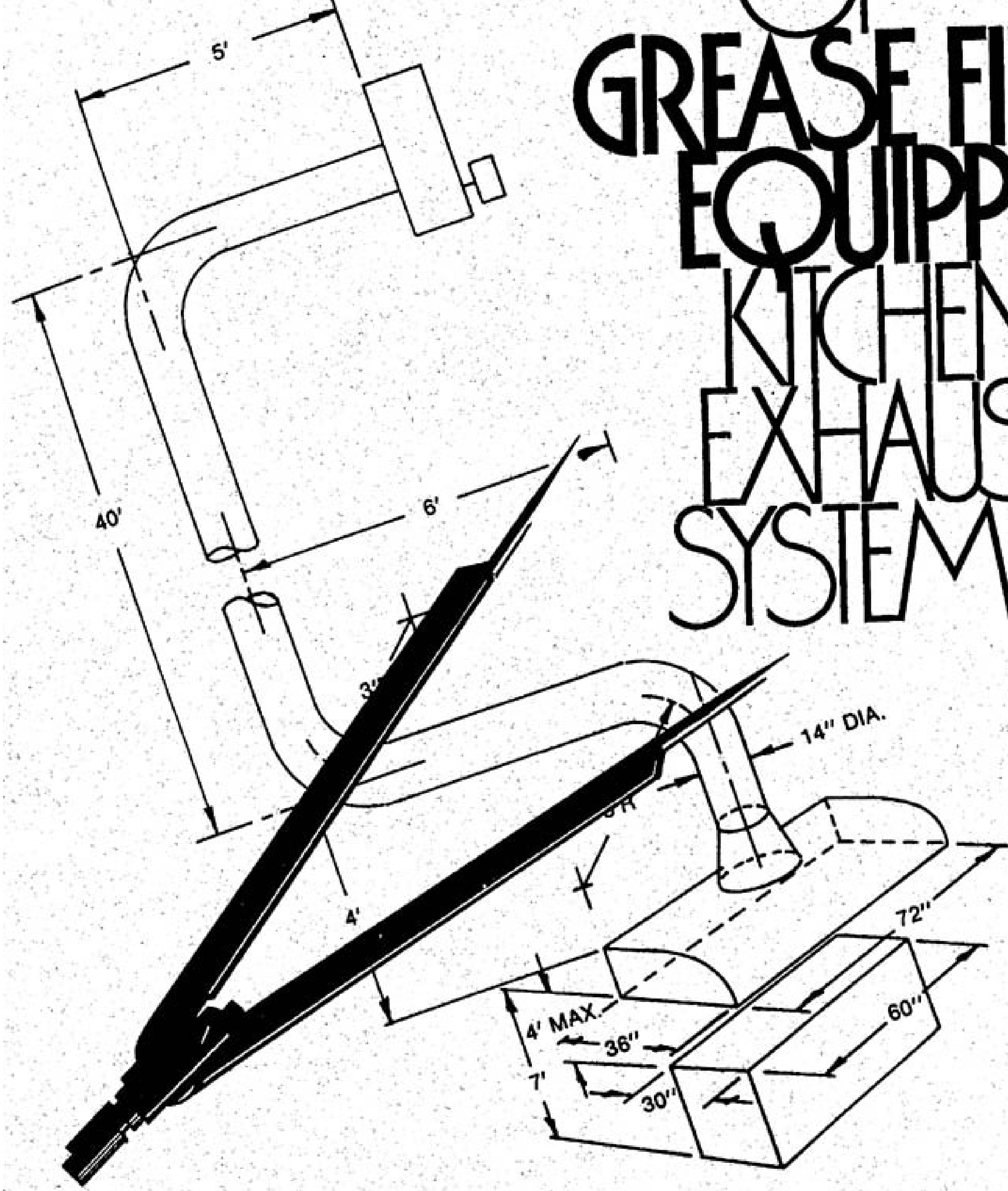
DESIGN OF GREASE FILTER EQUIPPED KITCHEN EXHAUST SYSTEMS



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DESIGN OF GREASE FILTER EQUIPPED KITCHEN EXHAUST SYSTEMS

CONTENTS

The need for a well designed grease filter equipped kitchen exhaust system has become widely recognized. Authoritative organizations, as well as local fire and health inspectors and industrial commissions, realize its importance. The properly designed exhaust system encourages better working conditions and, therefore, improves employee efficiency.

HOODS, WHY?

The purpose of the hood is to capture, as nearly as possible, all the heat, smoke, odors, grease and grease vapors produced in the cooking process and to contain them until the fan can exhaust them.

GREASE FILTERS, WHY?

Frequently, flash fires originating from cooking operations spread from the stove to grease deposits in the exhaust system. Non-filtered systems are prone to collect accumulations of highly combustible grease deposits throughout the entire duct system. Because of the chimney effect created in a vertical ductwork, a very intense rapidly spreading fire can engulf the entire system. A filtered system is protected from extensive damage because baffle type RP grease filters are designed to allow grease run off or the grease quantities collected on the mesh type filter is limited to that collected between cleaning. The buildup of extensive grease deposits in out of sight inaccessible locations is limited to the very small amount that passes through the filters (with efficient grease filters, usually less than 10%). Grease filters protect exhaust equipment. When filters are not used in the exhaust system, grease will collect on the blower wheel and motor. This is detrimental in many ways. Grease deposits on the wheel will cause unbalance resulting in unnecessary bearing wear. Grease accumulations on the motor will cause overheating which will create an additional fire hazard. The grease also has a tendency to deteriorate the insulation on wires thus adding another fire hazard.

The data noted here is based on examination of recommended practices and rules of national regulatory agencies. To the best of our knowledge, it represents the existing "state of the art" at the time this manual went to press.

DISCLAIMER OF WARRANTIES

CAUTION: OPERATION OF GREASE FILTER HOODS MAY BE SUBJECT TO FIRE, HEALTH OR OTHER HAZARDS. RESEARCH PRODUCTS CORPORATION MAKES NO WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO THE RECOMMENDATIONS IN THIS MANUAL. This material is offered to assist those planning the design or purchase of a hood.

Baffle type RP grease filters simplify the cleaning process because most of the grease deposits run off the baffles to a collection device. (The mesh type grease filters collect the deposits on the filter in an easily accessible area.) Minimum cleaning problems promote regular cleaning; thus safety, sanitation, and health standards are greatly improved.

