SMOKE VENTILATION TRAINING MANUAL

SUPER VAC
THE VENTILATION SPECIALISTS

⚠ DANGER

PERSONAL RESPONSIBILITY CODE

The member companies of FEMSA that provide emergency response equipment and services want responders to know and understand the following:

1. Firefighting and Emergency Response are inherently dangerous activities requiring proper training in their hazards and the use of extreme caution at all times.
2. It is your responsibility to read and understand any user's instructions, including purpose and limitations, provided with any piece of equipment you may be called upon to use.
3. It is your responsibility to know that you have been properly trained in Firefighting and/or Emergency Response and in the use, precautions, and care of any equipment you may be called upon to use.
4. It is your responsibility to be in proper physical condition and to maintain the personal skill level required to operate any equipment you may be called upon to use.
5. It is your responsibility to know that your equipment is in operable condition and has been maintained in accordance with the manufacturer's instructions.
6. Failure to follow these guidelines may result in death, burns or other severe injury.

FEMSA

Fire and Emergency Manufacturers and Services Association, Inc.
P.O. Box 147, Lynnfield , MA 01940 www.FEMSA.org

Super Vac,
"The Ventilation Specialists",
manufactures a wide variety of
portable ventilators powered by electricity, gasoline, battery, air
and water used for emergency smoke and fume ventilation.
For information on the entire line of Super Vac ventilation
equipment, refer to your Super Vac fire equipment catalog,
contact your dealer or visit our website at:
www.supervac.com

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Super Vacuum Manufacturing makes no warranty implied or stated about the specific use of any of the applications in this manual. Organizations using this manual are strongly encouraged to practice ventilation theories under controlled conditions. Everyone using ventilation products must thoroughly understand the SAFETY PRECAUTIONS on page 25 of this manual.

INDEX

VENTILATION

Throughout this manual, ventilation is discussed in relation to smoke. Smoke is a convenient media to use in illustrating air movement because of its visibility. However, the same principles apply to many toxic fumes, paint, welding fumes, vehicle exhaust, dust, and other airborne contamination.

The replacement of the products of combustion, heat and fire gases, with fresh air is VENTILATION. Ventilation on the fire ground is essential to the overall objective in that it enables fire fighters to complete their mission of RESCUE and EXTINGUISHMENT faster and safer. Through a coordinated attack that includes the ventilation of the fire building, fire fighters will work in an environment that is more tenable for the fire fighters themselves and any trapped occupants in the building. Ventilation reduces the conditions of back draft and flashover in addition to increasing visibility for other fire ground operations.

Fire ground commanders are now realizing the benefits of ventilation through the efforts of many years of research by manufacturers, fire departments, insurance companies, and through their own experiences. Research has shown that the sooner the ventilation process occurs in the overall fire ground plan, the greater the reduction in property damage, and the greater the reduction in manpower and equipment needs. As fuels have changed over the past several years, the ventilation objective has become more and more important. With this change in fuels, fire gases have become considerably toxic. This increase in the toxic content of fire gases has had a dramatic effect on the way we attack fires.

Ventilation can be achieved through “natural means” or through “mechanical means”. Natural ventilation includes opening windows and allowing the wind to provide fresh air to the fire building environment. It also includes self-ventilation of the fire when it burns through the roof, thereby allowing the trapped fire gases to escape through the roof opening. Mechanical ventilation includes using HVAC systems built into buildings, using fog streams out of windows to create air movement, and negative or positive pressure ventilation through the use of specialized fire service fans. This manual will concentrate on the use of specialized fire industry fans to create positive and negative pressure ventilation.

Super Vac has been providing special fire service fans to the fire service since 1926. Since that time, Super Vac has been involved in every development in fire service ventilation practices. Our research and development people receive hundreds of inquiries and suggestions throughout the year. Super Vac works with many fire service training organizations such as the International Fire Service Training Association (IFSTA) and the International Society of Fire Service Instructors (ISFSI) to improve the technologies available to fire departments. This manual is an example of our commitment to the fire service personnel of the world.

WHY VENTILATE?

During the incipient state of fire (the early state), the oxygen content of the environment is not changed dramatically. The fire is however adding carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), water vapor, and other gases to the atmosphere. During this phase of fire, flame temperatures reach 1000 degrees, while the temperature in the room may only change a few degrees. The products of combustion - $C0_2$, SO_2, CO, and H_20 - all have oxygen in their makeup (0 or 0_2). This means that oxygen is being used during the combustion process; if a continuous supply of oxygen is not available, the fire will go out (smoldering phase). The second phase of fire is the free burning phase. This phase can not occur without the continued supply of oxygen. As air is introduced to the base of the flame, heat and fire gases will rise until stopped by the ceiling usually, or until they cool to equal ambient temperature. These super heated gases may reach temperatures between 1200 and 1500 degrees Fahrenheit. The inhalation of these fire gases can cause instant death.

In the smoldering phase, the third phase, burning is reduced due to the lack of oxygen. The greatest smoke generation occurs during this phase. So much smoke may be generated that it pressurizes the structure with smoke. Smoke may be seen from the exterior of the building. Smoke and fire gases may still be above 1000 degrees Fahrenheit.

During a fire, different areas of the structure may be at different stages of combustion. Smoke and hot fire gases kill more people and cause more damage than flames. In addition, these products of combustion make it more difficult to perform rescue and extinguishment operations because of low visibility and physical stress placed on personnel.

SMOKE AND FIRE GASES

Smoke is the mixture of the products of combustion with air and dust. These products include, but are not limited to, carbon, organic acids, aldehydes and tar. Many products of combustion are heavier than air, however, in the heated environment of the fire, they expand and rise. As the room cools, these lethal fire gases become denser and fall to the floor level. For this reason, ventilation and the use of breathing apparatus must continue during the overhaul phase of operations. Breathing apparatus use does not preclude the use of ventilation techniques; many products of combustion may be absorbed through the skin, especially in the areas of the fire fighter’s neck and wrists. Fire fighters assigned to busy companies have an additional risk in that fire gases are cumulative in the body. Conditions that affect the level of danger include:

The level of oxygen in the area
The temperature of the fire gases
The products involved in the fire
The duration of exposure
The physical condition of the fire fighter

Ventilation can effect all but the physical condition of the fire fighter, thereby reducing the risk considerably. Fire fighters exposed to the products of combustion should be given 100% oxygen therapy. Again, ventilation reduces the risk. The long term effects of exposure to fire gases are still not known. However, we do know that carcinogens are produced during the combustion of some products. In addition to the carcinogens, immunosuppressants are produced during fires. These suppressants inhibit the immune system of the body from protecting itself.

FLASHOVER

Flashover occurs when the contents of a room or area reach their ignition temperatures almost simultaneously. Flashover may appear as a wave because as one space ignites, the increase in temperature causes the next space to reach its ignition temperature. Ventilation procedures can reduce the flashover risk by reducing the temperature in the entire area.

BACKDRAFT

A backdraft situation exists when the environment should be in a flashover, however there is not sufficient oxygen to support combustion. When oxygen is introduced into this environment, an explosion occurs as the fire speeds.

Ventilation is required in this case. It is important to understand the entire ventilation process and carry it out carefully under backdraft situations. Some signs of backdraft are:

Puffing smoke outside the building or area
Dense black smoke turning grey to yellow
Little or no flame
Smoke stained windows
Smoke leaving then re-entering the building
Excessive heat with no visible fire

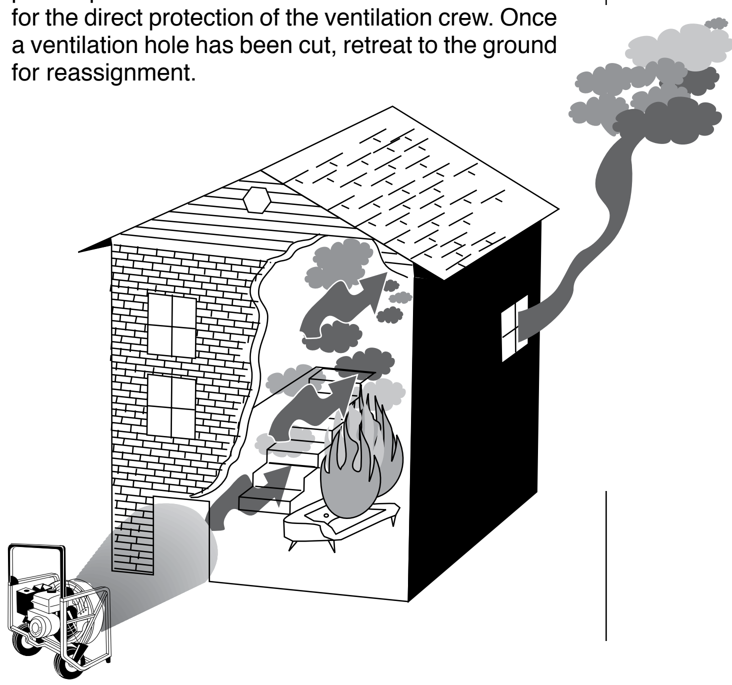
TACTICS

Fire attack and / or rescue operations should occur around the same time as ventilation operations or soon thereafter. Coordination of the fire attack and ventilation operations are essential, as they dramatically affect the outcome of the situation. Ventilation can be destroyed by attack crews who are not acting in concert with ventilation crews. Also, attack operations not in conjunction with ventilation operations may not reach their objective: the fire or the rescue. Ventilation crews should return to or communicate with the command post for reassignment.

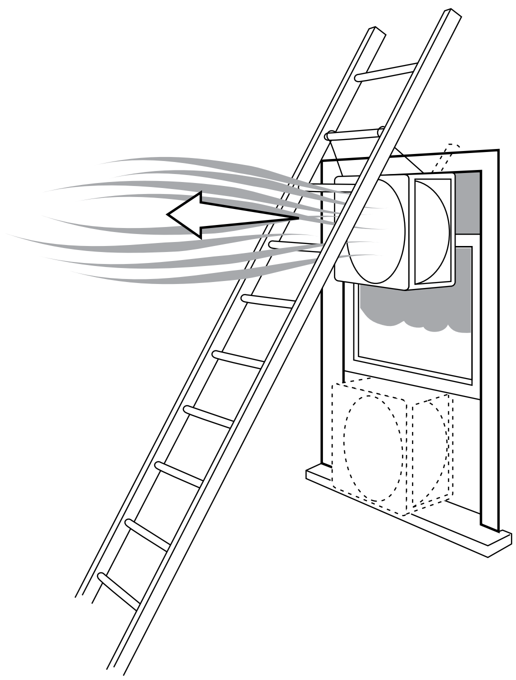
Protection lines for the ventilation crew should not be used for fire fighting lines unless specifically directed to do so by the command post. Attack crews could be in jeopardy if ventilation crews fight the fire from the wrong vantage point. The tactical objective of the ventilation crew will determine where and how ventilation is done. For rescue, generally, positive pressure is needed between trapped occupant(s) and the fire and between the trapped and the exit. This may or may not be easily identifiable. Once the rescue mission is completed, ventilation equipment may need to be repositioned for attack operations or for overhaul operations.

During attack operations, positive pressure is needed between attack crews and the fire with the exhaust opening on the opposite side of the attack.

Whenever possible, ventilation crews should take advantage of smoke and fire gases' natural tendency to rise. While a potentially dangerous operation, some situations call for fire fighters to make their way to the roof and cut it open. This will release super heated fire gases, smoke and sometimes fire through the hole. A protection line is required. Never put the protection line on or in a vent hole unless it is for the direct protection of the ventilation crew. Once a ventilation hole has been cut, retreat to the ground for reassignment.



On a smaller scale, fire fighters can take advantage of smoke's tendency to rise by placing fans at the highest point in the exhaust opening. This opening may be a window or a door, or it may be an opening created during the ventilation process. During positive pressure operations, ventilate the bottom floor first and work your way to the top.



