MSYS 4490
AC Systems

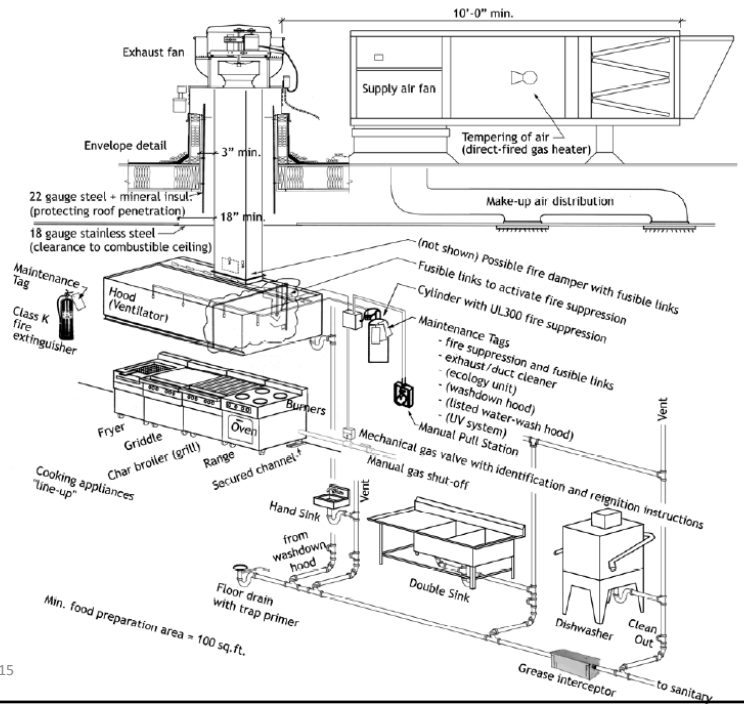
Winter 2015

KITCHEN VENTILATION SYSTEMS

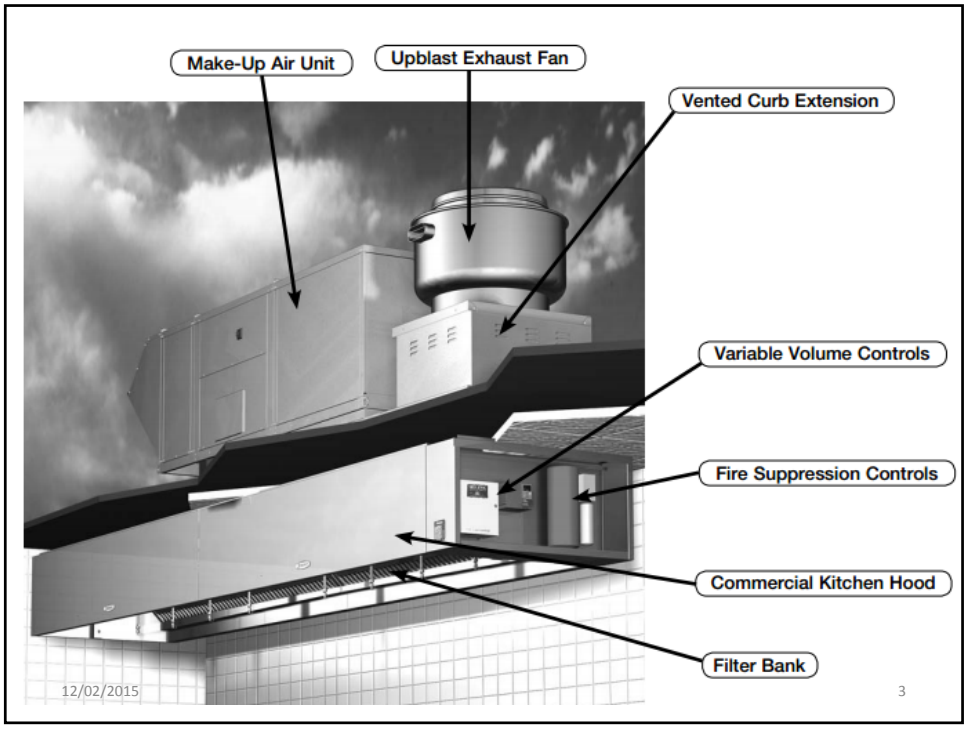
By

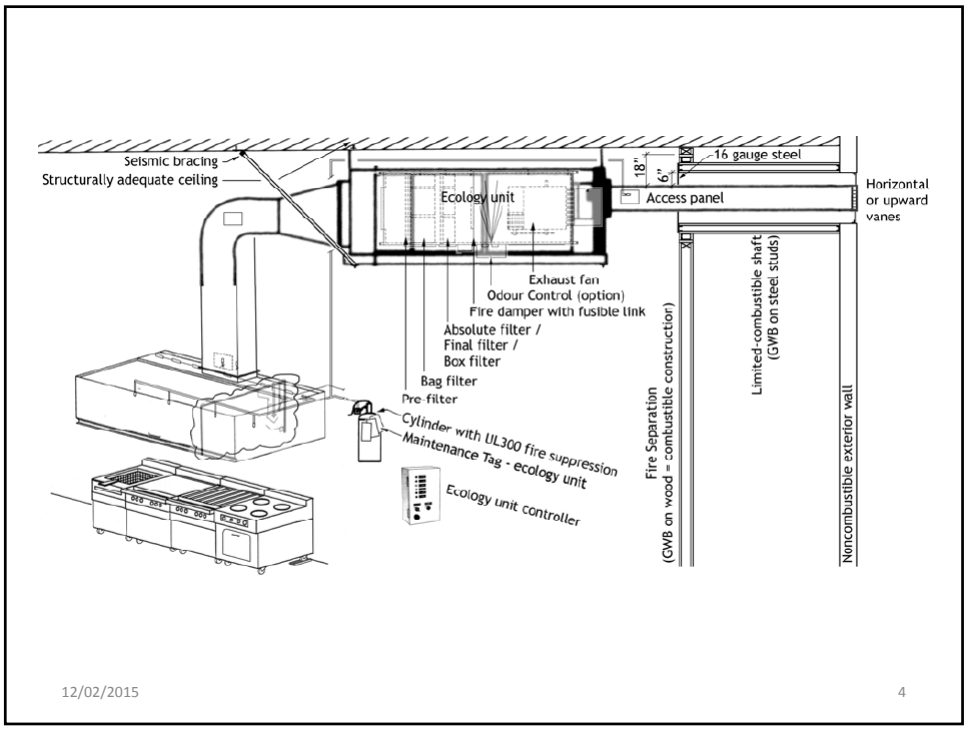
Satwinder Singh

12/02/2015 1



12/02/2015 2


Make-Up Air Unit
Upblast Exhaust Fan
Vented Curb Extension
Variable Volume Controls
Fire Suppression Controls
Commercial Kitchen Hood
Filter Bank
12/02/2015
3


Seismic bracing
Structurally adequate ceiling
Ecology unit
18"
6"
16 gauge steel
Access panel
Horizontal or upward vanes
Exhaust fan
Odour Control (option)
Fire damper with fusible link
Absolute filter /
Final filter /
Box filter
Bag filter
Pre-filter
Cylinder with UL300 fire suppression
Maintenance Tag - ecology unit
Ecology unit controller
Fire Separation
(GWB on wood = combustible construction)
Limited-combustible shaft
(GWB on steel studs)
Noncombustible exterior wall
12/02/2015
4

