TACTICAL VENTILATION

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'Ventilation when performed correctly saves lives, eases firefighting conditions and reduces damage. '

1. Introduction

The first consideration in any incident is the safety of the occupants and firefighters. One of the best ways of doing this is by restoring a breathable atmosphere. Early and effective ventilation can do this.

Ventilation can be defined as:

" The planned and systematic removal of heat and smoke from the structure on fire and their replacement with a supply of fresher air in order to facilitate other firefighting priorities."

Rescue is obviously a priority, but the presence of hazardous materials, processes or conditions will have an effect on the O.I.C's decision to commit crews. A critical decision that must be made in developing a plan of attack is whether or not ventilation is needed.

O.I.C's points to consider:

- ***"Is ventilation necessary?"***

- ***" How can this be done?"***

  Defensive; away from the fire to improve access and escape routes

  Offensive; ventilating close to the fire to have a direct effect on the fire itself by making conditions safer for the firefighter.

The traditional approach to ventilation is to locate and extinguish the fire and then to ventilate afterwards to clear residual smoke and heat from the structure.

We need to consider ventilation at an earlier stage, this will allow search and rescue to be carried out more thoroughly, it will also ease the working environment for the firefighting personnel.

Where to ventilate will be decided by:

- Location of the fire
- Possible location of occupants
- Condition within the building (backdraught condition may be present)
- Structure of building
- Extent of fire

FLASHOVER

In a room on fire the hot smoke layer descends and the remaining contents become heated to the stage where they give off flammable gases. Once flammable gases are being given off by the majority of the room contents, the transition from a localised fire to total involvement can take a matter of seconds - a **FLASHOVER.**

Signs and Symptoms:

The primary requirement for a flashover to occur is that there will be significant thermal radiation from above felt as a rapid increase in temperature. Tongues of flame will be running through the gas layer and combustible materials may be giving off visible smoke and flammable gases.

- **Actions by firefighters:**
  As the main reason for a flashover is radiation from the hot gases and flames above them, the logical solution is to cool this area. It will be most effective to attack the hot gases with pulses of spray, observing their effect, judging when sufficient water has been applied. Once this danger has been eliminated it is important to ventilate as soon as possible.

BACKDRAUGHT

In general, hot gases in a compartment fire draw air into the room. If the air supply to the room is restricted the effect will be a progressive lowering of the concentration of oxygen, possibly combined with an increase in temperature. The flames will start to die down but flammable gases will still be produced and the room will still be very hot. This situation requires only a new supply of oxygen, caused for example, by opening a door, for it to form an explosive mixture with potentially lethal consequences - a **BACKDRAUGHT.**

Signs and Symptoms*:*

The first clue is the history of the fire, has it been burning for some time and generated lots of smoke without major areas of flame being visible from outside? Smoke may be pulsing out of gaps with windows being blackened. If a decision is taken to open the door, there may be an inrush of air resulting in small flames appearing where the fresh air meets the gases from the room.

- **Actions by firefighters:**
  Once a door has been opened to a compartment with an oxygen starved fire, there is little that can be done to prevent a backdraught happening. Firefighters should be ready to close the door quickly, if a backdraught appears likely. This may not prevent the backdraught but may direct its force away from the firefighters. If a backdraught situation is suspected in a compartment, the safest method is to ventilate the flammable gases from the compartment via external openings. There is a possibility that a backdraught may occur during ventilation so the following precautions should be taken:

- Branches must be charged and in position before any ventilation is carried out;

- Firefighters must get down low, keeping well clear of the likely flame path through the vent opening;

- It must be remembered that a backdraught could be delayed several minutes and that it might have sufficient energy to break other windows in the compartment.

- Smoke from outer corridors should be removed prior to dealing with backdraught condition

Ventilation can be achieved by:

Automatic ventilation - generally operates at an early stage of the fire and may or may not be controlled by the Fire Service.

Tactical ventilation - used to assist fire fighting operations by the following methods:

- **Top ventilation**

- **Side ventilation**

- **Forced ventilation** (negative or positive)

2.**Ventilation - Top**

Top ventilation makes maximum use of the buoyancy of the hot smoke and gases. Top ventilation is most effective as an offensive ventilation tactic. In defensive ventilation, its efficiency depends on its proximity to the fire. Top ventilation is particularly useful for fires in attics, high rise and buildings with few openings.

- It can minimise the risk of backdraught.

3.**Ventilation - Side**

Side ventilation is the most frequently used form of ventilation and also the easiest. Firefighters entering the building for search and rescue or fire attack start a form of side ventilation by opening doors and windows to make entry.