MECHANICAL VENTILATION

Mechanical ventilation is required whenever natural ventilation is even partially unsatisfactory. Mechanical ventilation procedures should begin immediately to assist in rescue or attack operation, or when it is felt that the natural process is too slow, causing excessive damage to property. Mechanical ventilation should be used to maintain egress routes for occupants and fire fighters. Mechanical ventilation should be used to augment natural ventilation, or when smoke is below grade. Generally speaking, when applied correctly, you can not over ventilate. More often than not, the fire service under ventilates during fire operations due to poor training, severe manpower limitations, poor equipment, or a misunderstanding of the value of ventilation procedures. Usually it is a combination of the above.

Mechanical ventilation is possible by creating positive and negative areas and directing air currents with the principle that air will travel from a positive or neutral area of pressure to an area of negative pressure. Using mechanical force, we can create negative or positive pressure on the fire ground in one of two ways.

1. SPECIALLY DESIGNED SMOKE VENTILATORS
2. FOG STREAMS

FOG STREAMS

Fog streams have the capability of moving considerable amounts of air, however they have many drawbacks:

Use large quantities of water for non-attack operations

Must be continuously manned

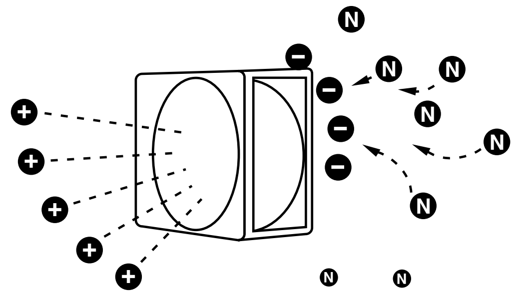
Often can only be used directly to outside of building

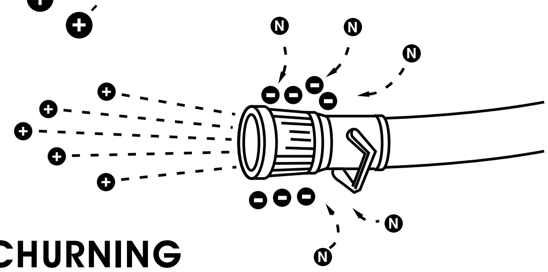
Creates additional water damage

Requires continuous use of pump

PRESSURE GRADIENTS

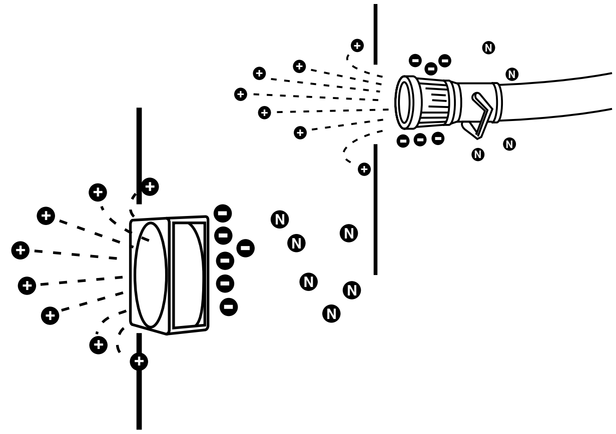
When smoke and fire gases are on the side of the fan where the pressure is positive, that is called POSITIVE PRESSURE VENTILATION. When smoke and fire gases are on the negative side of the fan, that is called NEGATIVE PRESSURE VENTILATION. All electric Super Vac fans are employable in the positive pressure operation or in the negative pressure operation. Using any gas fan in the negative pressure mode is not recommended due to the smoke and gases being pulled into the carburetor. Fire fighters should know how to use both positive pressure procedures and negative pressure procedures as different situations call for different operations. There are no rules for determining when to use positive pressure or when to use negative pressure ventilation. In many situations, both positive pressure and negative pressure procedures will be in operation at the same time.



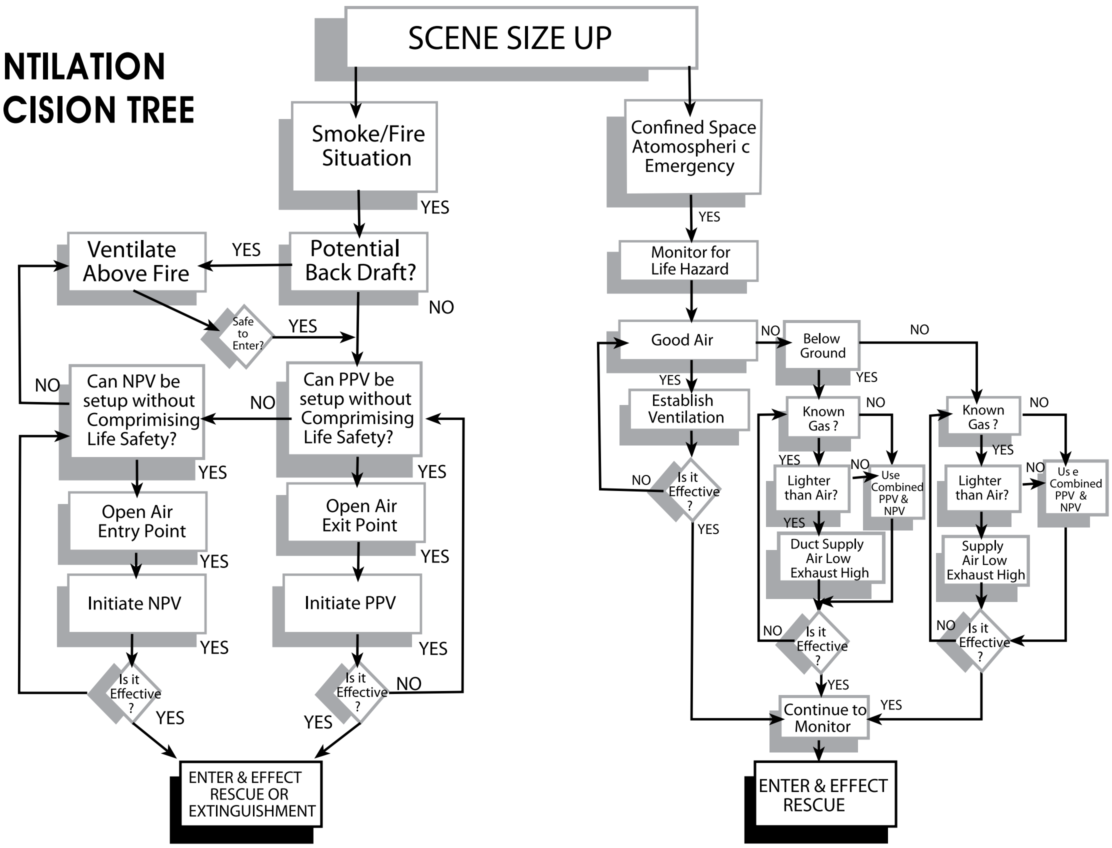


CHURNING

A division must be maintained when creating mechanical ventilation between the positive side of the equipment and the negative/neutral side. If a separation is not made, air will flow from the positive side back around to the negative side making the operation less effective (churning).



VENTILATION DECISION TREE

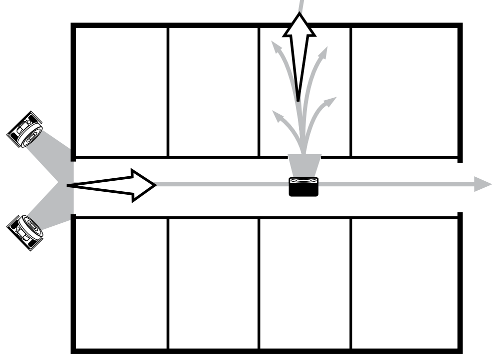


REQUIREMENTS FOR EFFECTIVE MECHANICAL VENTILATION

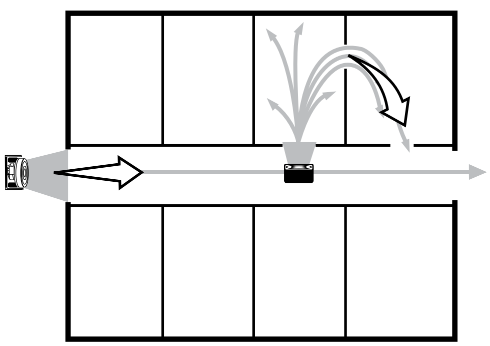
1. Use good, reliable, portable equipment.
2. Be sure to use large enough fans or enough fans to perform the necessary task.
3. Provide proper training in techniques to acquire maximum benefit from the equipment.
4. Practice good pre-fire planning that includes ventilation options.
5. Take advantage of smoke's natural tendency to rise.
6. Initiate ventilation as soon as tactically possible.
7. Include ventilation as part of standard operating procedures (S.O.P.).
8. During negative ventilation operations place fan as close to smoke source as possible.
9. Use combinations of fans to achieve the best performance, either combinations of positive and negative pressure, or multiple fans for additional volume.
10. Use prevailing winds as much as possible.
11. Keep air paths clear. Take advantage of air's natural tendency to follow the path of least resistance.
12. Remove screens and other obstacles. Maintain the closure integrity so the window or door can be closed.
13. Coordinate the ventilation operation with rescue and attack operations.
14. Maintain control of replacement air and/or exhaust openings.
15. When ventilating more than one floor, start at the bottom and work toward the top.
16. Never use gasoline powered fans in smoke atmospheres.
17. Use only fans with explosion proof motors inside questionable atmospheres.
18. Never place hose lines into ventilation openings.
19. Make sure that created drafts do not close doors or windows.
20. Maintain ventilation operations during overhaul.
21. First open,then pressurize maintaining control of air movement.

USING COMBINATIONS OF FANS

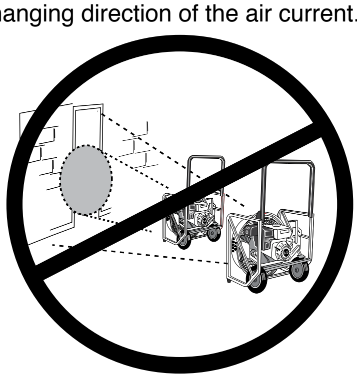
Using more than one fan increases air input and speeds up the ventilation operation. This can be multiple fans at a single inlet, using more than one outlet, or using fans in a stack. Combinations can also include both positive and negative pressure operations. When using gas fans, remember that it is not recommended that gasoline fans be used indoors. Use electric fans for indoor or outdoor use.



A. Multiple fans at inlet, with position pressure fan changing direction of the air current.

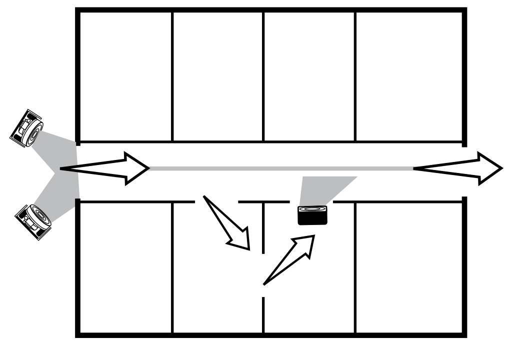


B. Single fan at inlet with positive pressure fan changing direction of the air current.

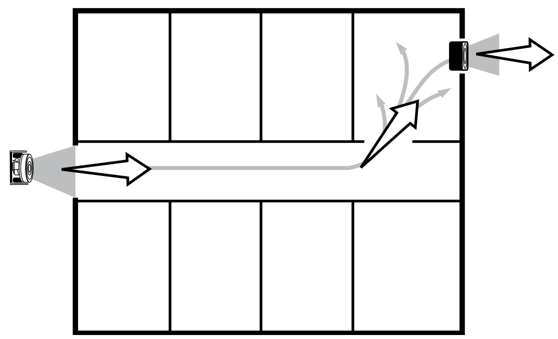


Older series method of using fans is not as effective as *Parallel Methods.* This is similar to pumps flowing water, where parallel pumps will move more water than series pumps.

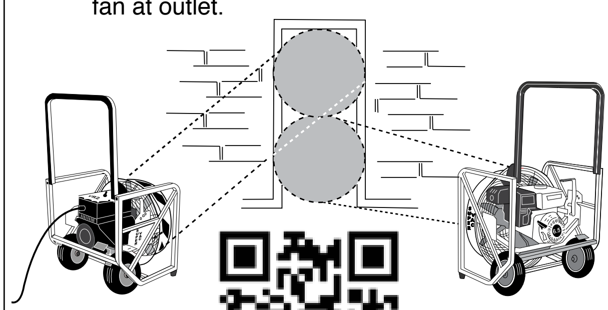
When using combinations of fans it is very important to allow sufficient openings for air to flow to a fan in negative pressure operation and from a fan used in positive pressure operation. If openings are too small the efficiency of the fan will be reduced.