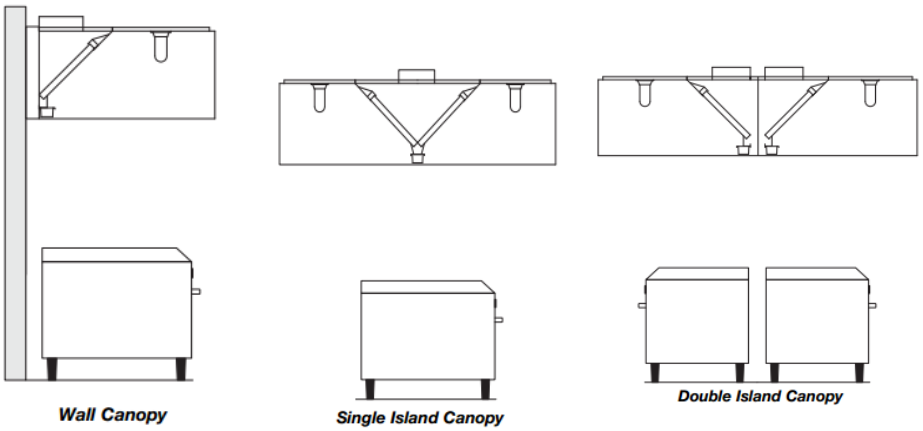
Types of Hoods

- Type I:
  - used over cooking equipment producing heat and grease laden effluent.
- Type II:
  - used over non-grease producing cooking equipment exhausting heat and condensation.

Type 1

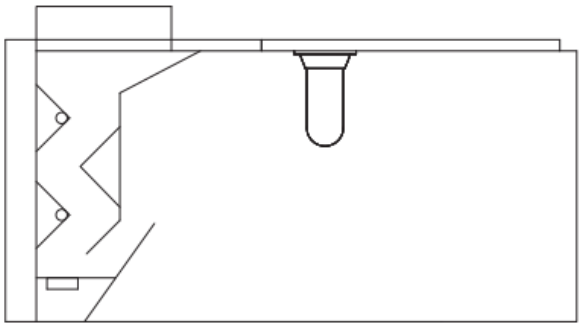
- Type I Canopy Hoods
  - Wall,
  - Single island,
  - Double island

Type 1 – Canopy Hoods



12/02/2015 7

Type 1: Water Wash Hoods



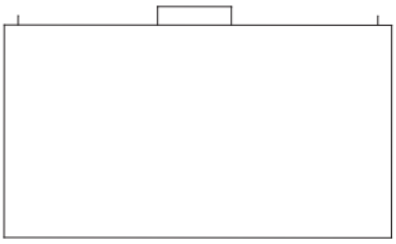
Water Wash Hood - End View

12/02/2015 8

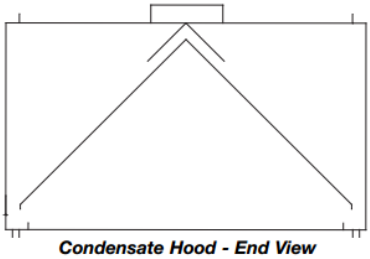
Type II

- Type II
  - Remove heat, moisture, and odor-ridden air from non-grease producing appliances
  - Do not contain grease filter banks but rather a duct collar to exhaust the contaminated air.
  - Does not need to be fully-welded, instead it can be a standard galvanized duct because there is no grease loading.
  - Flex-duct is not allowed for TYPE II hoods

TYPE II Hoods



Oven Hood - End View



Condensate Hood - End View

Hood Certification

- TYPE I exhaust hoods to bear the Underwriters Laboratory Canada (ULC) label

Classes of Cooking Operation

Class 1 Cooking Operation:	Grease-laden vapors
Class 2 Cooking Operation:	Steam and heat removal
Class 3 Cooking Operation:	Dwelling units)
Class 4 Cooking Operation:	Self-contained
Class 5 Cooking Operation:	No hood

Class 1 – Grease Laden Vapors

Any cooking process which produces significant smoke or grease-laden vapors.

Requirements:

- Full compliance with NFPA 96 (*Type I hood*)
- Minimum 50 GPM grease *interceptor*
  - Mesh filters are not permitted in new installations [NFPA 96, 6.1.3]. It is recommended that mesh filters in existing systems be replaced due to increased fire risk.