Grease filters have established themselves as an extremely important part of any kitchen exhaust system. In many areas, they are required by law. They should be included in any newly designed hoods and incorporated in remodeled hoods. The design and selection of grease filters play an important role in the overall effectiveness of the entire kitchen exhaust system.

TYPES OF HOODS

There are two basic hood types:

1. Ventilator or back shelf hood.
2. Canopy type hood.
   a. Canopy - island hood.
   b. Canopy - wall hood.
   c. Canopy - corner wall hood.
   d. Canopy - slot type hood.

VENTILATOR OR BACK SHELF HOOD

The ventilator or back shelf hood (Figure I) is designed to be as close as possible to the cooking surface, usually 18 to 24 inches above it. Heat and fumes are caught close to the point of origin. The entrainment velocity moves the air under the shelf away from the cook. The design details of ventilators and auxiliary equipment are generally furnished as a package by the manufacturer of this type of equipment. Various patented features may be included. Usually the hood is pre-assembled, then installed according to manufacturer's recommendations. The design of the hood will not be covered in this brochure because of this fact; however, the filter, the fan, motor and ductwork are basically the same as the canopy type hood covered in detail later in the text.

The exhaust air volume through a ventilator hood will vary from approximately 300 to 350 cfm per lineal foot of hood length. If a hood of this type is being considered, the manufacturer should be consulted.

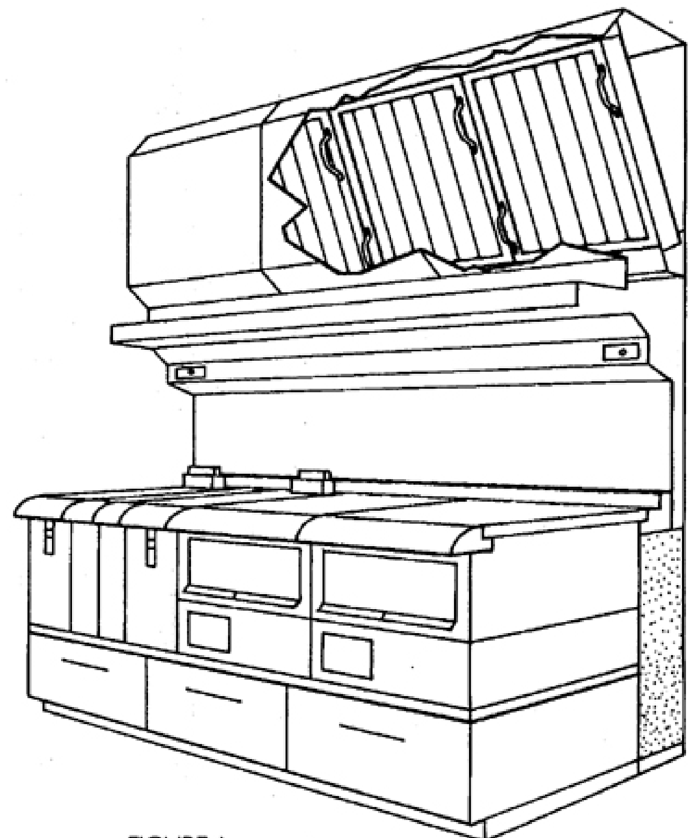


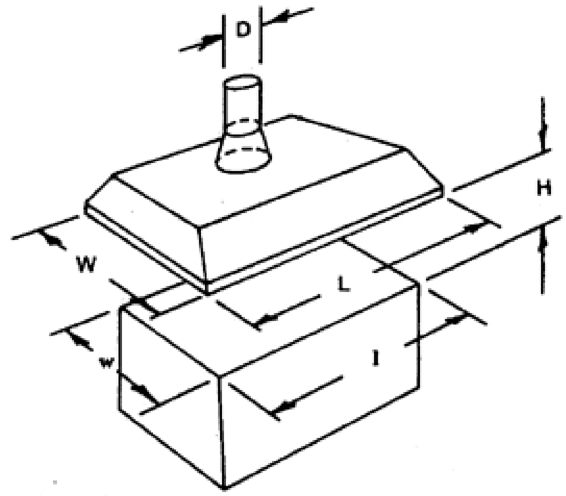
FIGURE I

CANOPY HOODS

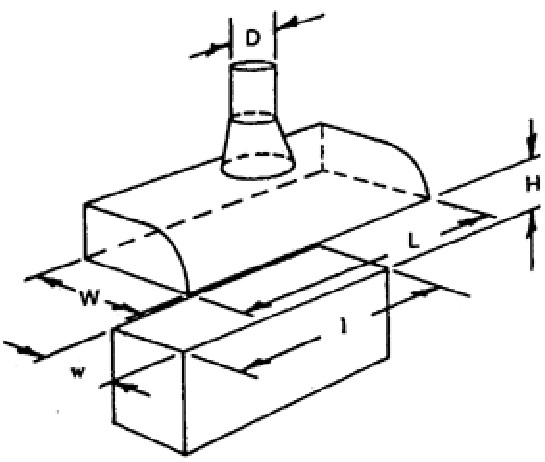
The more commonly used canopy hoods have several variations. Figures 2a, b, and c, show the three basic variations of this hood design.

Fig. 2a CANOPY-ISLAND type with 4 sides exposed.
Fig. 2b CANOPY-WALL type with 3 sides exposed.
Fig. 2c CANOPY CORNER type with 2 sides exposed.

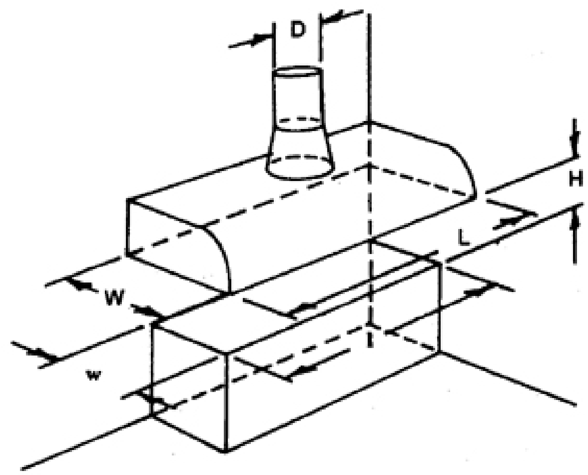
The canopy type hood, since it is by far the most widely field fabricated, will be used as the hood in the step-by-step design problem that we will develop.