C. Multiple fans at inlet, with negative pressure fan changing direction of the air current.



D. Single fan at inlet with negative pressure fan at outlet.



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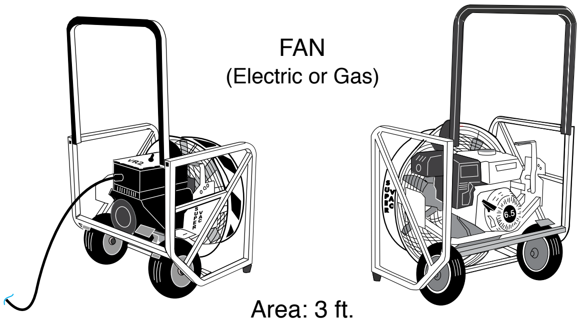
The V-Attack will ventilate faster and more effectively then series PPV while allowing straight in access. Place fans at 45° to door, one aimed high, one aimed low.

VENTILATION THEORY

FANNING A FIRE

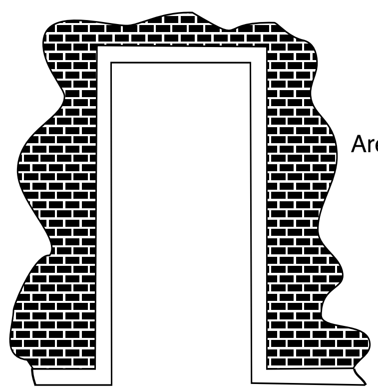
It is important to realize the relative speed of air in ventilation situations. This can aid the ventilation team in determining the number of fans and ventilation method required.

FAN
(Electric or Gas)



Area: 3 ft.
Average Wind Speed
60 mph

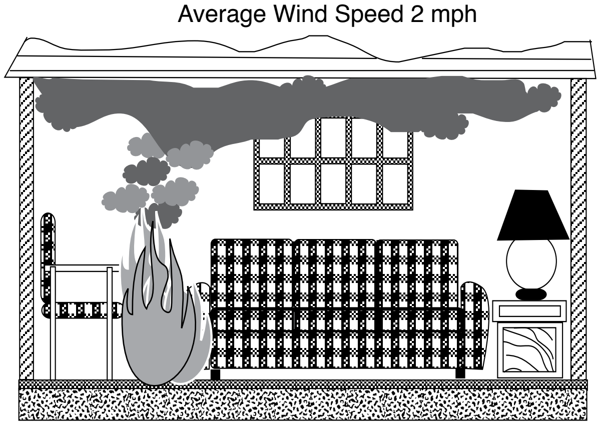
DOOR



Area: 18-20 ft.^{2}
Average
Wind Speed
10 mph

ROOM

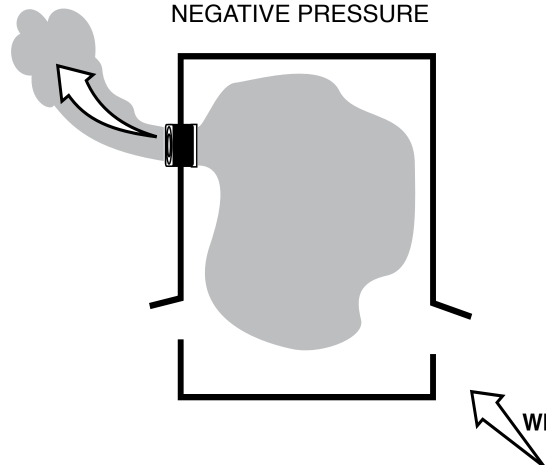
Cross Sectional Area: 120 ft.^{2}
Average Wind Speed 2 mph



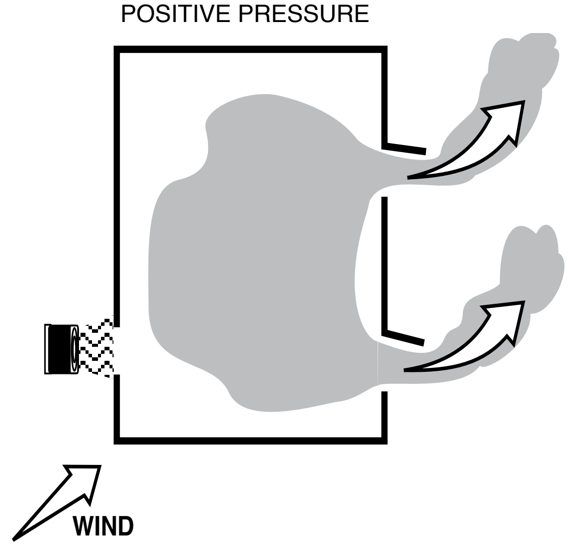
USING WIND DIRECTION

One of the most important requirements of successful ventilation is knowing how to use the prevailing wind to your advantage. Once the wind speed and direction is determined, the ventilation team can begin their set-up using either positive or negative pressure ventilation to best clear the smoke.

NEGATIVE PRESSURE



POSITIVE PRESSURE



POSITIVE PRESSURE VENTILATION

Positive pressure ventilation is when fresh air is introduced through a fan into an area to increase the pressure in that area. When the pressure is increased, the air will move to an area of lower pressure. This follows the law that air will always move from an area of higher pressure to an area of lower pressure. During this movement, the air will always follow the path of least resistance.

Fire fighters can take advantage of the positive pressure laws in the area of smoke removal. By pressurizing a structure, and by using the selective process of opening and closing doors and windows, fire fighters can direct the movement of smoke and fire gases faster than ever before. Because positive pressure ventilation is initiated from outside the structure, fire fighters can implement ventilation operations immediately without entering the hostile environment. This will help cool the space,provide oxygen to victims and increase visibility for victims and fire fighters. As with all ventilation practices, fire fighters performing ventilation should know where the fire is before they begin, as the ventilation process has the potential of moving fire and fire gases. Generally speaking, positive pressure should be initiated between fire fighters and the fire, or between the fire and trapped occupants. The exhaust port should be on the opposite side of the fire fighters or the occupants. Pressurization should occur after opening any exhaust port.

ADVANTAGES OF POSITIVE PRESSURE VENTILATION

1. Reduces property damage.
2. Increases visibility and safety.
3. Can maintain primary and secondary egress routes.
4. Reduces overhaul time.
5. Can utilize electric or gasoline powered fans.
6. Does not require explosion proof motors.
7. Can be initiated from the exterior of the building.
8. Is effective on all structures when doors or windows are maintained.
9. Does not require smoke and fire gases to pass through the fan.
10. Is quicker than negative ventilation.
11. Keeps doorway clear of equipment.
12. Air velocity within building is increased.
13. Equipment cleaning time is reduced.
14. Works well in large areas.

FAN PLACEMENT

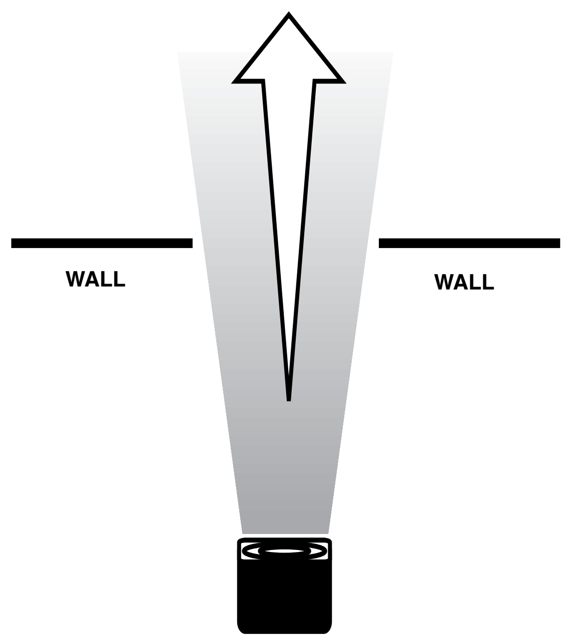
With the fan on the outside of the doorway, place a fan or fans far enough away from the doorway so as to fill the doorway with a cone of air coming from the fans. This will create a venturi effect with the air going in the door, increasing the fans effectiveness.

Parallel fans will increase volume greatly, reducing ventilation time and increasing ventilation effectiveness. For oversized doors, place fans side by side to overlap their cones of air.

In large door openings, place fan slightly farther back or use multiple ejectors.

Positioned in this manner the fan not only moves the air passing through the propeller, but also draws air into the air stream on the discharge side. Efficiency increases by 20 to 100% of rated capacity. Actual increase varies according to the size of the fan, <u>the size of the door opening, and the size of the exhaust opening.</u>

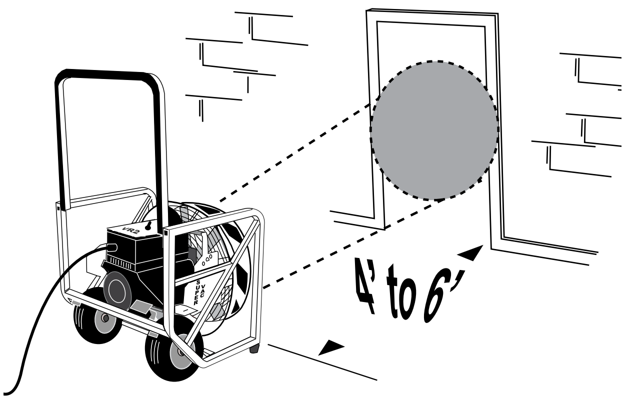
The smaller the fan, the lower the increase in capacity, and vice versa. This is mainly because of the difference in velocity and the concentrated reach of the air stream. By positioning either a 18” or a 24” Super Vac 4 to 6 feet outside a door measuring 30” x 84”, the volume of air exhausted will increase about the same for either fan (30 to 40%).



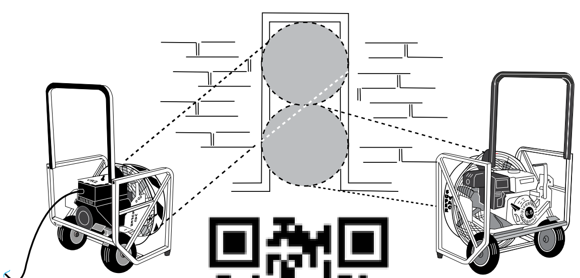
POSITIVE PRESSURE VENTILATION

FAN PLACEMENT

Following are guidelines as to the placement of fans for positive pressure applications. As with all such guidelines, one should follow these based on practice and experience.



The design of the V-Attack is such that the door is sealed top to bottom with the units at 45° angles. This leaves a straight shot for attack lines.



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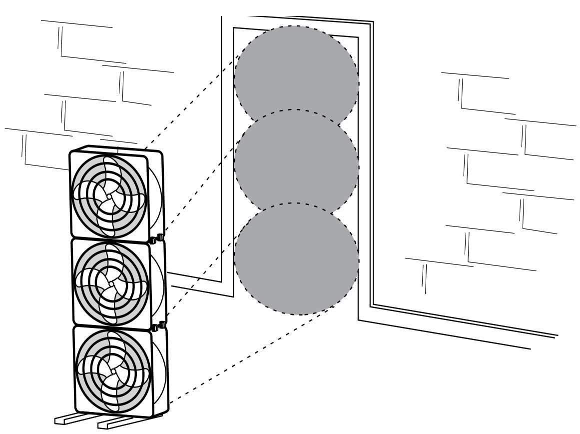
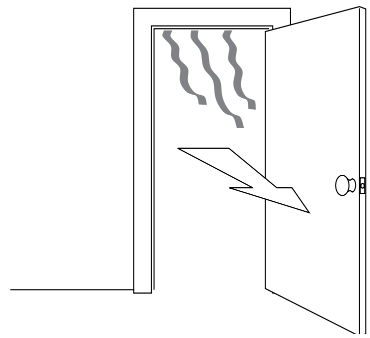
The design of the saddle stack is such that all the air seals the door.