Example of Equipment:

range (burners or hot top), stove, hot plate (gas burner, electric coil or flat top), induction cooker, electric frying pan, conveyor convection oven if used for cooking chicken wings or other bulk meat, oven used for cooking meat, char broiler, wok, fry grill, griddle, salamander, deep fat fryer, pan frying, barbecue, rotisserie, Donair vertical broiler, tilting skillet, braising pan, any equipment recommended to have fire suppression by the manufacturer, any equipment which produces or has been designed by the manufacturer to have the potential to produce comparable amounts of smoke or grease. [NFPA 96, A.10.1.2]

Class 2 – Steam and Heat

Any cooking equipment or process which produces significant steam or heat but does not produce grease-laden vapors.

Requirements:

- *Type II hood* and exhaust with general HVAC ducting

Example of Equipment:

Any of the following if they are > 6 kW (20,478 BTU/h)7: closed pizza oven, conveyor pizza oven if used only for pizza or bread, baking oven, coffee maker, coffee roaster, hot dog display heater, pastry oven, popcorn maker, roll warmer, steam reconstitution device, steamer, toaster, warming oven

Class 3 – Dwelling Units

Any cooking equipment or process where limited smoke and limited grease-laden vapours are produced such as in normal usage in a single family home. This Class of Cooking Operation typically utilizes a domestic range.

Requirements:

- A domestic hood with a grease filter is the required minimum.
- The exhaust and make-up air systems must comply with the requirements for a typical self-contained mechanical ventilation system serving only one *dwelling unit*

Example of Equipment:

- single-family usage, a single, four burner domestic range in a Fire Hall, a single, four burner domestic range in an amenity room in a residential building, care home, congregate housing, employee break room or church where there is no cooking that produces grease-laden vapours, e.g., used for food warming or baking cakes , a microwave is recommended rather than a range where possible), a home-economics classroom in a high school where only domestic cooking is taught domestic range in a Licensed Childcare Facility. a single domestic range used in a showroom that sells non-food products, such as a showroom for selling domestic ranges, where the range is used once on the occasional day for a small number of people.
- Class 3 does not include commercial food operations.

12/02/2015 15

Class 4 – Self Contained

Cooking equipment listed by an accredited certification organization such as ULC, cUL or ETL to ventilate into the room. These devices typically have their own fire suppression and grease filtering systems.

Requirements:

- Comply with the manufacturer's installation, operational and listing requirements.

Example of Equipment:

- Giles Ventless Hood Fryer (previously called Chester Fried Ventless Hood Fryer)
- Perfect Fryer PFC model series, ventless commercial deep fat fryers
- Belshaw Donut Robot Fryer with Insider ventless cabinet

12/02/2015 16

Class 5 – No Hood

Cooking equipment where a hood is not provided. Products from the cooking operation may be removed by the room ventilation. Class 5 does not include cooking procedures which produce significant grease-laden vapors, significant steam or significant heat.

Requirements:

- Comply with the manufacturer's installation, operational and listing requirements.

Example of Equipment:

- the following if they are ≤ 6 kW: coffee maker, coffee roaster, hot dog display heater, pastry oven, closed pizza oven, baking oven, warming oven, popcorn maker, roll warmer, toaster
- Pennine grills (for making Pennines, i.e., not for processes which cause grease-laden vapours such as grilling or braising meat)
- microwave oven, crock pot

DESIGN -Minimum Exhaust Rate

	Canopy open on ≤ 3 sides	Canopy open on 4 sides
≤ Medium duty* appliances	80 cfm/sq.ft	125 cfm/sq.ft
Heavy duty* appliances	100 cfm/sq.ft	150 cfm/sq.ft

Medium Duty cooking appliances include **electric** discrete element **ranges** (with or with out 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) and electric and gas **rotisseries**.