ISLAND CANOPY FIGURE 2a



WALL CANOPY FIGURE 2b



CORNER CANOPY FIGURE 2c

FIGURE 2d

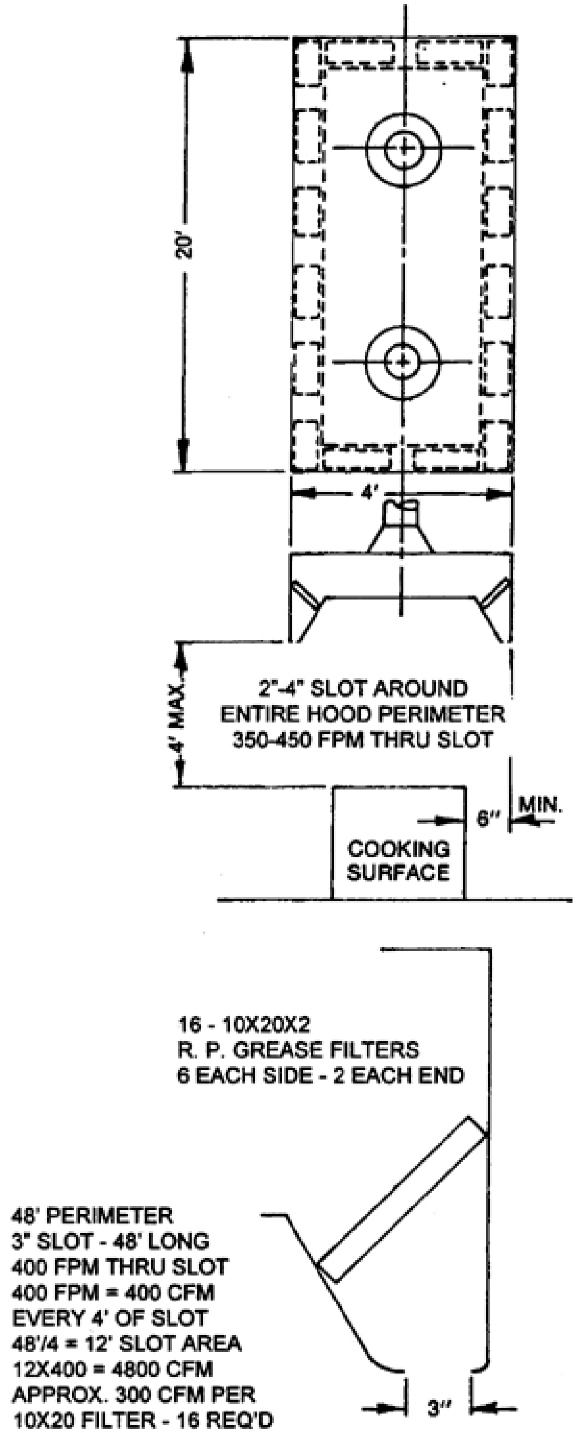


Fig. 2d CANOPY-SLOT type hood. An example lay-up and filter placement for a typical hood is shown.

The slot type hood is not primarily designed for the commercial kitchen exhaust system; however, it is periodically called for by the design engineer. This hood is also sometimes called a double cavity hood or just plain slotted hood.

There are potential problem areas when utilizing a hood of this design.

The heat generated in the cooking process is not exhausted as rapidly as in the conventional design.

Filter placement and good fit are difficult in a hood of this design.

The cleanability of the filters, as well as the cleanability of the entire hood cavity becomes more difficult with this design.

If the canopy-slot type hood is to be used, it has its greatest value in the extremely large island type (4 sided exposed) hood design.

The greatest asset of this type hood is the removal of smoke and grease contaminants with the minimum exhaust requirement. However in many applications more ventilation air is required than exhausted, so the prime reason for having this type hood is lost.

The hot contaminated air rises from the cooking surface and is held in the hood cavity until such time as it can be removed through the slot that goes completely around the perimeter of the hood. Two important design considerations are (I) have the hood as low as possible over the cooking surface and (2) extend the hood out 6 inches minimum beyond the edge of the cooking surface,

Typical hood construction would have a 2 to 4 inch slot around the entire perimeter of the hood. The air velocity through this slot is normally between 350 and 450 fpm.

The placement and choice of filters is important to assure optimum airflow through them. Optimum operating velocities for the baffle type grease filter is 300 fpm. Optimum operating velocities for the mesh type grease filter is 350 fpm. This will make it necessary to blank off several areas in the filter rack to increase the air speed through the filter area.

Lack of field information and design criteria for this type hood limits its use.

Designing the Kitchen Exhaust System
(See Sample Problem)

Following is an example of the recommended step-by-step procedure for the design of a grease filter equipped kitchen exhaust system. Critical specifications to be determined are:

1. Dimensions of the hood.
2. Volume of air to be exhausted.
3. Number of filters required.
4. Diameter of the duct from the hood to the point of discharge.
5. Resistance against which the blower must exhaust the calculated volume of air.
6. Make-up air.
7. Codes.

STEP 1

TO DETERMINE DIMENSIONS OF THE HOOD

The dimensions of the base of the hood are larger than the cooking surface it covers to adequately remove the contaminants generated in the cooking process. A general rule that has proven very satisfactory is summarized as follows:

The length and width of the hood base should equal the overall dimension of the appliances it covers plus a 6 inch minimum overhang on each side of the equipment that is not enclosed by an apron or an adjacent wall. The distance from the base of the hood to the cooking surface will normally be 3 to 4 ft. since the kitchen employees must work underneath the hood. Excessive clearance between the cooking surface and hood hampers the effectiveness of the exhaust system and should be avoided. Four feet is maximum.

STEP 2

VOLUME OF AIR TO BE EXHAUSTED

The volume of air to be exhausted is governed by state or local codes. If no code exists, the total quantity of air (cfm) to be exhausted from the hood shall be determined by one of the following formulae:

For canopy hoods less than 8 feet long:

cfm = 150 A (for hoods open all sides)

cfm = 100 A (for hoods open 3 sides or less)

For canopy hoods 8 feet or longer:

cfm = 200 P

Note:

cfm = 200 P was derived from the formula

cfm = 50 PD and establishing D as 4 feet

(cfm = 50 x P x 4 = 200 P)

"cfm" - shall mean the total quantity of air required to be exhausted by the ventilating system in cubic feet per minute.

'A' - shall mean the cross section of the plane extending over the canopy hood opening in square feet.

"P" - shall mean the perimeter of the open sides of the hood.

"D" - shall mean the distance between the cooking surface and the face of the hood.