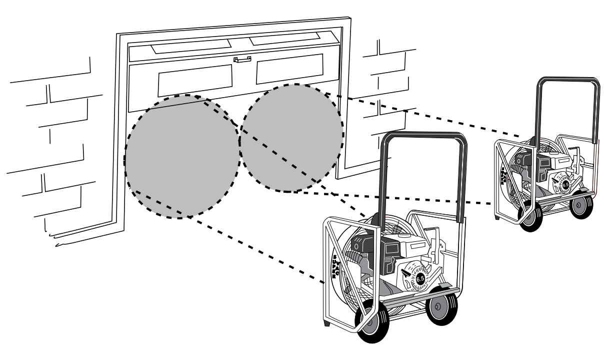


USE OF DOORS

Because fans are not located directly in the doorway for positive pressure operations, the ingress/egress route is not blocked by the fan. Because fans are not in the doorway, fire fighters entering the building should be aware not to stand in the doorway as that will block the incoming air. Streamers can be hung in the doorway to indicate that it is a positive pressure ventilation inlet.



When using a garage door, open it only partway. Then using two fans, seal the doorway with the cones of air.



Do not block the air supply by standing or stooping in back of the fan.

WORKING WITH POSITIVE PRESSURE

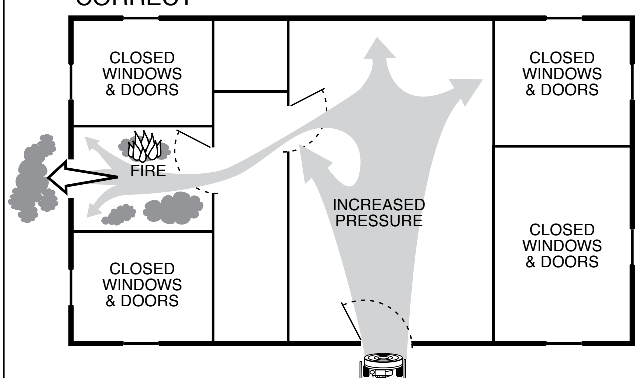
All ventilation operations should be under the direction of the incident commander. This can be direct supervision, through a company officer such as a truck company officer, or through a ventilation section leader. Ventilation operations are as critical to the overall operation as are other procedures. If the ventilation operation is neglected, the overall operation suffers.

Once a crew has been assigned to perform the ventilation operation, they must identify the location of the fire and the mission of the team. For example, if there is a backdraft condition, the crew should open up above the fire to exhaust super heated fire gases and products of combustion. If a rescue is to be made, the crew needs to place a positive pressure zone between the trapped persons and the fire, and a positive pressure zone between the rescue crew and the fire. When making a direct attack, the ventilation crew needs to open up on the opposite side of the attack crew, then place a pressure zone between the attack crew and the fire.

To initiate positive pressure operations, either gas powered or electric powered fans may be used. Generally speaking, a larger fan will produce faster results. However, always compare fans by their rated output, not by their size in inches.

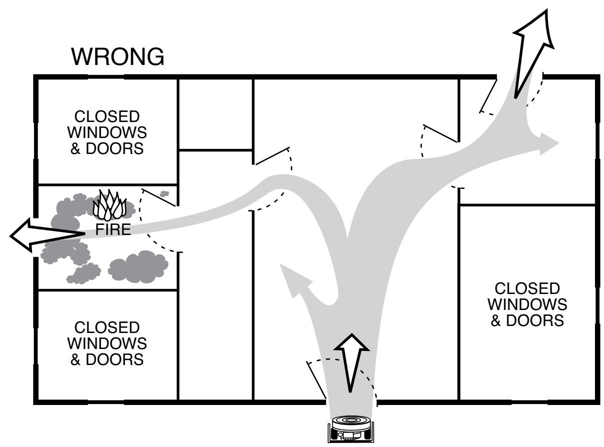
Because positive pressure requires the select opening and closing of air exit points, care should be taken not to destroy the integrity of windows or doors so that they are capable of being opened and closed to change the direction of air flow. This is contrary to the standard practice of many departments and will require new awareness and training. Also, fire fighters using several doors as ingress and egress routes can reduce the effectiveness of the ventilation effort. Again, training and coordination is important. If windows are broken, use doors to compartmentalize room(s).

CORRECT



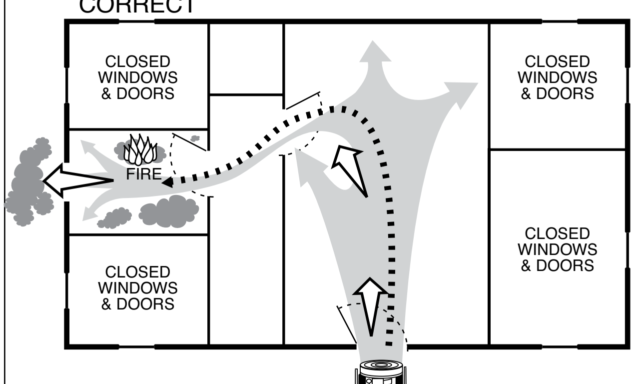
AIR FLOW WITH DOORS AND WINDOWS CONTROLLED

WRONG



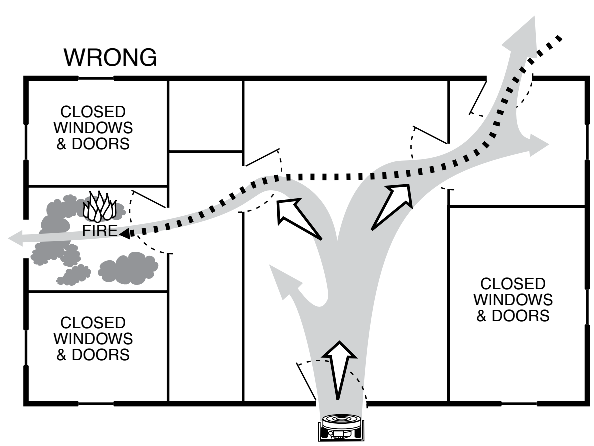
AIR FLOW WITH UNCONTROLLED OPENING OF KITCHEN DOOR ALLOWING PRESSURE TO SEEK PATH OF LEAST RESISTANCE

CORRECT



ATTACK CREW SHOULD WORK IN CONCERT WITH VENTILATION

WRONG



AN UNCOORDINATED ATTACK WILL WORK AGAINST BOTH ATTACK AND VENTILATION

NEGATIVE PRESSURE VENTILATION

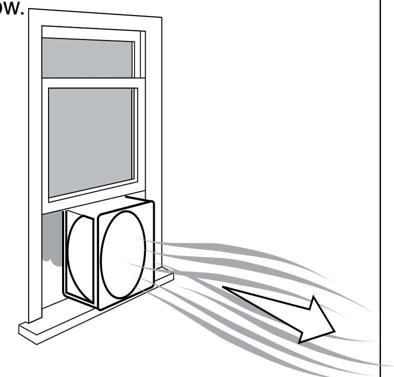
Negative pressure is when smoke is moved through the fan from the negative side first. It has been the industry standard for many years and remains the most versatile tool in ventilation. It is the only recommended method of ventilation in situations involving hospital and nursing home uses, cave-ins, and interior rooms. Electric fans do the majority of negative pressure work since they are not affected by the ambient, do not produce CO, and can be used in any position.

ADVANTAGES OF NEGATIVE PRESSURE VENTILATION USING ELECTRIC SMOKE EJECTORS

1. Reduces property damage.
2. Increases visibility and safety.
3. Can maintain primary and secondary egress routes.
4. Reduces overhaul time.
5. Can utilize electric fans.
6. Can utilize explosion proof motors.
7. Does not require a great deal of coordination with other operations.
8. Is not upset easily.
9. Requires little training.
10. Can be used in conjunction with flexible duct equipment.
11. Works well in small area situations such as a single room.
12. Works well in the removal of heavier than air gases.
13. Works well from aerial equipment from the exterior of high rise rooms.
14. Works when opening integrity is not maintained.
15. Electric smoke ejectors do not produce CO.
16. Can be used in cave-ins.
17. Can be used to cool fire fighters in staging areas.

WINDOW PLACEMENTS

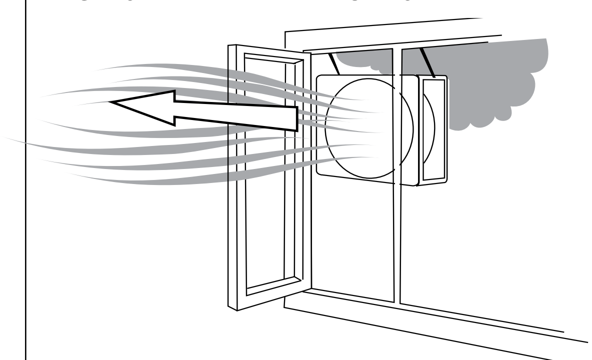
There are as many ways to utilize the Super Vac unit in window locations as there are types of windows. However, two principal kinds of windows are encountered, the double-hung window and the casement-type window.



DOUBLE-HUNG WINDOWS

1. Raise lower window.
2. Place Super Vac unit on window sill and pull window down onto handles.
3. Secure both hooks of the Super Vac hanger unit into bottom sill of the window.
4. Wrap cable of hooks around handle to obtain length which will hold smoke ejector securely on lower sill of window. Properly installed, the Super Vac unit performs unattended and ejects smoke at maximum efficiency. NOTE: Be sure the unit is correctly placed. To direct smoke, fan blade must be on the inside forcing air over motor to outside. Reverse the position to pull in fresh air.

CASEMENT WINDOWS



1. Roll window open and place one hanger hook over top window hinge.
2. Fasten the second hook into the mullion of the window to steady the unit.
3. Rest unit on metal edge of window to prevent damage.
   This placement is of tremendous value in venting the common mattress fire or similar one-room fires.

NEGATIVE PRESSURE DOOR PLACEMENT

With the fan on the smoke side of the doorway, place a fan or fans far enough away from the doorway so as to cover the doorway with a cone of air coming from the fans. This will create a venturi effect with the air going out the door, increasing the fans effectiveness by as much as 100%. Stacking fans will increase volume greatly, reducing ventilation time and increasing ventilation effectiveness. For oversized doors, place fans side by side to overlap their cones of air. An alternate method of using two fans in a doorway is to place one fan on the door, and a second fan away on the floor.

The following guidelines should be used only as an aid in determining the correct placement of Super Vacs based on the sizes of the door and the fan.

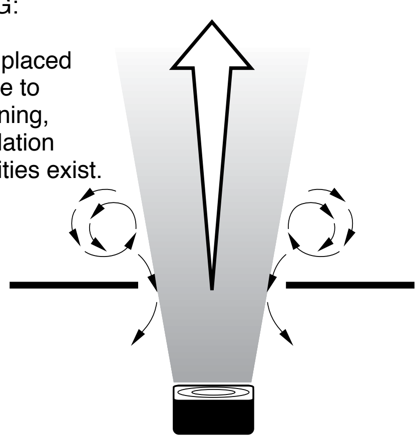
16” Super Vac exhausting through a 36” door should be positioned 6’ to 8’ from opening.

20” Super Vac exhausting through a 48” door should be positioned 8’ to 10’ from opening.

24” Super Vac exhausting through a 48” to 60” door should be positioned 6’ to 10’ from opening.

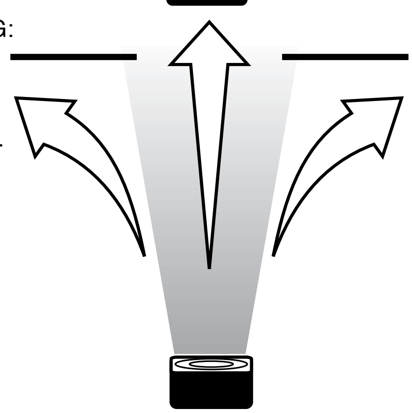
WRONG:

If fan is placed too close to the opening, re-circulation possibilities exist.



WRONG:

Too far from opening.