Smoke movement is caused by two factors:

- The wind;
- The temperature of the gases.

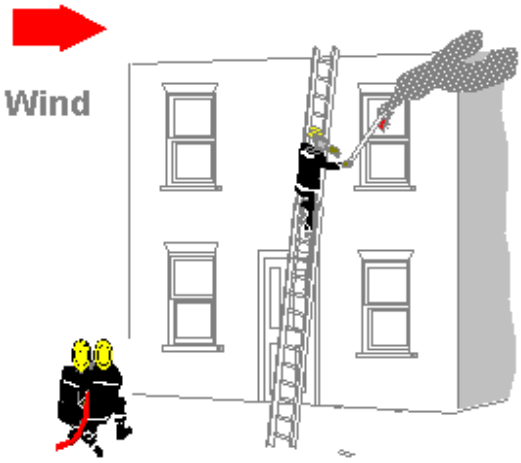

Fig 2:Making an outlet vent (side)

Close to the fire, the buoyancy of the gases will assist, away from the fire the affects of the wind will be dominant.

For **defensive** ventilation the overall objective is to let fresh air into as much of the building as possible. Vent locations need to be chosen to avoid directing fresh air towards the site of the fire . **The decision as to where to vent may be greatly assisted by the use of the *Thermal Imaging Camera.***

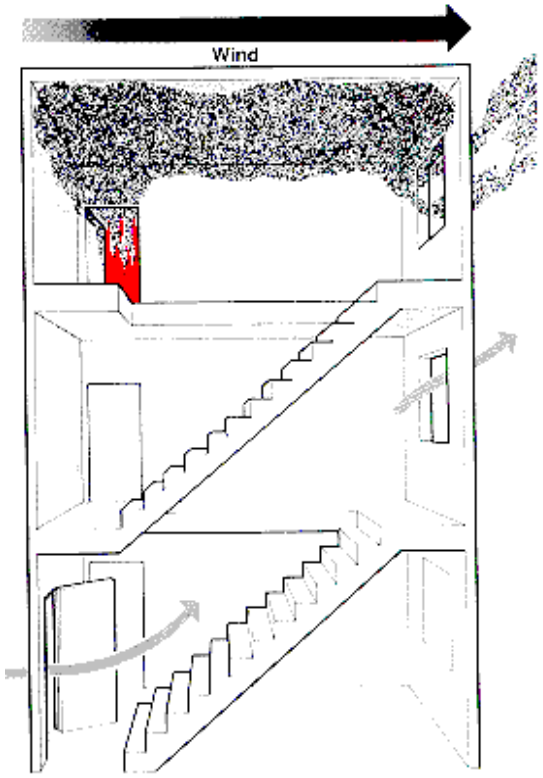

Fig 3:Improving Firefighter's access using defensive ventilation

For **offensive** ventilation the outlet vent should be as close to the fire as practicable. It is desirable to use the firefighters route to the fire as the inlet vent, as this reduces smoke and heat along their route making their job safer and more tolerable.

Before the outlet vent is opened in an offensive operation, the vent must be covered with a charged branch. The branch can be used to cool the smoke and gases as they come out but **UNDER NO CIRCUMSTANCES *should the water be directed in through the vent*** when ventilation is taking place. This will interfere with the ventilation process and could place firefighters inside the building at risk.

SAFETY POINTS

Hot smoke will rise and hug the building. Firefighters opening a vent should never position themselves above the vent

Letting fresh air into a compartment may result in a backdraught, firefighters should not be directly in front of the window, but should be to the upwind side using a ceiling hook or axe.

Glass from windows, particularly from high rise may travel a long way outwards.

4. Forced Ventilation

Forced ventilation may take the form of:

- Water - Fog assisted
- Negative pressure
- Positive pressure

Water - Fog assisted

A fog stream directed out through a window or door will draw large quantities of heat and smoke in the direction in which the stream is pointing. Compared to smoke extraction fans fog streams have been found to remove up to four times the amount of smoke dependant upon the angle of the fog pattern and the location of the nozzle in relation to the opening.

To achieve best results the fog stream should:

- Be located approx. 0.5 metre inside the opening
- Have a 60^0 angle fog pattern
- Cover 85-90% of the opening

A water spray directed ***across*** an opening will also assist in entraining smoke and heat from a building by means of the Venturi principle. **NO WATER SHOULD BE DIRECTED INTO THE OPENING** if it is being used for ventilation purposes.