The volume figures should be somewhat higher for charcoal and charcoal type cooking. Some city codes demand double exhaust volumes for these cooking areas.

STEP 3

NUMBER OF FILTERS REQUIRED

It is important to select the proper number of the correct size grease filters of a reputable make. Too many filters increase cost. Too few filters increase the resistance to airflow and also increase the filter cleaning frequency. Optimum operating velocity range for the baffle type PIP grease filter is 150 - 300 fpm. Optimum operating velocity for the mesh type grease filter is 350 fpm.

The number of filters required in the hood can be determined by dividing the total volume of air to be exhausted by the cfm rating of the filters. The manufacture's optimum rating should be used (see Table I). The use of standard size filters is advisable from a cost, delivery, and replacement standpoint. Any space in the hood not filtered should be blanked-off with sheet metal. It is important to install filters at the ends of the hood; however, grease filters should not be installed directly over a broiler flue, or any other flue from kitchen cooking equipment. The hot gases would make filters very difficult to clean and could damage them. The blanked off space, if required, should be divided equally between the filters. This will ensure optimum performance and will equalize the air velocity over the entire length of the hood opening.

TABLE I

BAFFLE TYPE

Nom. Size	(Max.)Rating (cfm)
20H x 25W	865
20H x 20W	675
16H x 25W	675
16H x 20W	525
I OH x 20W	300
16H x 16W	400
25H x 20W	865

MESH TYPE

Nom. Size	Opt. Rating (cfm)
20x25	1000
20 x 20	800
16 x 25	800
16 x 20	640
15 x 20	600
10x20	400

The hood itself must be deep enough to permit the installation of the grease filters at a minimum 45 degree angle from the horizontal. This will eliminate grease globules dropping back onto the cooking surface. A design of this type also permits enough volume in the hood so that unusually large "puffs" of steam and greasy vapors have a place to accumulate until the exhaust fan can remove them. This design also allows mixing of room air with the hot air over the cooking area. Proper design keeps the temperature at the filters less than 200 degrees F. and reduces the possibility of accumulated grease run off or vaporizing and passing through the filters. There isn't a grease filter made that will effectively remove vapors. Assuming the temperature at the filters is less than 200 degrees F., the grease deposits will be brownish and easily removed. Above 200 degrees F., the deposits tend to bake on the filter, darkening in color, and are extremely difficult to remove.

The baffles of the baffle type RP grease filters must be positioned vertically, not horizontally. There must be a positive air seal around the perimeter of the grease filter and each baffle type grease filter must be retained on the downstream side.

Most filters are designed so that the accumulated grease will run down the face of the filter and drop from the lowest edge into a drip tray Drip tray should be pitched to drain to an enclosed metal container having a capacity not exceeding one gallon. (ref.NFPA No. 96)

Some codes suggest that the minimum height from the cooking surface to the lower edge of the grease filter should not be less than:

a. No exposed flames - grills, trench fryers, etc. - 2½ ft.
b. Exposed charcoal and charcoal type fires - 4½ ft.
c. Exposed fires other than b. - 3½ ft.

STEP 4

DESIGN OF THE EXHAUST DUCT

The duct leading from the kitchen exhaust air is discharged must be correctly sized. The velocity of the exhaust air must be high enough to minimize condensation on the various parts of the duct system; however, avoid the use of excessively high air velocities because of the resulting noise. Also, more power is required to drive the blower.

It is important to discharge the air at a location that will not cause discomfort to the people in the vicinity or damage surrounding property. The bends and elbows of the ductwork should be kept at a minimum. When elbows are used, a radius of 2 to 2½ times the duct diameter is recommended. This will minimize the resistance against which the blower must move the air.

The duct take-off at the top of the hood should be transitioned. This will reduce the entrance loss and resistance offered to airflow at the entrance point. If the hood length exceeds 10 ft., it is desirable to have two discharge ducts from the top of the hood join the main exhaust duct. These should also be transitioned where they join the hood. This ensures good air distribution throughout the entire hood area.

Two thousand (2000) ft. per minute velocity should be used to determine the duct diameter, unless otherwise specified. The area of the duct (sq. ft.) can be calculated by dividing the total exhaust cfm by 2000 fpm. This duct area is converted to a diameter in Table II.

Table II can also be used to determine the branch duct size if more than one discharge duct is required. Divide the total volume of air to be exhausted by the number of branches to determine the cfm per branch. Then divide the cfm per branch by 2000 fpm to give the sq. ft. area which can be converted to a duct diameter.

TABLE II

Duct Area (Sq. Ft.)	*Duct Diameter (Inches)*	*Friction Loss/ Ft. of Duct (Inches W.G.)*
.545	10	.0058
.785	12	.0047
1.069	14	.0039
1.396	16	.0033
1.767	18	.0029
2.182	20	.0025
2.640	22	.0023
3.142	24	.0020
3.690	26	.0018
4.276	28	.0016
4.909	30	.0015
5.580	32	.0014
6.310	34	.0013
7.080	36	.0012
7.880	38	.0012
8.720	40	.0011
10.550	44	.0010
12.550	48	.0009

DUCT CONSTRUCTION

See National Fire Protection Association Standard No. 96, Ventilation of Restaurant Cooking Equipment for more information. Important considerations in duct construction are:

1. A circular duct requires a smaller space. If rectangular ducts are used, they should be as nearly square as possible.
2. The duct should be constructed of 16 gauge or heavier steel (see NFPA #96).
3. A minimum of 18" clearance should be provided from unprotected combustible construction. (See NFPA #96, Appendix B, for clearance from protected construction.)
4. All seams and joints shall have a liquid tight continuous external weld.
5. Exhaust ducts from kitchen hoods must be independent and not connected with any other ventilating system.
6. An opening shall be provided at each duct direction change for inspection and cleaning.
7. Vertical risers should be located outside the building and adequately supported by the exterior building wall. When risers must be located within the building, they should be enclosed in a continuous enclosure (see NFPA #96). A base residue trap should be provided on all risers. Exhaust ducts should not pass through fire walls or fire partitions.

STEP 5

RESISTANCE AGAINST WHICH THE BLOWER EXHAUSTS THE CALCULATED VOLUME OF AIR

It is essential that the blower selected meet the following two requirements:

A. It must exhaust the calculated volume of air.

B. It must exhaust this air against the maximum resistance encountered in the entire kitchen exhaust system.

While the use of a propeller type fan may be tempting, they normally do not work well against the resistance encountered in a commercial kitchen exhaust system. The use of a blower for best results is strongly recommended. To conserve the exhaust air, a 2 speed motor is suggested. Low speed can be used during the "off," or low production time, and the high speed for peak production loads.