Heavy Duty cooking appliances include electric under-fired **broilers**, electric chain (conveyor) broilers, gas under-fired broilers, gas chain (conveyor) broilers, **gas** open-burner **ranges** (with or with out oven), electric and gas **wok** ranges, and electric and gas over-fired (up right) **broilers** and **salamanders**.

Note: these requirements are the minimum. The professional engineer is responsible to assure adequate exhaust for capture and containment of the grease-laden vapors, smoke, gas and products of combustion.

DESIGN – Make-up Air Rate

Type of make-Up Air Unit	Make-Up Air
If not direct-fired,	min.= 80%
If direct-fired and openings between kitchen and public area ≤ 16 ft^2	≥ 90% and ≤ 110%.
If direct-fired and openings between kitchen and public area > 16 ft^2	≥ 95.2% and ≤ 100%

DESIGN – Exhaust Ducts

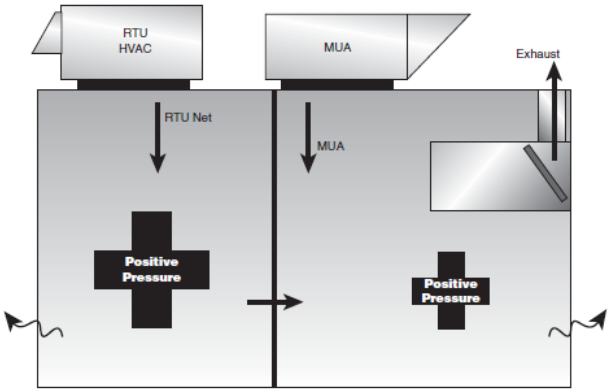
Exhaust duct velocity	• Required to be ≥ 500 fpm and ≤ 1800 fpm
Type 1	• NFPA 96 Compliance • Stainless Steel, welded liquid tight construction
Type II	• Standard Duct construction

DESIGN – Make-Up Air

	Canopy open on ≤ 3 sides
Temperature	Must be tempered BCBC 2012 6.2.3.11.(3)
Ductwork Design	≤ 0.1 "WG loss/100 ft
Pressurization	Pressure levels should not exceed negative 0.02 in. wg.
Ductwork	Galvanized Sheet Metal Perforated Ceiling Perforated Face supply

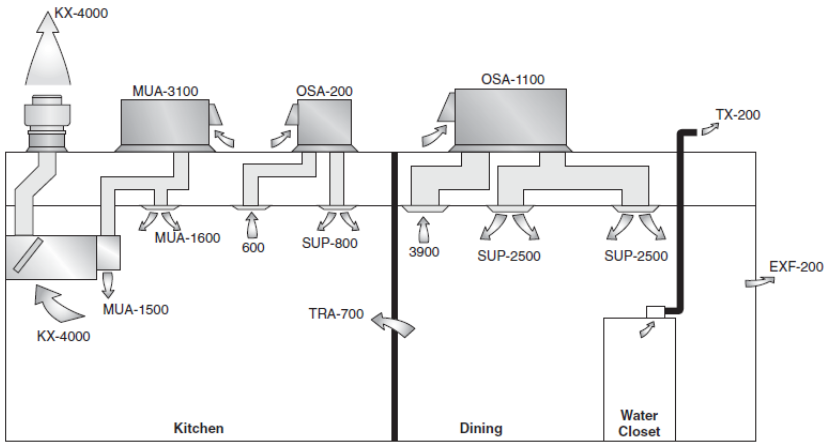
12/02/2015 21

Room Pressure

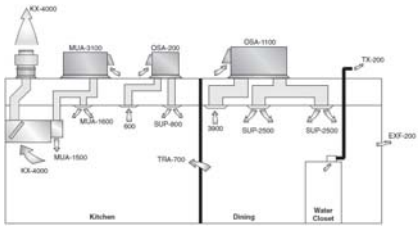


12/02/2015 22

Room Pressure



Room Pressure



Air Balance (units of cubic feet per minute (cfm)