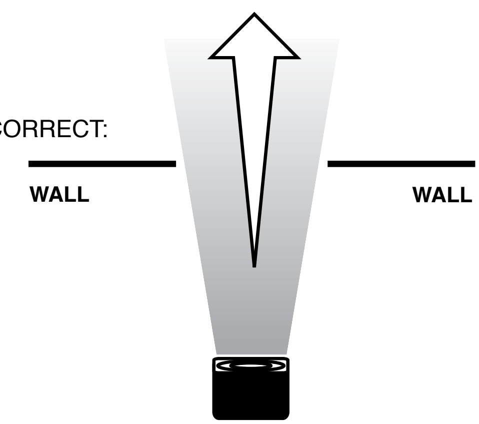


In large door openings, place fan slightly farther back or use multiple fans.

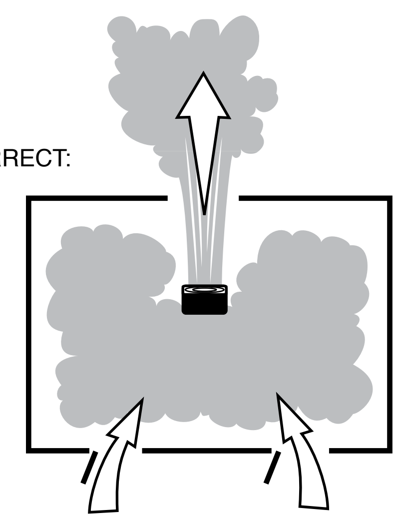
Positioned in this manner the ejector not only moves the air passing through the propeller, but also draws air into the air stream on the discharge side. Efficiency increases by 20 to 100% of rated capacity. Actual increase varies according to the size of the fan, the size of the door opening through which it is exhausting and the size of the opening providing replacement or make up air.

The smaller the fan, the lower the increase in capacity, and vice versa. This is mainly because of the difference in velocity and the concentrated reach of the air stream. By positioning either a 16” or a 24” Super Vac 8 to 10 feet inside a door measuring 30” x 84”, the volume of air exhausted will increase about the same for either ejector (30 to 40%).

CORRECT:



CORRECT:

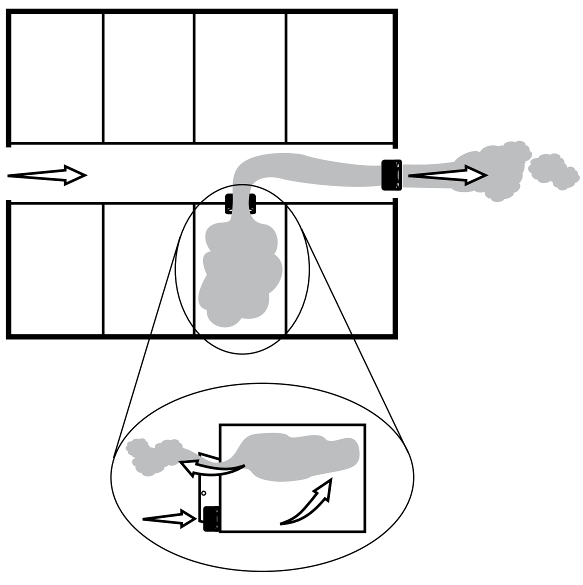


TYPICAL PLACEMENT FOR
EFFICIENT VENTURI EFFECT.
Air inlet approximately 2 times air outlet.

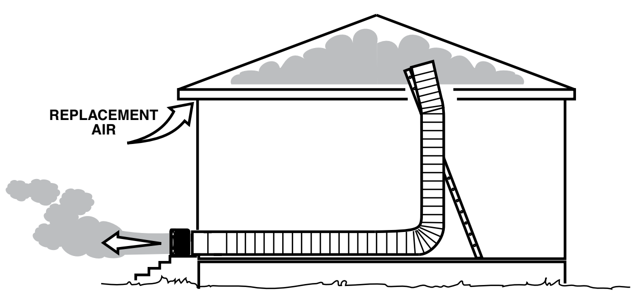
NEGATIVE PRESSURE VENTILATION

WORKING WITH NEGATIVE PRESSURE VENTILATION

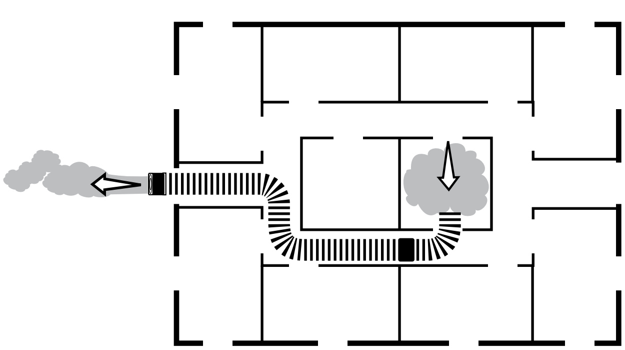
Shown below are some of the many situations requiring the use of negative pressure ventilation.



VENTING VAULTS, CLOSETS, OR CLOSED ROOMS

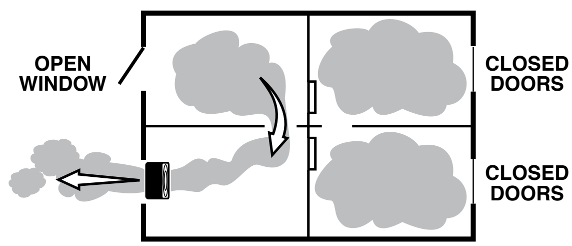


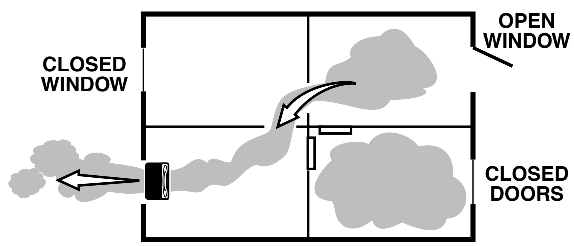
ATTIC

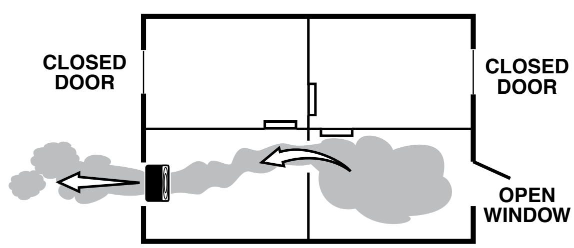


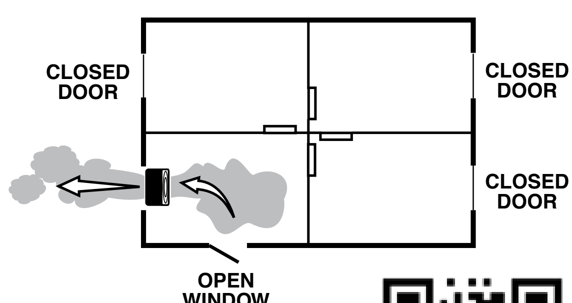
EXHAUSTING INTERNAL ROOMS
WITHOUT OUTSIDE ACCESS

To use fans effectively, a path must be provided for make up air to flow in and replace the smoke being pulled out through the fan. The sequence below shows how this may be applied to selective ventilation of an enclosure. Note: If windows have been broken, doors can be used to close off areas.









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CONFINED SPACE EMERGENCIES

Rescue problems in confined spaces are usually a result of asphyxiation or due to falls. Unfortunately, many people have been seriously injured or killed in efforts to make confined space rescues without insuring that the hazardous conditions have been removed. Confined Space Ventilation (CSV), exhausting internal atmospheres and replacement of those atmospheres with fresh air is required before entry. Extreme care must be taken when using gas powered blowers to provide air to confined spaces due to CO produced by the gasoline engine. A specialized electric fan used properly is the best ventilation tool for confined space.

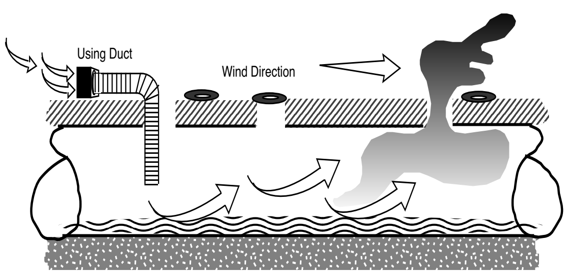
In most cases, CSV can be set up without entering the space. This can greatly increase the chance of survival for victims in the space, without endangering the life of rescue personnel.

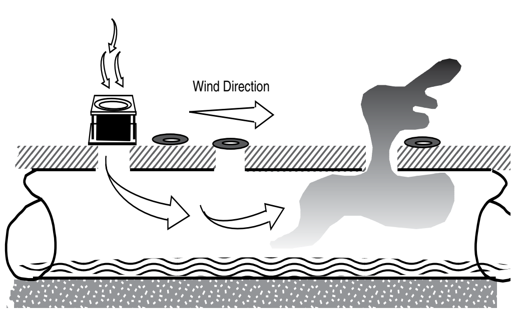
SAFETY PRECAUTIONS

When using Super Vac fans to ventilate confined spaces, always remember the following points:

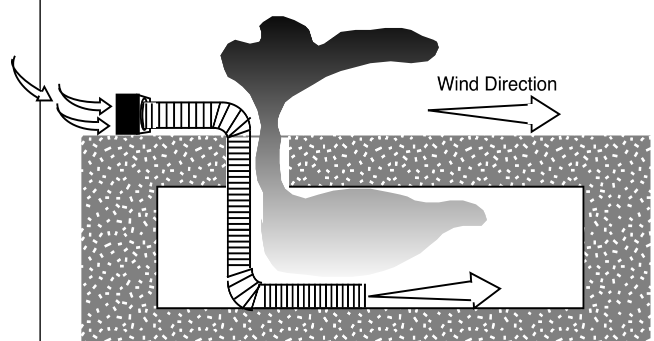
- Never enter an area without monitoring the atmosphere.
- Air must be able to flow into and out of an area for effective ventilation.
- Always pressurize an area by blowing into it with a fan when explosive fumes are present.
- No fan is explosion proof (the fan motor may be) but any rotating device (Blade) that is in close contact with a stationary device (Housing) can cause a spark, either by static discharge or a small metallic item entering the fan guards.
- Do not use a manhole adapter if the manhole is the only method of ingress/egress.
- The vapor density of the gases being ventilated must be known.
- Liquids in confined spaces should be completely removed before ventilation if possible.
- If there is a sparking hazard, the fan or fan duct combination must be grounded.

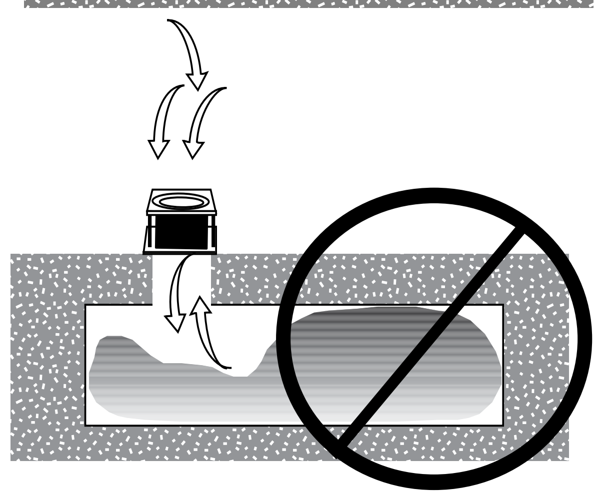
Confined spaces with LIGHTER than air gases or smoke and more than one opening





Confined spaces with LIGHTER than air gases or smoke and only one opening

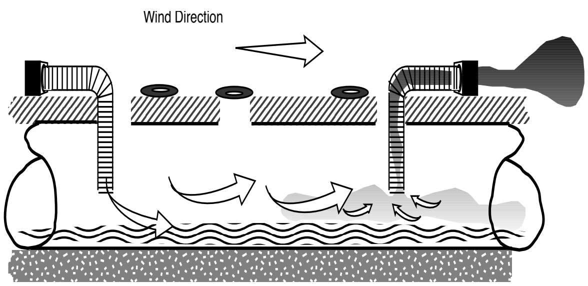




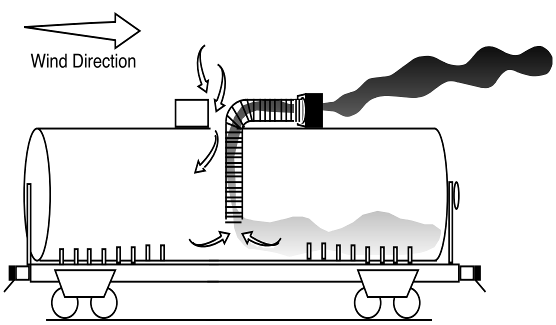
SPECIAL SITUATIONS

CONFINED SPACE EMERGENCIES

In confined spaces containing heavier than air gases, it may be necessary to use more than one fan to ventilate properly. Using one fan with an explosion-proof motor and spiral duct, pull a negative pressure into the area low enough to remove the fumes. Ideally, another more powerful fan should be used to supply clean air to the area. This second fan pressurizes the space so contaminates are not pulled into the space from unknown sources.