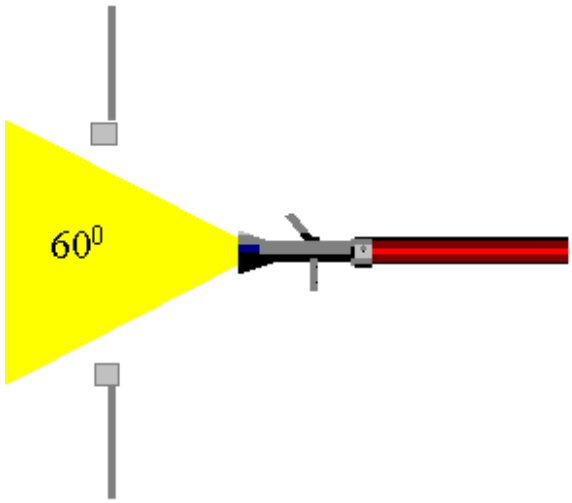

Fig 4: Ventilation using a branch

Negative Pressure Ventilation

This method involves the siting of mechanical fans and trunking within the fire area or at suitable openings to draw smoke from the building.

This method of ventilation is considered to be ineffective because:

- In a fire situation it is almost impossible to form a negative pressure on a structure
- The larger the space to be ventilated the less effective the method
- If the space is sealed air movement is limited
- The equipment requires cleaning after use

Positive Pressure Ventilation

PPV is a technique where fans are placed outside the structure to be ventilated. These fans force air into the structure to create a slight increase in the atmospheric pressure inside the structure that is equal throughout.

When an exhaust opening is created it is possible to use this pressure differential to drive heat, gases and other products of combustion from parts of the structure out of the exhaust openings to open air.

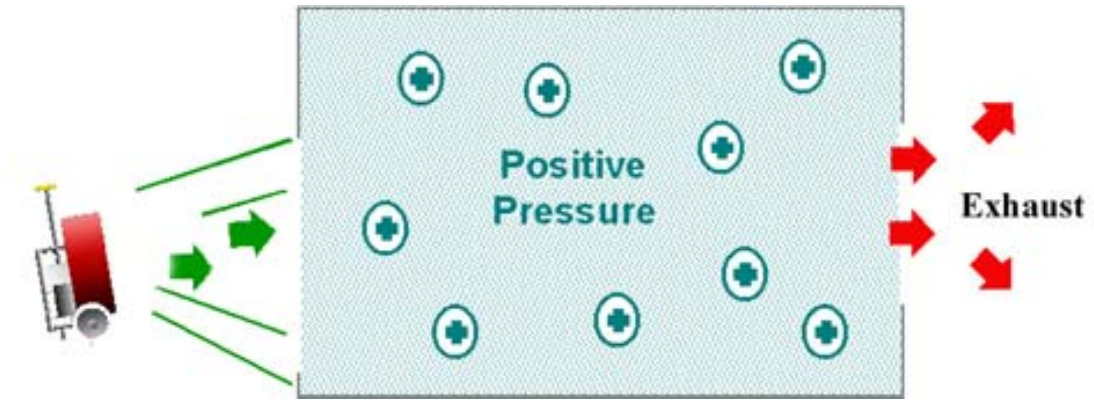

Fig 5: Principles of positive pressure

Implementation of PPV requires training and should not automatically be used, it must be stressed there will be situations when the use of PPV will be inappropriate, counter productive or cannot be utilised. ***The emphasis on safety must prevail at all times when the decision to use PPV is made.***

In order to avoid the creation of dangerous conditions **PPV may only be used in the following circumstances:**

1. When the fire is totally extinguished;

2. When the fire is controlled and ventilated;

3. When entry into the building is delayed by large volumes of smoke;

4. To pressurise the stairway of a multi-storey building in order to keep forward control point free of smoke and maintain a means of escape;

5. During salvage/turning over operations to provide better working conditions.

Advantages of PPV

1. Most of the work to set up PPV takes place outside the building;

2. It provides a flow of cool, fresher air into the building at a point where firefighters make their entry;

3. It achieves all the benefits of natural ventilation faster, and to a certain extent, independently of weather conditions;

4. It is a more controllable form of ventilation;

5. Provides safer, more comfortable working conditions for crews during salvage/turning over.

Concerns regarding PPV

1. It requires considerable training and experience to be used correctly;

2. If used incorrectly, may spread the fire and smoke to previously unaffected parts of the building.

5. Command and Control Procedures - PPV

The decision to initiate PPV will only be made by the OIC. The unit may be deployed in readiness but should only be started on the instructions of the OIC who will consider:

- Information from BA crews that the fire is extinguished or under control and vented. *(It must be taken into account that whenever PPV is used, there will be the possibility of concealed seats of fire being spread by forced air, OIC's **must** check for fire or smoke spread much earlier.)*

- The best location for an exhaust opening to be created.
  *(The OIC should consider the use of the **Thermal Image camera** to scan the exterior of the structure to give an indication where the initial exhaust openings should be made. This information to be passed onto relevant BA crew.)*

- The location of the fire.