Other factors that might influence the selection of a blower are location, space limitations, permissible noise level, installation and operation costs; however, A and B are the primary requirements.

The system resistance calculations are based on normal room temperature. In those cases where air temperatures are increased significantly by the heat input from the appliances under the hood, consult the ASHRAE Guide for more detailed information on sizing ductwork and blowers for the specific temperatures involved.

This resistance is usually assumed to be the total of the following four items:

1. The resistance of the grease filter is based on the manufacturer's rating. A value of .2 in. w.g. is ample for the mesh type filters. Use .56 in. w.g. for baffle type RP grease filters.
2. "The entrance loss" resistance occurring where the exhaust duct attaches to the hood will be approximately. I" water gauge when the exhaust duct velocity is approximately 2000 fpm. The opening at the hood and discharge duct should be transitioned as shown by the hood sketches on the calculation sheet.
3. The resistance from wind currents at the exhaust opening will vary anywhere from .I" to .5" water gauge depending upon the type and location of the outlet and on local wind conditions. .5 inches is a maximum figure and should be used only if the exhaust is directly into the prevailing winds. Normally, something substantially less will be used. .2" water gauge is satisfactory in most installations.

4. The resistance of the duct system is the total of all the straight duct, plus the elbows and bends expressed in equivalent length of straight duct. The total of the two sums is then multiplied by the friction loss per foot for the duct size and air velocity involved. Table II can be used to determine the friction loss per foot of duct. The equivalent length of straight duct for bends varies considerably depending upon the angle of the turn and the radius of the bend. A radius of 2 to 2½ times the duct diameter is desirable and would represent what is considered long bends. If the radius of the bends is less than 2 times the duct diameter, they are considered short bends. Table III can be used to determine the equivalent length of straight duct represented by 9° and 45° long bends.

TABLE III

Equivalent Length of Long Bends

Type of Bend	*Duct Diameter Under 12"*	*Duct Diameter Over 12"*
90°	I ft./in. of duct diameter	1.25 ft./in. of duct diameter
45°	½ ft./in. of duct diameter	¾ ft./in. of duct diameter

As mentioned previously, the hood that exceeds 10 ft. should have more than one duct take-off. When two or more discharge ducts are used, there will be an entrance loss where the branch duct enters into the main discharge duct. This must be included in calculating the system resistance. Table IV gives resistance figures for air velocities of 2000 fpm.

TABLE IV

30° angle of entrance = .05" water gauge
45° angle of entrance = .07" water gauge
60° angle of entrance = .12" water gauge

For uniform air movement over the entire length of the hood, the resistance in each branch should be equal.

For purpose of fan selection, the highest single resistance of any branch connection is added to the resistance of the system beyond the point of entry at the main duct.
The total resistance against which the blower must move the calculated volume of air is then determined by totaling the resistance values obtained as described above.

MAKE-UP AIR

Make-up air or replacement air must be introduced into the establishment and be approximately equal to the amount of air exhausted by the kitchen equipment and any other exhaust fans in the building. If make-up air is not designed into the system, the building will be under a negative pressure and this could cause the following serious problems:

1. The exhaust fan could not exhaust the design volume of air because it is not available.
2. Negative pressure would cause improper venting of water heaters, space heaters, or other individually vented gas appliances in the building.
3. It would also cause a rush of unconditioned outside air into the building whenever entrance doors are opened.

The codes of most cities and states require ventilation to the dining area. This provides clean, fresh air to maintain comfortable air temperatures and humidities. Since most codes will specify a specific amount of ventilation air, this air can be exhausted through the kitchen exhaust system after it moves from the dining area into the kitchen area. If the ventilation air is less than the calculated exhaust requirement over the cooking area, and it normally is, the difference should be supplied directly into the kitchen through a make-up air system. Introducing outside air by simply opening a kitchen window should be avoided since there is no control over when and how much air will come in or actually even when the windows will be open. Cold, outside air during the winter months would be extremely uncomfortable and create serious drafts.

The recommended procedure is to supply outside air through a designed make-up air system located to prevent drafts. The air should be tempered by separate control and filtered. Their velocity through the make-up air system should be low enough to eliminate the possibility of drafts. It is important that the location of the air inlets is carefully considered to eliminate any short circuiting.

A hypothetical restaurant layout as shown on Fig. 3 will be a typical example. This is a one-story building, 40 ft. wide by 100 ft. long with a 10 ft. ceiling. The dining area is 40 x 85 and the kitchen is 15 x 40.

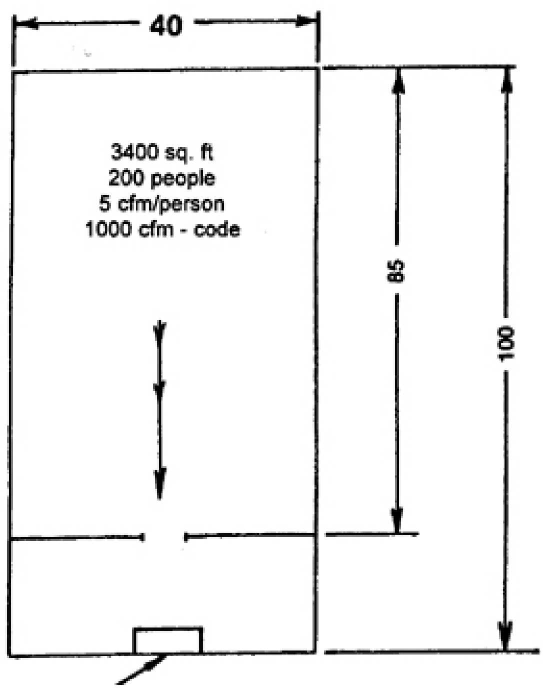
The dining area of the restaurant, including the cocktail lounge, will seat 200 persons. Assuming that the local code requirement is 5 cfm of outside air per person, the heating and air conditioning system is designed to bring in 1,000 cfm of outside air. This fresh air, along with the recirculated air, is conditioned year-round. It is generally considered good design practice to have the air moved from the dining area into the kitchen.

Correct kitchen exhaust design procedure for this hood requires that we exhaust 100 cfm per sq. ft. of hood area. A 3 x 6 ft. wall type hood is required to cover the 2½ x 5 ft. cooking surface. 100 cfm per sq. ft. x 3 x 6 = an exhaust requirement of 1800 cfm.