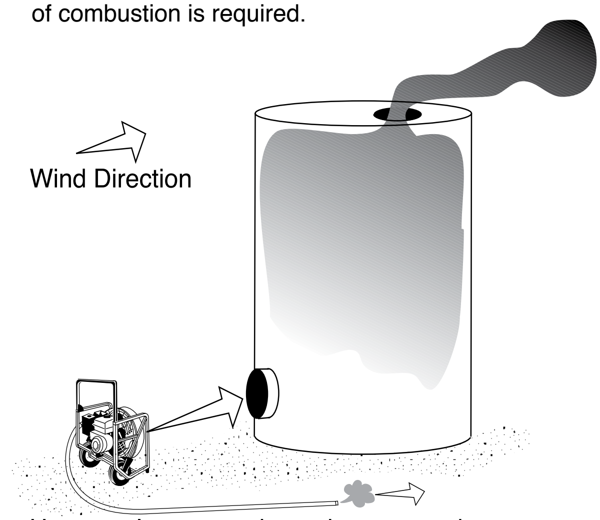
Heavier than air gas with multiple openings using auxiliary fan to supply fresh air and create positive bubble.



Heavier than air gas with only one opening. Liquid should always be completely removed if possible.

CONFINED SPACE VENTILATION PRECAUTIONS

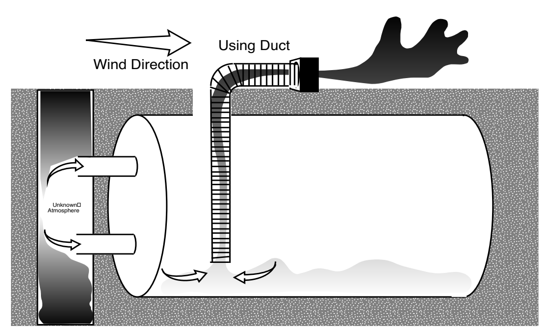
Caution must be used when using gasoline powered fans for confined space ventilation. Never use a gas fan that does not have the capability to remote (6-8 feet) the exhaust from the area of the fan. Regular monitoring of the space for CO and other by-products of combustion is required.



Use metal remote exhaust hose extender

Gas powered fan used for confined space ventilation showing remote exhaust.

When using only negative pressure ventilation for confined spaces, it is possible to pull contamination from unknown sources such as the ground or through small pipes. Continuous monitoring of the atmosphere of the space for a number of possible contaminates is required.



Using only negative pressure may pull contamination into the space.

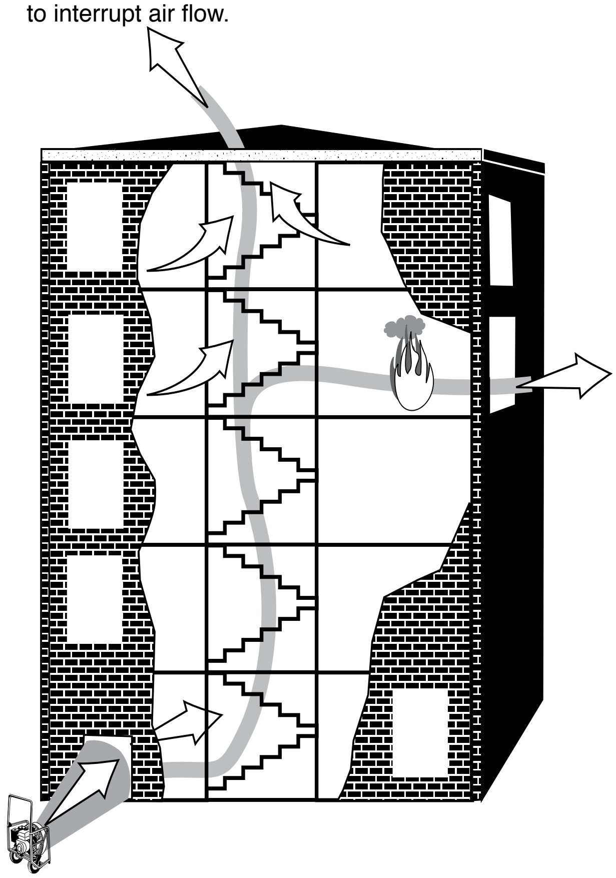
SPECIAL SITUATIONS

HIGH RISE BUILDINGS

High rise buildings create special ventilation problems. However, the ventilation principles are the same. Air still moves from an area of higher pressure to an area of lower pressure. Factors included in high rise ventilation include:

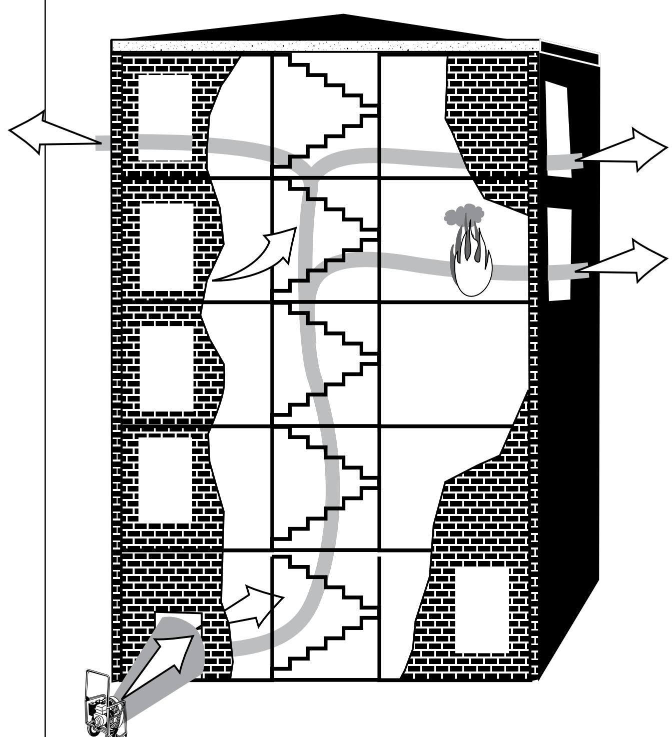
Distance from ground level to roof
Number of potential openings
Stairwells and elevator shafts
Occupants
HVAC systems
Weather
Prefire planning
Manpower

Although the height of a high rise is a factor in ventilation (it effects the time involved), it does not negate the usefulness of ventilation. Air will tend to always rise in high rise buildings. This tendency is multiplied in shafts that extend the entire height of the building. Shafts that start and terminate within the building will not flow as much air as shafts that cover the entire building. Because of the large number of doors and windows associated with high rise buildings, the potential for interruption of air flow and currents created by mechanical ventilation is multiplied accordingly. In some cases, fire fighters have been required to “police” ventilation corridors to insure that doors and windows were not opened or closed to interrupt air flow.



Stairwells are the main arteries of high rise buildings. They are the means of egress for occupants and the means of ingress for fire fighters. When pressurizing stairwells to maintain this egress/ingress route, fire fighters must understand that smoke and fire gases are still going to rise to the top floors and mushroom down. If there is not an opening at the top of the stairwell, it may be possible to force smoke through the fire floor to the outside; smoke in the stairwell above the fire will have to be exhausted through the top floor and out.

Many buildings have pressurized stairwells built into them. Prefire planning should indicate if



stairwells are pressurized and how the HVAC system accomplishes the pressurization. Fire service fans can assist in the pressurization of HVAC pressurized stairwells and/or direct pressurized air.

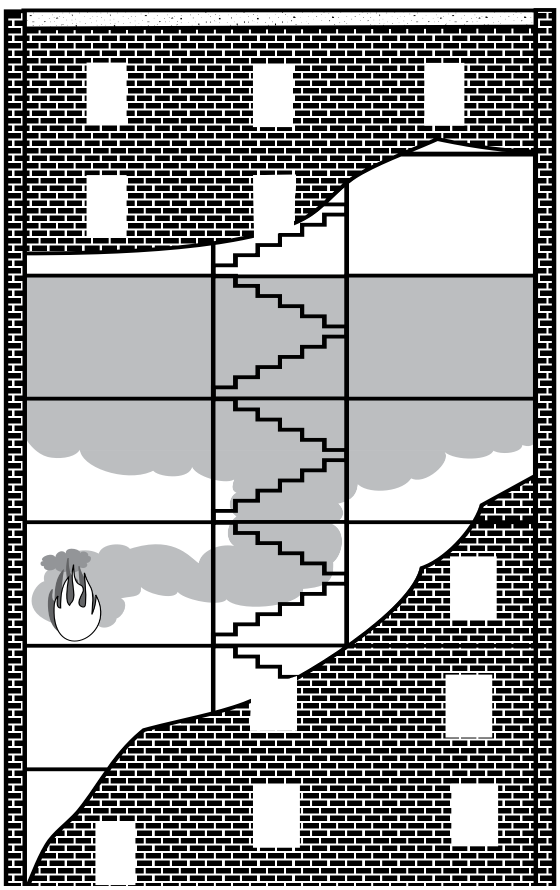
Because high rise buildings usually have many occupants , the need for rescue and ventilation operations is increased accordingly. In addition to being a rescue problem, occupants may inhibit ventilation operations by opening doors and windows that fire service personnel have closed to direct air currents.

HVAC Systems can be of great benefit for fire fighters during the ventilation process. HVAC systems that have not been preplanned however can send smoke and/or fire to areas previously unaffected by the fire. In cases where the fire department is very familiar with the HVAC system, fire service fans can augment the system.

HIGH RISE BUILDINGS

Weather is a factor in high rise buildings, but again it should not stop fire service personnel from performing the ventilation function. Air will rise until it reaches a level where its temperature is the same as the temperature of the surrounding air. Air flow that stops rising at ambient temperature is called the "stack effect." As the air rises, it cools. The longer the distance the air has traveled, the more it cools. The higher the building, the greater the chance that the air will cool to the ambient temperature. Weather is a factor in the ambient temperature. However, tests have shown that in a pressurized situation, air will always tend to rise.

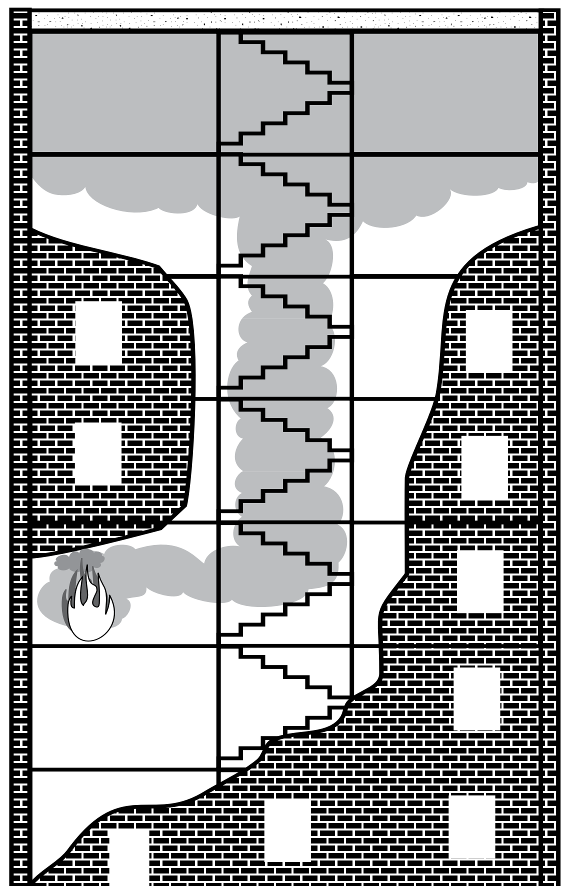
Smoke will rise to the highest available point. If there is no opening to the outside, the smoke will bank or mushroom down to lower levels. If smoke cools to ambient temperature, it will stratify at that level and mushroom down from there.