Kitchen Systems	Airflow In	Airflow Out
KX - Exhaust		4000
MUA - to Hood	1500	
MUA - to Kitchen	1600	
SUP - HVAC Supply	200	
Total	3300	4000

Net=4000-3300= 700 transfer (TA) from dining

Dining Room Systems	Airflow In	Airflow Out
OSA - Outside Air	1100	
TRA - Transfer Air to Water Closet		200
Transfer Air to Kitchen		700
Total	1100	900

Net = 1100-900 = 200 Exfiltration

Grease Extraction

Without proper filtration, grease will:

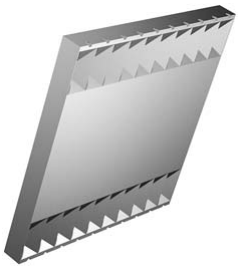
- **Collect in the exhaust plenum and ducts creating:**
  - **A fire hazard**
  - **An increase in the frequency of costly duct cleaning**
- **Collect on the fan causing it to become unbalanced and lead to premature failure**
- **Create odor in or near the restaurant**
- **Collect on the rooftop causing deterioration of roof materials**
- **Collect on the rooftop equipment and cooling coils**

Filters - Baffles

- **Designed to capture grease and drain it into a container**
- **Can be removed and cleaned**
- **Baffle filters use inertial impaction, which is the principle of the particle's momentum throwing the particle out of the airflow as it changes direction, to remove grease from the airflow.**
- **Typical pressure drops for a 9 ft. x 4 ft. hood at 2,050 cfm will be 0.5-0.6 in. wg.**

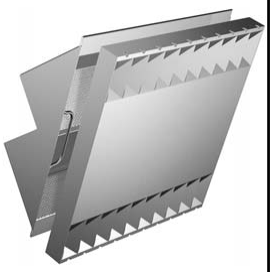
Filters - Grease Extractor:

- Integral part of the ULC listed hoods
- Series of horizontal baffles that are designed to removed grease and drain to a container.
- Can be removed and cleaned
- The use of centrifugal force rather than two dimensional impaction allows the efficiency to be improved without a high penalty in static pressure.
- Airflow enters the filters louvers and is spun in a chamber until it exits the back of the filter. Grease particles are thrown from the airflow during its helical path. The velocity of the airflow determines how small of a particle can be removed. The static pressure is between a baffle filter and a water wash hood.
- Typical pressure drops for a 9 ft. x 4 ft. hood at 2050 cfm will be 0.7-0.8 in. wg.



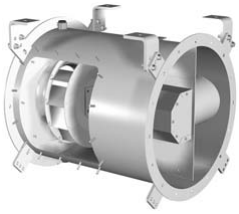
Filters – Multi Stage Filter/Extractor:

- uses a centrifugal type filter as the primary stage of filtration along with a packed bead bed filter as the second stage.
- Interception is the main filtration mechanism which works by adsorption of grease particles as they come in contact with the packed bead bed.
- Typical pressure drops for a 9 ft. x 4 ft. hood at 2050 cfm will be 1.1-1.3 in. wg.



Type of Fans

Upblast



Inline

Utility

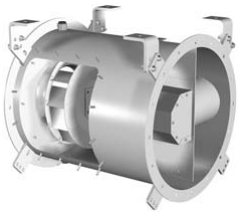
12/02/2015 29

Uplbast Fans

- **The most common type of kitchen exhaust fan.**
- **They use a centrifugal backward inclined fan wheel, are either direct drive or belt driven with an isolated motor, and can be roof or sidewall mounted.**
- **Grease drains/traps should be used on the fan to collect grease that has passed through the filtration system and may cause roof damage.**
- **A vented curb may be required in heat applications such as kitchen ventilation.**
- **Hinged curb cap and cleanout ports allow easy access to the inside of the fan and duct.**