It would be impossible to exhaust 1800 cfm when we bring in only 1000 cfm; therefore, an additional quantity must be introduced. The air should be brought in the kitchen area with properly located outlets.

It is desirable to have the kitchen under a very slight negative pressure. This prevents any infiltration of cooking odors from the kitchen into the dining area. If the exhaust exceeded the intake, it could create the problems pointed out in the opening paragraph. Our hypothetical restaurant layout keeps the dining area under slight positive pressure and the kitchen area under a slight negative pressure.

FIGURE 3



HOOD - 3' X 6'
EXHAUST = 100 CFM/SQ. FT. X 3 X 6 = 1800 CFM

EXHAUST	1800 CFM
F.A. INTAKE	1000
	800

A SLIGHT NEGATIVE PRESSURE SHOULD BE MAINTAINED IN THE KITCHEN.

MAKE-UP AIR INTO KITCHEN SHOULD BE APPROXIMATELY 750 CFM.

CODES

DESIGN DETAILS OF KITCHEN EXHAUST SYSTEMS ARE SUBJECT TO LOCAL REGULATIONS AND IT IS WELL TO CHECK WITH LOCAL FIRE, HEALTH, AND INDUSTRIAL COMMISSION AUTHORITIES BEFORE PROCEEDING WITH A DESIGN.

It is recognized that the extreme number of variations in codes throughout the country can cause excessive costs to users. It is costly for the authorities to keep the codes up to date. For these reasons, whenever there are nationally recognized standards available, they should be adapted and made a portion of the proposed code. Typically, recognized codes are those standards and recommendations of the National Fire Protection Association, the Underwriters' Laboratories, the American Society of Testing Materials, the American Gas Association, etc.

If there are no local or state codes governing the design, installation, and usage of commercial exhaust systems and since the pollution of air by grease is recognized as important because of the location of most commercial eating places in heavily populated areas, we would suggest the following code:

COMMERCIAL KITCHEN EXHAUST SYSTEM

"All restaurant cooking appliances such as ranges, deep fat fryers, grills, and broilers shall be provided with exhaust ventilating equipment to carry away the grease-laden air effectively in a safe manner. All exhaust ventilating systems shall be provided with grease filters or other means of grease extraction. All equipment and procedures shall comply with the National Fire Protection Association Booklet No. 96, 'Ventilation of Restaurant Cooking Equipment,' and any amendment or supplement thereof."

ACCESSORY ITEMS

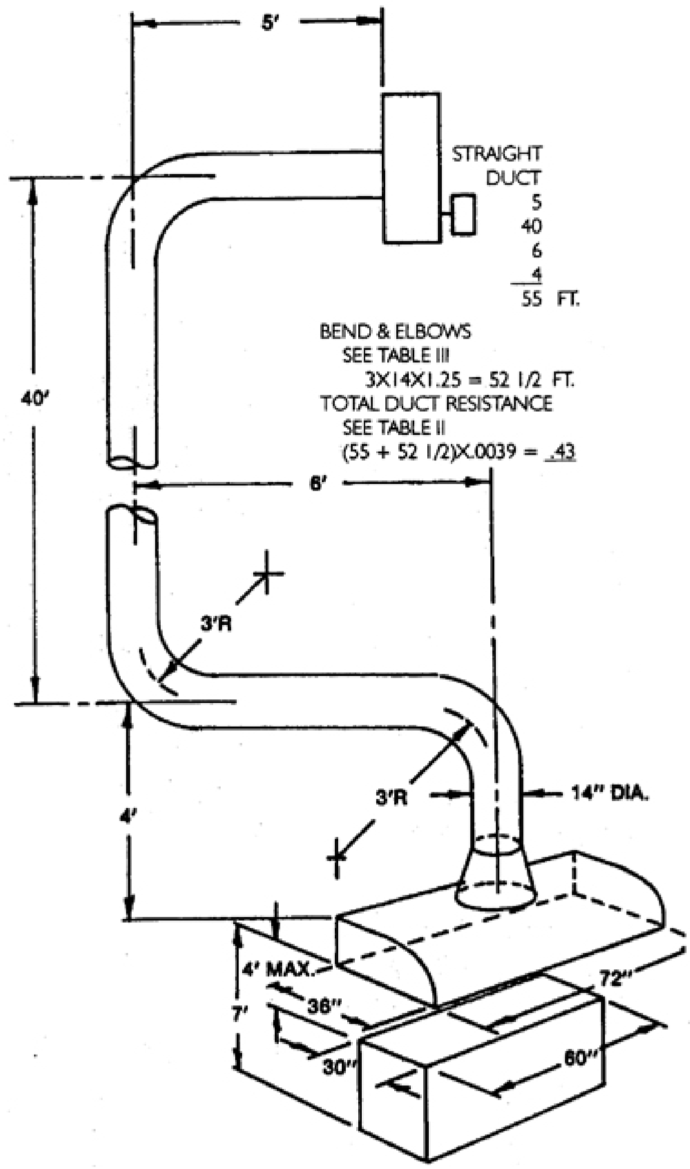
Manufacturers normally provide a variety of handles and locking devices, holding frames and lifting devices to facilitate the handling and placement of grease filters. If holding frames and handle locks are not used a continuous "U" channel should be incorporated in the hood design to hold the grease filters in place at top and bottom. For hoods which do not have continuous "U" channels for filter retention, Kleen-Gard retainer clip assemble No. 998 can be added. Filters must be tight fitting and firmly secured in place yet be easily accessible and removable for cleaning, to maintain sanitation, health, and safety standards. In most restaurants, which have continuous cooking, filters should be cleaned at least once a week. In kitchens of this type, usually two sets of grease filters are maintained so that a set of clean filters can be installed when the dirty set is removed for cleaning. The cleaning of the loaded filters can be scheduled into the routine maintenance of the kitchen or the filters can be sent to a filer service laundry. Usually a visual inspection of the filters can determine the cleaning schedule.

SUMMARY

The properly designed kitchen exhaust system has the following requirements:

1. There must be sufficient velocity of air over the cooking area in the hood to entrain grease particles. This is necessary to prevent particles from dropping off to the floor.. .a hazardous and unsanitary situation.
2. In addition to removing the contaminated air from the cooking surface, a quantity of cooler air from the kitchen is introduced to cool grease vapors coming off the cooking surface. No grease filter is effective in removing vapors. The filters remove particles of grease which result from splattering or when the vapor cools and condenses.
3. Sufficient air velocity through the filter to cause the grease particles to impinge on the filtering media is required.
4. The design must comply with the codes that are in effect.
5. The installation and operating costs must be kept within reason.

