systems.

I. Definitions:

- Cfm - cubic feet per minute (quantity of air).
- Fpm - feet per minute (velocity of air movement).
- Canopy hood - an overhead hood that completely covers the equipment it is designed to ventilate.
- Compensating hood - a hood that has an outside air supply with air delivered below or within the hood.
- Make-up air - air that is introduced into a room or area to replace air that is being exhausted.
- Type I hood - a kitchen hood for collecting and removing grease and smoke.
- Type II hood - a general kitchen hood for collecting and removing steam, vapor, fumes, heat or odors.
- Hood Static Pressure - the negative pressure existing in the exhausting duct immediately at the collar, which indicates the amount of suction available to draw air into the hood.
- Q - quantity of air to be exhausted expressed in CFM
- A - area of the hood opening expressed in square feet.
- P - perimeter of the open sides of hood expressed in feet.
- D - distance between the cooking surface and the lower edge of the hood. Where cooking surfaces vary in height, use the greatest distance (D) between the hood and the cooking surface.

II. Procedures:

STEP A. DETERMINE HOOD DIMENSIONS - the hood shall be sized to completely cover the equipment it is designed to ventilate plus an overhang of six (6) inches (measured from the inside perimeter of the grease gutter) on all open sides. Where practicable, hoods should be transitioned

toward the duct take-off. This will reduce the entrance loss and resistance offered to airflow at the duct entrance point and will insure improved air distribution throughout the entire hood area.

STEP B. CALCULATE VOLUME OF AIR TO BE EXHAUSTED using the appropriate formula.

- Type I hoods for use over charcoal and other solid-fuel charbroilers shall be provided with separate exhaust systems.

Undefined cooking equipment other than charcoal and solid-fuel charbroilers may be installed under a common hood. The minimum airflow for charcoal-, solid-fuel and grease-burning charbroilers and undefined equipment shall be:

Number of Exposed Sides	**Formula**
4 (island or central hood)	Q=300A
3 or less	Q=200A
Alternate formula	Q=100PD

- Type I hoods when the cooking equipment includes high temperature appliances such as deep fat fryers:

Number of Exposed Sides	**Formula**
4 (island or central hood)	Q=150A
3 or less	Q=100A
Alternate formula	Q=100PD

- Type I hoods where cooking equipment includes medium temperature appliances such as rotisseries, grills (griddles) and ranges:

Number of Exposed Sides	**Formula**
4 (island or central hood)	Q=100A
3 or less	Q=75A
Alternate formula	Q=50PD

- Type I hoods where the cooking equipment includes low temperature appliances such as medium to low temperature ranges, roasters, roasting ovens, pastry ovens and equipment approved for use under a Type II hood, such as pizza ovens (except for conveyor pizza ovens):

Number of Exposed Sides	**Formula**
4 (island or central hood)	Q=75A
3 or less	Q=50A
Alternate formula	Q=50PD

EXAMPLE - Hood with 3 open sides over a charcoal-burning charbroiler measuring 4 feet by 9 feet:

- Q = 200 x 36 sq. ft.
- Q = 7200 CFM

EXCEPTION: Listed grease extractors are to be installed in accordance with the terms of their listing and the manufacturer's installation instructions.

STEP C. GREASE FILTER REQUIREMENT

1. Total filter area in square feet = CFM (from step "B") / FPM rating of filter (from filter manufacturer)

2. The effective filter area of each filter is the actual mesh or baffle area of the filter (excluding border or frame) e.g., a 16-inch x 16-inch filter with a 1-inch border is effectively a 14-inch x 14-inch filter.

Effective filter area per filter in sq. Ft. = square inches per filter / 144

3. Number of filters required = total filter area / filter area per filter

EXAMPLES:

1. Total filter area in sq. ft. = 7200 CFM (from step "B"
350 FPM rating of filter (from filter manufacturer)
= 21 sq. ft. total filter area

2. Effective filter area per filter in sq. ft. = 16 in. X 16 in is actually 14 in x 14 in or 196 sq. in.
(Note: 144 sq. in equals 1 sq. ft) = 196 sq. in. / 144 sq. in
= 1.36 sq. ft per filter

3. Number of filters required = 21 sq. ft (total filter area)
= 1.36 sq. ft (effective filter area per filter)
= 15 filters

STEP D. STATIC PRESSURE - Resistance to airflow

Sizing a system is not simply a process of measuring the volume in a building. Proper sizing includes measuring the length and size of duct runs. As exhaust air travels along a shaft or changes direction, some amount of resistance is introduced into the system. Static pressure is the resistance to the airflow within the duct system. Every component within the exhaust system introduces some resistance to the airflow. Filters, ductwork, and elbows are all factors in determining static pressure. You must recognize that this resistance is present then you must size the exhaust blower to overcome that resistance.