As already stated, pre-fire planning is essential in the combat of high rise fires. In addition to roof top openings and HVAC systems, pre-fire planning should include the types of openings and windows in the building, the time of day that occupants occupy the building, the location of all shafts and hoist ways, and the availability of the building engineer in case of HVAC operation.

Through pre-fire planning, some departments have identified that fire service fans should be strategically located within the building so that they are available during an emergency. They are usually supplied by the building owner and are under the control of the fire department. While gas fans should not be used within buildings, in some cases they may have to be put into service because of the impracticality of advancing power cords to the area needed.

Manpower is a major concern during high rise fire fighting. Additional manpower must be assigned to the ventilation sector to cover the larger amount of area. Additional manpower may be needed to police ventilation ways so air is not redirected. As with all buildings, smoke removal should always begin on the lowest effected floor and progress toward the top most effected.



Communication with the command post should provide continuous status reports as the ventilation of high rise buildings is a top priority. Smoke is usually a greater danger than fire and in many cases causes greater problems.

SPECIAL SITUATIONS

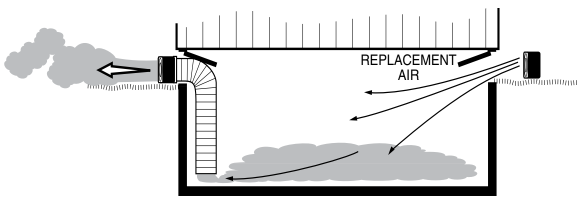
BELOW GRADE CONDITIONS

Because heavier than air gases by definition do not rise, they create special ventilation problems. These gases tend to accumulate in basements, tunnels, pits, and even drains. They can only be evacuated by mechanical means. Many heavier than air gases require Super Vac fans with explosion-proof motors.

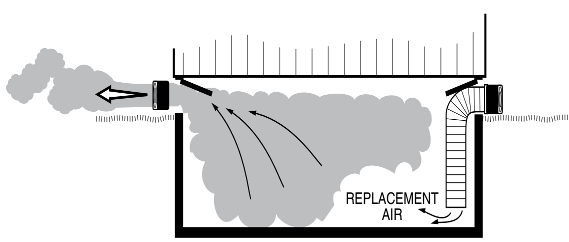
Utilizing fans with flexible ducting, place inlet to negative pressure fan at lowest point possible. Use positive pressure fan to supply replacement air.

Before entering below grade spaces, be sure to ventilate and monitor the atmosphere.

Basements
Electric fans with flexible duct

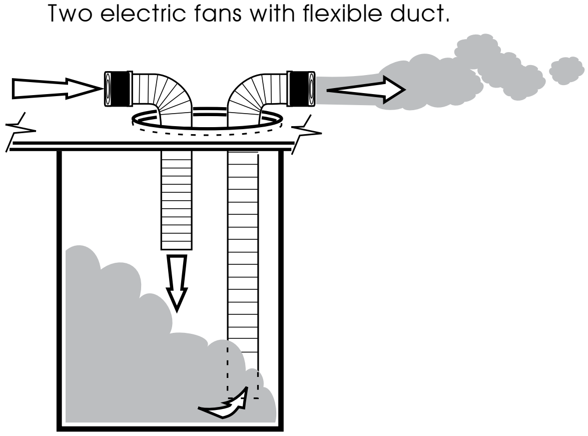


HEAVIER THAN AIR GAS REMOVAL BELOW GRADE



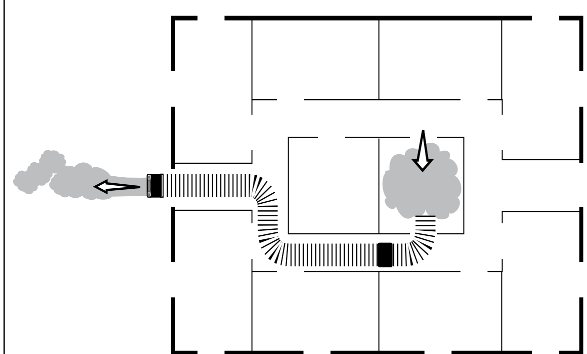
LIGHTER THAN AIR GAS OR SMOKE REMOVAL

Man Holes
Two electric fans with flexible duct.



INTERIOR ROOMS

Office buildings, computer rooms, and temporary walls set-up around a piece of equipment or operation are all examples of interior rooms. When ventilating interior rooms, be sure to allow for replacement air. This can be done by providing an opening twice the size of the fan or by using a fan or fan/duct combination to supply air. The pressure in the interior room should be slightly less than the pressure in adjoining rooms. This will prevent smoke or paint fumes from entering adjoining rooms.



Interior room atmosphere
is exhausted
by two electric fans and duct.

EMERGENCIES INVOLVING TEMPERATURE

Situations involving hot or cold temperatures range from those that have temperatures causing discomfort, to extreme temperatures that can cause death. Super Vac electric fans can move warm air to a cold area or they can move cool air to a hot area during temperature emergencies. Temperature emergencies involve situations such as persons trapped during inclement weather or industrial accidents near or in hot machinery. Fans may also be used in the rehabilitation area to warm or cool fire fighters.

REHAB

Fans may also be used in the rehabilitation area to cool fire fighters. Misting attachments can be used to provide additional cooling on scene or during training evaluations. Also,use shade trees, tarps and awnings to prevent sun exposure in the rehab area. And always set up the rehab in an area that is free of smoke and vehicle exhaust.

AIR MOVEMENT FOR COOLING

Introducing air and water to modern fire fighting techniques was first described in Scientific American Magazine as early as 1877. Super Vac introduced the air and water technique in their 1961 ventilation training manual.

Water is well known as a cooling or extinguishing agent, but air is more plentiful, more readily available and may be extremely effective where properly used. Normally, air with 30% or better relative humidity provides effective insulation against heat and fire. Air in an immediate fire area has been dried out, thus the fire burns vigorously unless heated air and smoke are removed or displaced. As temperature increases, the amount of moisture (humidity) near the fire is quickly absorbed. At higher temperatures the moisture absorption is much greater.

If we introduce cool moist air (all natural air has some moisture), not only is the air itself a coolant, but the natural moisture inhibits combustion. As temperature is reduced, much of the moisture in the heated air is released and contributes further to suppress combustion. Often we see this released moisture in the form of condensation after a fire is extinguished. A quick and efficient way to introduce moisture to dry air and gases in a fire is by using spray or fog nozzles. Water spray cools excessive heat and purges the fire area as water particles are expanded into steam and replace moisture lost from heat of the fire.

Moisture in air, whether natural or provided by hose streams, provides a barrier against radiated heat. Observe the protection afforded by a fog nozzle. It transfers heat from the fire area when converted into steam and interferes with the oxidation process.

Even after flame production ceases there may be considerable latent heat, but cool moist air serves to reduce this heat until fuel distillation ceases completely.

While small fog streams stop flame production, they have inadequate cooling capacity to remove the high latent heat remaining in the fuel. Sometimes twice as much water is needed in this "overhauling" stage than in "flame suppression" stage. Tests measuring quantities of water needed to control fires with fog nozzles point up to this fact.

Two difficulties in controlling fire and excessive water loss are (a) an excessive dependence upon water for cooling, and (b) the difficulty of getting nozzles into effective position in a highly heated area. Broken fog streams have limited range. Exclusive dependence upon water cooling ignores the efficient, practical and rapid means of getting rid of excessive heat by mechanical ventilation. Mechanical ventilation properly applied quickly removes heat to the outside atmosphere. Heat is dissipated at the ratio of the square of the distance, so that by doubling the distance of exposed fuel, we reduce tremendously the dangerous temperature:

To summarize, several basic means of heat reduction are readily available for fire suppression:

1. Cooling water sprayed to absorb and transfer excessive heat.
2. Mechanical ventilation to move heat outside where it is quickly dissipated.
3. Mechanical ventilation to move in cool moist air to replace heated gases and reduce fuel temperature.
4. Cool moist air to insulate fuel that might be heated by the fire to an ignition temperature.
5. Cool moist air to inhibit flame production.
6. Cool moist air to reduce temperature in the fire area and free latent moisture trapped by excessive heat (remember that relative humidity in the immediate burning area may approach zero).

THE USE OF SUPER VAC WITH FOG NOZZLES

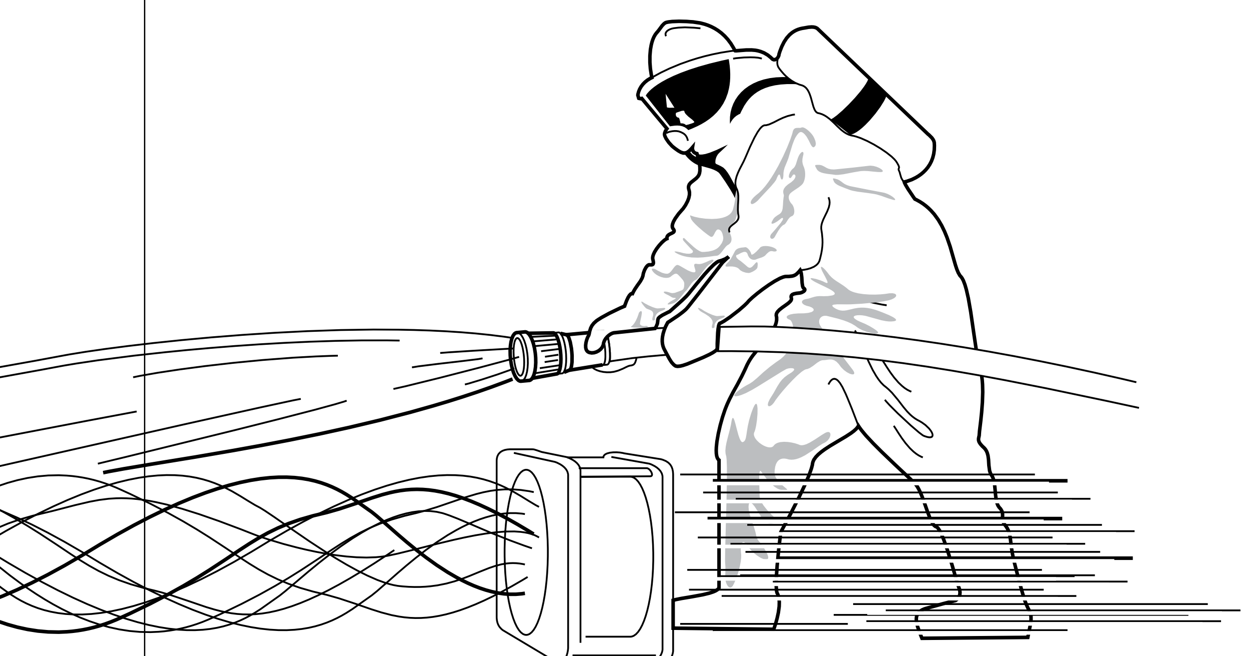
-

Fire fighters combating a blaze with fog equipment should hold the fog nozzle as high as possible and aim it directly at the source of the blaze. However, in many fire situations the water particles in fog streams do not have sufficient mass or weight to provide effective range. Also, obstructions such as shelves, partitions, etc. may prevent the fog stream from reaching the fire. These problems can be solved by using a Super Vac with the fog equipment.

Super Vacs permit the fire fighter to combine the best advantages of both water and air as extinguishing agents. By combining fog equipment with the powerful spiral air screw produced by the smoke ejector, the natural tendency of water to coalesce is averted. This combination of air pressure and aeration tends to keep the water droplets separate, and extends the range and effectiveness of spray streams. Water discharged in this manner can be directed far beyond the reach of a normal nozzle and in a form that can provide more effective extinguishing and purging than by water spray alone.