SAMPLE PROBLEM



NOTE: THIS IS A LINE DRAWING ONLY. DESIGN AND FABRICATION SHOULD BE PER LOCAL CODE AND N.F.P.A. NO. 96

SAMPLE PROBLEM CALCULATIONS

STEP I

To determine width & length of hood (see P. 13 for definitions)

l = 60" w = 30".
W = w + (6" x Y)
W = 30 + (6" x 1) = 36" = 3 ft.
L = l + (6"xZ)
L = 60 + (60 + 2) = 72" = 6 ft.

STEP 2

To determine volume of air to be exhausted
The volume of air to be exhausted is governed by state or local codes. If no code exists, the total quantity of air (cfm) to be exhausted from the hood shall be determined by one of the following formulae:

For canopy hoods less than 8 feet long:
- cfm = 150 A (for hoods open all sides)
- cfm = 100 A (for hoods open 3 sides or less)
- cfm = 100 x L x W = 1800

For canopy hoods 8 feet or longer:
- cfm = 200 P (perimeter of open sides of hood)
- cfm = 200 x P = ____.

STEP 3

To determine the number of filters required

$$\text{No. of filters} = \frac{\text{CFM (see step No. 2)}}{\text{Filter rating (see Table I)}}$$

$$\text{No. of filters} = \frac{\text{1800 CFM}}{\text{675 CFM}} = \text{3 filters}$$

(For a fraction of a filter, use next whole number)

TABLE I

RATING OF RP GREASE FILTERS

BAFFLE TYPE

Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20H x 25W	951	865
20H x 20W	952	675
16H x 25W	953	675
16H x 20W	954	525
10H x 20W	956	300
16H x 16W	957	400
25H x 20W	958	875

STAINLESS STEEL BAFFLE TYPE

Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20H x 25W	961	865
20H x 20W	962	675
16H x 25W	963	675
16H x 20W	964	525
10H x 20W	966	300
16H x 16W	967	400
25H x 20W	968	875

MESH TYPE

Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20 x 25	931	1000
20 x 20	932	800
16 x 25	933	800
16 x 20	934	640
15 x 20	935	600
10 x 20	936	400

STEP 4

To determine design of exhaust duct

$$\text{Duct Area} = \frac{\text{CFM (see step No. 2)}}{\text{Duct Velocity (if not specified, use 2000 FPM)}}$$

$$\text{Duct Area} = \frac{\text{1800 CFM}}{\text{2000 FPM}} = \text{.9 sq. ft.}$$

Use Table II to convert to duct diameter.
.9 sq. ft. = 13-14" duct diameter.

TABLE II

Duct Area (Sq. Ft.)	*Duct Diameter (inches)*	*Friction Loss/Ft. of Duct (inches W.G.)*
.545	10	.0058
.785	12	.0047
1.069	14	.0039
1.396	16	.0033
1.767	18	.0029
2.182	20	.0025
2.640	22	.0023
3.142	24	.0020
3.690	26	.0018
4.276	28	.0016
4.909	30	.0015
5.580	32	.0014
6.310	34	.0013
7.080	36	.0012
7.880	38	.0012
8.720	40	.0011
10.550	44	.0010
12.550	48	.0009

If more than 1 duct take-off is required, see Page 7.

STEP 5

To determine resistance for blower & motor sizing

1. Resistance of mesh type grease filters when loaded (use .2" w.g.) ______
   Resistance of RP baffle type grease filters (use .56" w.g.) .56
2. "Entrance loss" of air from hood to duct (if not specified use .l" w.g.) .1
3. Resistance of exhaust duct (use Table II Step 4 and Table III & IV below for calculating.) .43

TABLE III

Equivalent Length of Long Bends

Type of Bend	*Duct Diameter Under 12"*	*Duct Diameter Over 12"*
90°	1 ft./in. of duct diameter	1.25 ft./in. of duct diameter
45°	½ ft./in. of duct diameter	3/4 ft./in. of duct diameter

TABLE IV

30° angle of entrance - .05" water gauge
45° angle of entrance - .07" w.g.
60° angle of entrance - .12" w.g.

4. Resistance from wind current at exhaust opening (if not specified, use .2 w.g.) .2

Total resistance of system 1.29

Size blower & motor for (from Step 2) 1800 CFM
Against total resistance (from Step 5) 1.29 "w.g.