The best way to determine the static pressure drop through the filters is to refer to the filter manufacturer (*Engineering Data Sheets for the filters are required as part of the exhaust hood plan submittal*). For estimating purposes use a static pressure loss of 0.50″ for baffle or extractor filters. A typical static pressure drop through 90° elbows with a duct velocity of 1800 FPM is 0.2″ and 0.1″ for 45° elbows. Once the CFM and static pressure are determined a fan can be selected from a manufacturer based on their performance tables or catalogs.

To calculate the amount of static pressure in your system, use the following information and diagram.

Static Pressure

Filters	+	_____	sp
Entrance loss	+	_____	sp
Duct length	+	_____	sp
Elbows	+	_____	sp
Exit loss	+	_____	sp
	=	_____	total sp

Hood Schematic

STEP E. DUCT DESIGN - There shall be at least one duct per twelve (12) feet of hood length or fractional part thereof. Using 1800 FPM as optimum duct velocity, the duct area can be determined as follows:

Duct area = CFM (from step "B") / duct velocity
= 7200 CFM (from step "B") / 1800 FPM
= 4 sq. ft. of duct

See appendix A for circular duct sizing

Duct velocity = volume (CFM) / duct area (sq. ft.)
= 7200 CFM / 1800 FPM
= 4 sq. ft

Note: Acceptable range for duct velocity is between 1500 and 2500 FPM

STEP F. MAKE UP AIR

Make-up air must be supplied in a volume equal to the volume of air that is being exhausted and must be supplied by a mechanical system designed solely for that purpose. An electrical interlocking switch must connect the exhaust and make-up air systems. Windows and doors must not be used for providing make-up air. Compensating hoods must extract at least 20 percent of their required exhaust airflow from the kitchen area. Depending on the temperature of the appliances below the hood, the amount of air introduced through a compensating hood may be decreased.

The introduction of make-up air should be undertaken in a manner that will minimize short-circuiting, excessive air velocities and air turbulence conditions. The introduction of large volumes of air at high velocities tends to create conditions which compromise exhaust system efficiency and results in drafting which may be unsuitable for employee comfort and/or maintenance of food holding temperatures. It is recommended that no more than 1400 CFM is introduced back into the food service area from each register.

The following factors should be considered as part of the design of make-up air systems:

a) Increasing the size and/or number of make-up air registers and locating them appropriately;

b) Utilizing diffusers which slow and evenly distribute the air stream;

c) Using properly designed registers such as multi-directional louvered units.

In extremely small kitchens, the use of compensating hoods may be helpful in reducing air turbulence conditions since a portion of the air volume is introduced within the hood canopy. Similarly, the introduction of make-up air at the front face of the hood may be helpful.

III. Non-canopy hoods:

The velocity of air to be exhausted from non-canopy (back-shelf or ventilator) hoods shall not be less than 300 cubic feet per minute per lineal foot of hood. The length of the hood shall not be less than the length of the cooking equipment it serves.

EXCEPTIONS: Listed grease extractors are to be installed in accordance with the terms of their listing and the manufacturer's installation instructions.

APPENDIX A:

Duct Sizing Chart for Ducts at 1800 Feet per Minute Velocity

Diameter (Inches)	(Square Inches)	(Square Feet)
10	78.54	.545
12	113.1	.785
13	132.7	.9218
14	153.9	1.069
15	176.7	1.227
16	201.0	1.396
18	254.4	1.767
19	283.5	1.969
20	314.1	2.182
21	346.3	2.405
22	380.1	2.640
24	452.3	3.142
25	490.8	3.409
27	572.5	3.976
28	615.7	4.276
30	706.8	4.909

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