12/02/2015 30

Inline Fans



- **Inline exhaust fans use a centrifugal backward inclined fan wheel and are mounted as part of the ductwork, usually inside the building.**
- **Access panels are located on the housing allowing disassembly of the fan without removal from the ductwork.**
- **These fans are best suited for applications where mounting a fan on the exterior of the building is not possible.**
- **Examples would be a high-rise building where penetrating multiple floors with ductwork would not be feasible or a building where a fan would detract from its visual appearance.**
- **Inline grease fans have an isolated motor, adjustable pulleys, and two grease drain plugs with the capability of being mounted horizontally or vertically.**

12/02/2015 31

Utility Fans

- **Utility fans offer a variety of discharge positions and can be mounted inside or outside of the building, offering flexibility with respect to duct design.**
- **An isolated motor compartment and adjustable pulleys offer flexible speed adjustment for final system balancing.**

12/02/2015 32

Fan Selection Criteria

- **Which fan is suitable for the application?**
- **Determine Air Flows**
- **Calculate System Pressure**
- **Consider Sound Levels**
- **Select a fan**

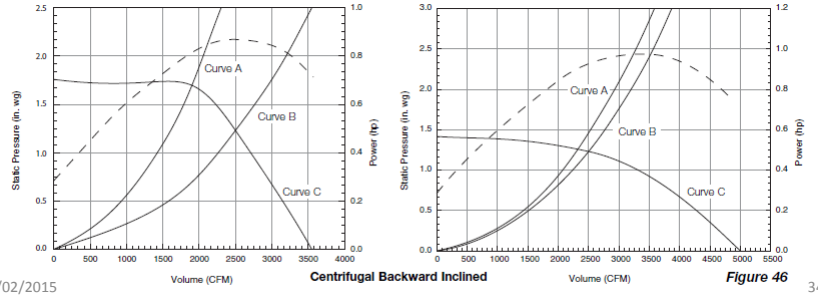
Each fan has a set of fan curves based on airflow, system resistance, motor power, and fan speed. It is crucial to choose a fan within the limits given by the fan manufacturer on the fan curves. The curve that represents system resistance begins at the origin and has an increasing slope on the fan performance graph. The curve that begins at a higher static pressure at zero airflow and tapers to zero pressure with increasing airflow is the fan performance curve. This is a line of constant fan RPM. To find the correct fan, operating points must fall on the fan performance curve to the right of the system resistance curve.

Fan Selection - Example

Given the following information, the table below shows properties of two fans that meet the criteria. However, it has yet to be determined which fan is better for this application.

Required Specifications: Upblast Fan, 2500 cfm of airflow, 0.25 in. wg static pressure

Fan Manufacturer Data													
Model	Relative Cost	Volume (cfm)	Fan RPM	Tip Speed (ft./min)	OV (ft./min)	Operating Power (hp)	Motor Size (hp)	Opening Width (in.)	Opening Length (in.)	Weight (lbs.)	Baffle	dBA	Sones
1	1.19	2500	1260	6103.0	856	.88	1	20.5	20.5	125	No	66	14.7
2	1.35	2500	838	5375	665	.91	1	26.5	26.5	174	No	63	12.7