Grease Filter Equipped Kitchen Exhaust System Calculation Sheet

RESEARCH PRODUCTS CORPORATION Madison, Wisconsin 53701

DATE

NAME

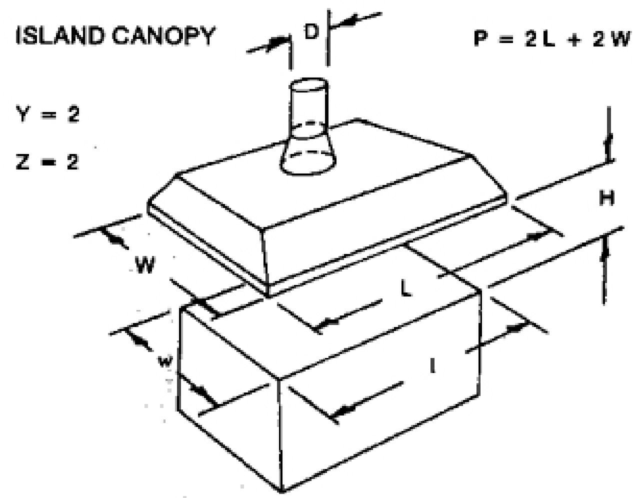
ADDRESS

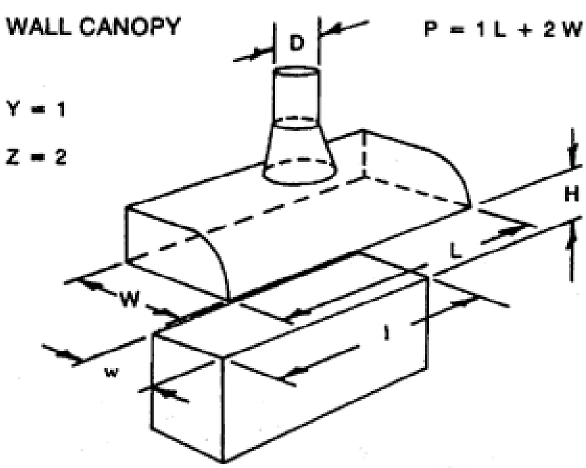
CITY STATE ZIP

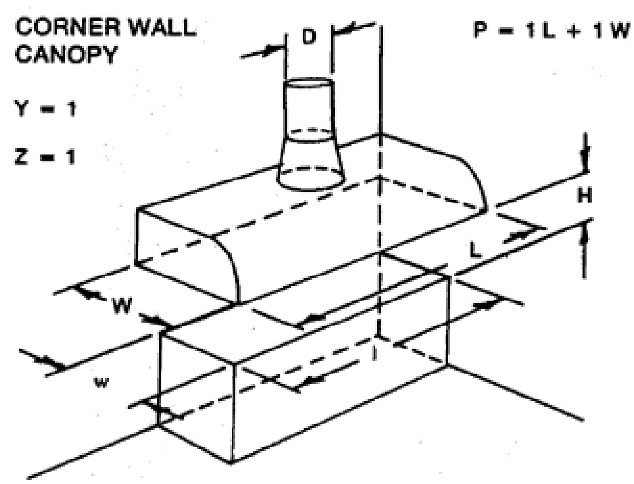
The recommended minimum distance from cooking surface to grease filter shall not be less than:
1. No exposed flame (grills, trench fryers, etc.)-2 I/2 ft.
2. Charcoal and charcoal type fires-4 I/2 ft.
3. Exposed fires other than Item 2-3 I/2 ft.

LETTER CODES

- I - length of cooking surface.
- w - width of cooking surface.
- L - Length of hood.
- W - Width of hood.
- P - Perimeter of the open sides of the hood.
- H - Distance between the cooking surface and the hood.
- D - Diameter of exhaust duct.
- Y - Number exposed sides in hood width, (W)
- Z - Number exposed sides in hood length. (L)
- A - Area of hood. (LxW)







CALCULATION SHEET

STEP I

To determine width & length of hood (see P. 13 for definitions)

l = _____ w = ______.
W = w + (6" x Y)
W = _____+ (6" x__) = ___ = ____ft.
L = l + (6"xZ)
L = _____ + (60 +__) =___ = ____ft.

STEP 2

To determine volume of air to be exhausted

The volume of air to be exhausted is governed by state or local codes. If no code exists, the total quantity of air (cfm) to be exhausted from the hood shall be determined by one of the following formulae:

For canopy hoods less than 8 feet long:

cfm = 150 A (for hoods open all sides)
cfm = 100 A (for hoods open 3 sides or less)
cfm = __ x L x W = ____

For canopy hoods 8 feet or longer:

cfm = 200 P (perimeter of open sides of hood)
cfm = 200 x P = ____.

STEP 3

To determine the number of filters required

$$\text{No. of filters} = \frac{\text{CFM (see step No. 2)}}{\text{Filter rating (see Table I)}}$$

$$\text{No. of filters} = \frac{\text{CFM}}{\text{CFM}} = \_\_\_\text{filters}$$

(For a fraction of a filter, use next whole number)

TABLE I

RATING OF RP GREASE FILTERS

BAFFLE TYPE		
Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20H x 25W	951	865
20H x 20W	952	675
16H x 25W	953	675
16H x 20W	954	525
10H x 20W	956	300
16H x 16W	957	400
25H x 20W	958	875
STAINLESS STEEL BAFFLE TYPE		
Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20H x 25W	961	865
20H x 20W	962	675
16H x 25W	963	675
16H x 20W	964	525
10H x 20W	966	300
16H x 16W	967	400
25H x 20W	968	875
MESH TYPE		
Nom. Size	RP Stock No.	(Max.) Rating (cfm)
20 x 25	931	1000
20 x 20	932	800
16 x 25	933	800
16 x 20	934	640
15 x 20	935	600
10 x 20	936	400

STEP 4

To determine design of exhaust duct

$$\text{Duct Area} = \frac{\text{CFM (see step No. 2)}}{\text{Duct Velocity (if not specified, use 2000 FPM)}}$$

$$\text{Duct Area} = \frac{\text{CFM}}{\text{FPM}} = \_\_\_\_\_\_\text{sq. ft.}$$

Use Table II to convert to duct diameter.

_____sq. ft. =______duct diameter.

TABLE II

Duct Area (Sq. Ft.)	*Duct Diameter (inches)*	*Friction Loss/Ft. of Duct (inches W.G.)*
.545	10	.0058
.785	12	.0047
1.069	14	.0039
1.396	16	.0033
1.767	18	.0029
2.182	20	.0025
2.640	22	.0023
3.142	24	.0020
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If more than 1 duct take-off is required, see Page 7.

STEP 5

To determine resistance for blower & motor sizing

1. Resistance of mesh type grease filters when loaded (use .2" w.g.) _________
   Resistance of RP baffle type grease filters (use .56" w.g.) _________
2. "Entrance loss" of air from hood to duct (if not specified use .1" w.g.) _________
3. Resistance of exhaust duct (use Table II Step 4 and Table III & IV below for calculating.) _________

TABLE III

Equivalent Length of Long Bends

Type of Bend	*Duct Diameter Under 12"*	*Duct Diameter Over 12"*
90°	1 ft./in. of duct diameter	1.25 ft./in. of duct diameter
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TABLE IV

30° angle of entrance - .05" water gauge
45° angle of entrance - .07" w.g.
60° angle of entrance - .12" w.g.

4. Resistance from wind current at exhaust opening (if not specified, use .2 w.g.) _________

Total resistance of system _________

Size blower & motor for (from Step 2) _________ CFM
Against total resistance (from Step 5) _________ "w.g.

CALCULATION SHEET

STEP I

To determine width & length of hood (see P. 13 for definitions)

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W = _____+ (6" x__) = ___ = ____ft.
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Nom. Size	RP Stock No.	(Max.) Rating (cfm)
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16 x 25	933	800
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To determine design of exhaust duct

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$$\text{Duct Area} = \frac{\text{CFM}}{\text{FPM}} = \_\_\_\_\_\_\text{sq. ft.}$$

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4. Resistance from wind current at exhaust opening (if not specified, use .2 w.g.) _________

Total resistance of system _________

Size blower & motor for (from Step 2) _________ CFM
Against total resistance (from Step 5) _________ "w.g.

FORM NO. 1898.6.7.96