THREE REQUIREMENTS FOR SUCCESSFUL SUPER VAC/FOG NOZZLE FIRE FIGHTING:

1. Place the blower on the floor so the spiral blast of air is directed toward the fire.
2. Hold the fog nozzle so that it is parallel with the air stream and is just above the edge of the fan, and see that the fog stream contacts the air stream 3 to 4 feet from the exhaust end of smoke ejector.
3. Diligent practice and drilling must be observed to acquire the necessary skill to combat effectively the unique problems present in each activation of fire.



PORTABLE GENERATORS

Frequently fire departments must depend on emergency power generation to operate lights, electric drills, saws, and electric smoke ejectors. The following guidelines should be followed to achieve the highest performance when operating electric smoke ejectors on emergency electrical power supplies.

1. Super Vac smoke ejectors with AC motors are either permanent split phase or capacitor start motors and are designed to operate at a continuous constant RPM. It is important the voltage and cycles remain constant or within plus or minus 3% of specifications. Continued operation outside of these limits causes over-heating and probable motor failure.

2. Selection of the correct generator is important. Not only must it provide adequate amperage to operate all of the smoke ejectors required at one time, but it must supply sufficient amperage to operate during the start up phase as the amperage draw is much higher during start up than during the running phase.

3. When running on a generator, smoke ejectors should be plugged in one at a time. When a fan is up to full speed, another fan may be plugged in.

4. Generators must operate at a constant voltage and cycle and provide the rated amperage.

5. Apparatus powered generators should be monitored to provide the proper RPM's to produce the required voltage and cycles.

6. Use heavy gauge extension cords. Small gauge extension cords reduce voltage to fans.

7. Keep distance between fans and generators to a minimum.

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EXTENSION CORDS

Extension cords work in much the same way as fire hoses. More pressure is required for 100 G.P.M. at the end of a 400 foot 1 1/2" hose than for 100 G.P.M. at the end of a 50 foot 1 1/2" hose. The longer the extension cord, the less voltage there is at the workable end. This problem can be overcome by using extension cords with heavier wires which conduct more electricity and result in a lower voltage drop. The voltage drop caused by undersized extension cords usually cuts the performance of the smoke ejector to below the motor name plate specifications.

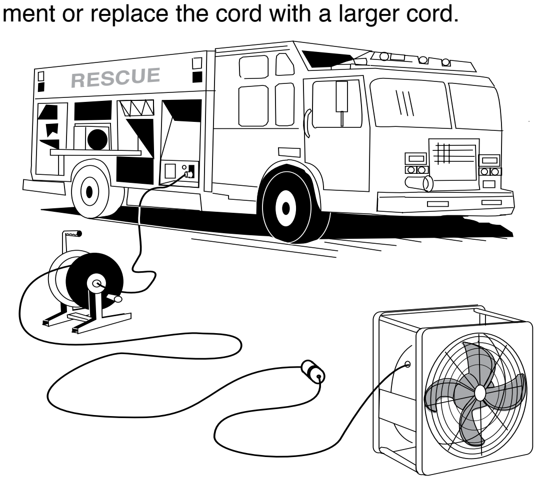
FANS HP	FANS QTY	STARTING WATTAGE REQUIRED	MAXIMUM CABLE EXTENSION LENGTHS (Meters 25, 50, 75, 100; Feet 50, 100, 150, 200, 250, 300, 350)
1/3*	1	2000	14 GA / 12 GA / 10 GA
1/2*	1	2000	14 GA / 12 GA / 10 GA
	2	4000	12 GA / 10 GA / 8 GA
	3	6000	10 GA / 8 GA / 6 GA
1 *	1	4000	12 GA / 10 GA / 8 GA
	2	8000	10 GA / 8 GA / 6 GA
1½*	1	6000	10 GA / 8 GA / 6 GA
	2	12000	8 GA / 6 GA / 4 GA

* FOR 220 VOLT - FANS, DOUBLE THE MAXIUM LENGTH CABLE EXTENSIONS SHOWN ABOVE.

Recommended extension cords:
WARNING: Never exceed cable extension lengths. Always use required wire guage. Never use reeled or coiled cable. Power supply must handle wattage requirements.

CORD REELS

Care must be taken when using cord reels to power any portable electric equipment. If the cord is not completely unrolled,the unrolled part of the cord produces a counter EMF (electromotive force). The counter EMF in effect reduces the current carrying ability of the cord. If the cord size and length are near the limits recommended above, either pull the entire length of cord off the reel when using portable equipment or replace the cord with a larger cord.



COMMUNITY SERVICES

1. As a public service, use Super Vac fans to remove obnoxious odors, fumes, gases, refrigerants and fumigants in homes, restaurants, offices, businesses, storage areas, etc.
2. Use the fans to cool by increasing circulation in these situations:

   a. Overheated rooms or buildings not involved in fire, especially those occupied for public assembly purposes.

   b. To improve working conditions when firemen are cleaning up.

   c. To cool electric motors when they overheat and normal ventilation around the motor is inadequate.

   d. On generators, transformers, and condensers when needed or requested.

   e. On internal combustion motors to remove exhaust gases and to cool engines to prevent overheating.

   f. On any machinery which becomes abnormally warm and additional circulation will be advantageous.

   g. In refrigerated rooms to distribute low colder air evenly over all products for even chilling or freezing especially during periods of hot weather or when the plant is overloaded.
3. Aid in evaporation:

   a. In drying newly finished walls and floors when they won't dry properly.

   b. To distribute deodorizing agents to absorb odors.
4. Aid law enforcement agencies by removing tear gas, "stink bombs", and other gases rapidly and effectively.
5. Supply fresh air to mine shafts, holds of ships, tunnels, caves, and below grade places.
6. Permanent installations:

   a. Exhaust systems for restaurants, manufacturing plants, industrial plants, and large storage buildings.

   b. Dust collecting systems for cement in concrete mixing plants.

   c. Exhaust systems in parking garages.

   d. Cooling and circulation systems in any building to increase comfort and efficiency of employees.

   e. Roof and attic ventilating units for homes to cool them for more comfortable living.

NEUTRALIZING AND DEODORIZING

An extensive study of smoke odors shows that quick and complete removal of smoke eliminates most smoke odors. The degree of effectiveness is determined by the speed and thoroughness of smoke removal upon arrival of the fire department. When damage is extensive or smoke has cooled and condensed upon the building and its contents, there are large smoke damage problems. By making smoke removal a part of basic fire fighting, fire departments can render an invaluable service.

To be practical for fire departments, deodorants or neutralizers must possess the following qualities:

1. Be non-allergenic to the occupants.
2. Be safe (non-toxic) for fire fighters and occupants during application and after fire fighters have left.
3. Be relatively inexpensive and readily available.
4. Be a product with which the occupants are familiar and can understand so they can reapply it after the fire fighters have gone.
5. Be fast and easy to apply so the job is completed in a relatively short time.
6. Be safe, reliable, and leave no objectionable residual odors. Unsatisfactory results can lead to liability suits against the fire department (especially since deodorizing is not considered an emergency in many cases).

Average household deodorants work very well. They meet most of the above standards and are safe for use by fire fighters. When conditions require a stronger deodorant, the job should be done by professional deodorizers. They have the necessary chemicals, applicators, time, and insurance for complete service.

The following is an outline of the process used by two national deodorizing firms:

1. Remove smoke as quickly and thoroughly as possible.
2. Remove heavily damaged material such as charred furniture, wood, and drapes.
3. Apply deodorant freely on and around all over-stuffed furniture, closets containing clothes, drapes, curtains, and on charred wood, or as directed on the container of the deodorant.
4. Use Super Vac fans to circulate, and distribute the deodorant throughout the area with all openings closed.
5. After deodorants have taken maximum effect, place Super Vacs in door and window openings to expel deodorant agent from area. Open other doors and windows to obtain a cross-draft.
6. Repeat procedure as necessary.

USE INSTRUCTIONS

SAFETY PRECAUTIONS

The following list of safety items must be read thoroughly by anyone using ventilation equipment.

1. This manual contains an overview of safety standards. Fire fighters, chiefs, and confined space entry professionals must understand these precautions and ventilation fundamentals before using this equipment.
2. Never enter an area without monitoring the atmosphere and/or wearing self contained breathing apparatus.
3. No fan is explosion proof (the fan motor may be) but any rotating device (Blade) that is in close contact with a stationary device (Housing) can cause a spark, either by static discharge or a small metallic item entering the fan guards.
4. All gasoline powered fans produce CO and other emissions. When using gasoline powered fans, this must be taken into account.
5. Never use a fan with a damaged electrical cord or plug.
6. In combustible atmospheres place the smoke ejector in a position with switch in the OFF position. Plug the unit into an outlet in a safe environment as far away as possible from the fan. Turn the switch ON. When the switch is turned on, the starting arc is contained inside the motor. Never operate a unit in a combustible atmosphere if the motor has been tampered with.
7. Fans must never be operated or adjusted while the guards are removed from the unit.
8. Always unplug the fan before cleaning or removing the guards. Units are provided with an automatic overload that allows the motor to restart after it has cooled down.
9. The guard with the smaller spacing must be attached to the blade side of the fan to prevent accidental contact between fingers and the blade.
10. Warning labels are key equipment parts. Do not remove, change or cover these labels. If the labels are not readable, contact Super Vacuum Manufacturing Co. for new ones.
11. An electric fan must be properly grounded.
12. Prevent heavier-than-air gases from entering other low areas where damage or injury could occur. Drive gases forcefully upward into the atmosphere where they can be diluted.
13. Prevent paper, plastic, and cloth from covering the intake of a fan.
14. Do not operate fans too long in severe cold weather, especially if the fire has effected the heating system. Prolonged operation can cause water pipes to freeze.
15. Pick up the fan ONLY by its handles or hangers with caution and good lifting practices.
16. When a blowing fan is on the floor, supervise traffic in the area. The suction of the fan can draw loose clothing into the unit. Keep Children Away From Any Operating Fan.

MAINTENANCE

As with any fine piece of equipment, a fan that is properly maintained will perform better and last longer.

1. Keep the fan blade clean. If soot and tar are not removed, accumulations will cause unbalanced blades, which can create excessive vibration and motor bearing failure. Following use, remove fan guards and clean blade, motor, and inside of housing with detergent and water. If necessary use solvents. Do NOT use abrasives, sharp tools, knives, screwdrivers, etc. These tools may score the blade, thereby causing imbalance or weakening. Super Vac blades are made of cast aluminum so do not use caustics that attack aluminum.
2. There are fan guards on the intake and discharge sides of the smoke ejector. They are NOT interchangeable. When replacing guards after cleaning, position them with the rings to the outside and with the row of spot welds holding the rings on the bottom. A missing hold down bolt can allow a corner of the guard to vibrate, permitting a finger to get behind the guard and into the fan. Fan guards are spaced for maximum safety and should always be on the ejector.
3. Always keep the rubber feet on the ejector. If they are removed, the thrust developed by the blade causes the unit to move along the floor.
4. Proper maintenance of gas powered fans is very important and needs to be done on a routine basis. Oil level must be checked prior to operation. Be sure the octane level of the gasoline is acceptable. On two cycle engines, also be sure the oil and gas mixture is correct. Spark plugs should be examined periodically and carburetor jets must be adjusted for maximum RPM. Cold weather may effect engine operation.

Super Vac "The Ventilation Specialists" manufactures a wide variety of portable ventilators powered by electricity, gasoline, battery, air and water used for emergency smoke and fume ventilation.
For information on the entire line of Super Vac ventilation equipment, refer to your Super Vac fire equipment catalog,contact your dealer or visit our website at: www.supervac.com

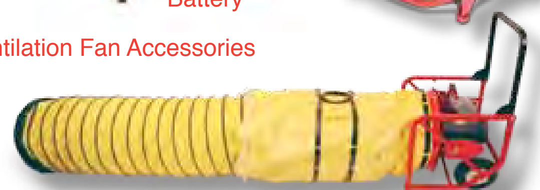
Ventilation Fans Sizes: 16",18",20",24"and 30"

Battery

Gas

Electric

Ventilation Fan Accessories



Water

Confined Space

Smoke Machine

70,000 to 750,00
CFM Blowers

Rescue Saws

Smoke Ejectors

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