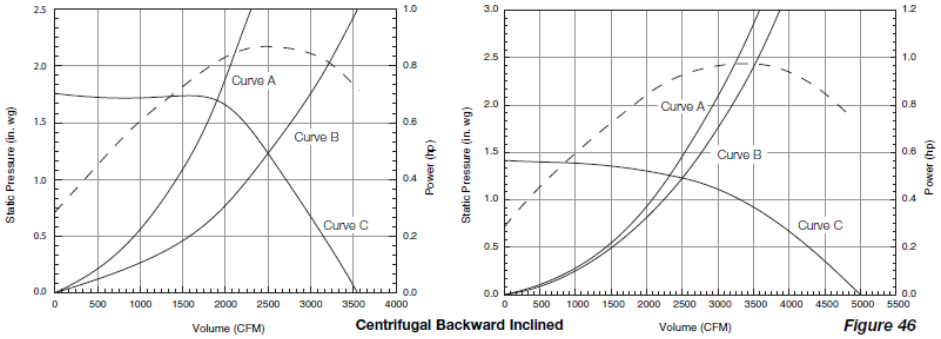


Model 1 — Centrifugal Backward Inclined — Model 2

Figure 46

Upblast Fan, 2500 cfm of airflow, 0.25 in. wg static pressure

Fan Manufacturer Data													
Model	Relative Cost	Volume (cfm)	Fan RPM	Tip Speed (ft./min)	OV (ft./min)	Operating Power (hp)	Motor Size (hp)	Opening Width (in.)	Opening Length (in.)	Weight (lbs.)	Baffle	dBA	Sones
1	1.19	2500	1260	6103.0	856	.88	1	20.5	20.5	125	No	66	14.7
2	1.35	2500	838	5375	665	.91	1	26.5	26.5	174	No	63	12.7



Centrifugal Backward Inclined

Figure 46

MAKE-UP AIR SELECTION

UNTEMPERED — Not allowed in Canada

HEATING:

1. **Direct Gas — The most common units, especially in the northern half of the United States, are the direct asfired units. These units provide outside air that is usually untempered in the summer months and heated in the fall, winter, and spring months. They have an operating efficiency of nearly 100% because the flame is directly in the airstream. Some efficiency is lost in the combustion process. A temperature sensor is set in the unit to regulate the heating cycle.**
2. **Direct gas-fired units move the air directly over a burner to obtain the desired leaving air temperature. A unit that is running too slowly is likely to introduce unwanted by-products into the building airstream. Fortunately, many manufacturers have the ability to operate their units at 70-50% of the total airflow. A modulating damper at the inlet maintains a minimum airflow velocity of 3000 fpm across the burner. It is important to verify the heat and airflow turndown with the manufacturer to prevent costly redesigns.**
3. **Indirect Gas — Similar to direct gas-fired, indirect gas-fired units also heat the air when needed or otherwise bring in untempered outdoor air during warm months. This process uses a heat exchanger which is 80% efficient. Gas is fired through a clamshell or S-tube heat exchanger. Heat is then transferred to the air as it passes over the clamshell or tubes while combustion by-products are vented to the outdoors.**
4. **Steam Coil — Air reaches its leaving temperature by flowing over steam-heated radiator coils. Steam from a boiler system can be tied into a series of coils in a make-up air unit. This allows the use of steam in heating air during cold periods.**
5. **Hot Water — Hot water can be used similar to a steam coil but is uncommon in kitchen applications.**
6. **Electric Heating — Electric-heating coils can be placed in a heater control cabinet on a make-up air unit to provide heat during cooler periods of the year. However, electric heat can be costly.**

MAKE-UP AIR SELECTION Criteria

1. **Determine required tempering options. If required, decide which type of heating and/or cooling.**
2. **Determine required supply airflow.**
3. **Determine external static pressure.**
4. **Select the proper motor voltage for the application.**

General Requirements – NFPA 96

1. **Use 16 gauge carbon steel or 18 gauge stainless steel (minimum thickness)**
2. **All joints and seams to be fully-welded and liquid tight**
3. **Ductwork shall lead directly to the building exterior**
4. **Follow clearance to combustibles**
5. **Minimum airflow of 500 fpm through ductwork**
6. **Ductwork shall not be interconnected with any other type of building ductwork**
7. **To prevent accumulation of grease in horizontal ductwork, cleanout ports are required every 20 feet, and the duct should slope towards the hood 0.25 inches every foot for duct runs under 75 feet. Runs greater than this require a slope of 1 inch per foot.**

Note: These are only a few of the requirements; NFPA 96 and local codes should be consulted