- Appointing an officer (Minimum rank of Lff) to co-ordinate ventilation operations.
  (They will liaise directly with BA crews in the building to control opening and closing of windows and doors. The need to co-ordinate the activities between fire attack and ventilation crews is paramount.)

- Informing control that PPV is in use.

- Informing all fireground personnel that PPV is in operation and the location of exhaust vents.

- Once PPV has commenced, entry to the structure will be made by the inlet opening only.

- The location of the Entry Control Board will need to be away from the petrol driven fan due to it's operating noise.

- One Ff with orange surcoat and radio (on savox channel) to remain in visible contact with the fan at all times.

- All fireground personnel to be made aware of any changes regarding inlet or exhaust locations.

- All crews to be debriefed whether PPV worked effectively.

Ventilator Placement

The number and placement of ventilators is crucial to the successful application of PPV techniques.

Single Ventilator

A single unit must be placed so the cone of pressurised air just covers the entrance opening, too close and it will not fully cover the opening, too far away and the air in-flow will be drastically reduced.. A useful starting position is generally 2 Metres, for a regular single leaf door.

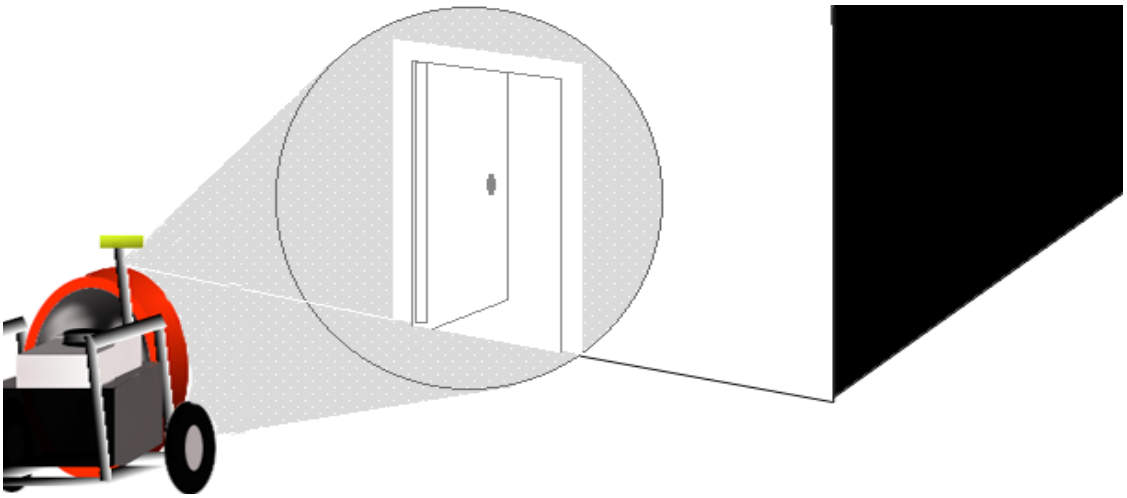

Fig 6: Siting the fan

Multiple Ventilators

To increase airflow into a structure more than one ventilator can be used. The ideal position is to place two units in line, with the largest 1 Metre from the opening, and the second 1 Metre behind the first.

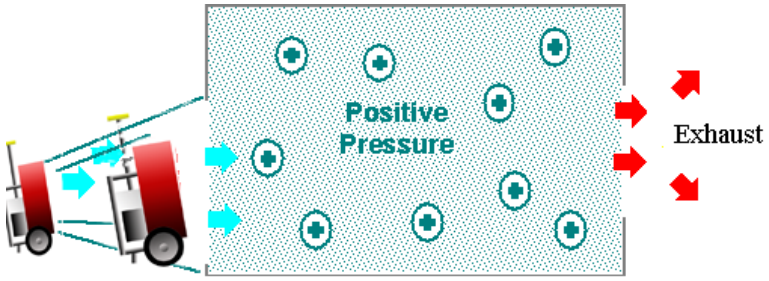

Fig 7: Using two fans inline

Where entrance openings are larger, the units can be arranged in parallel, although it is more effective to reduce the size of the opening, if possible.

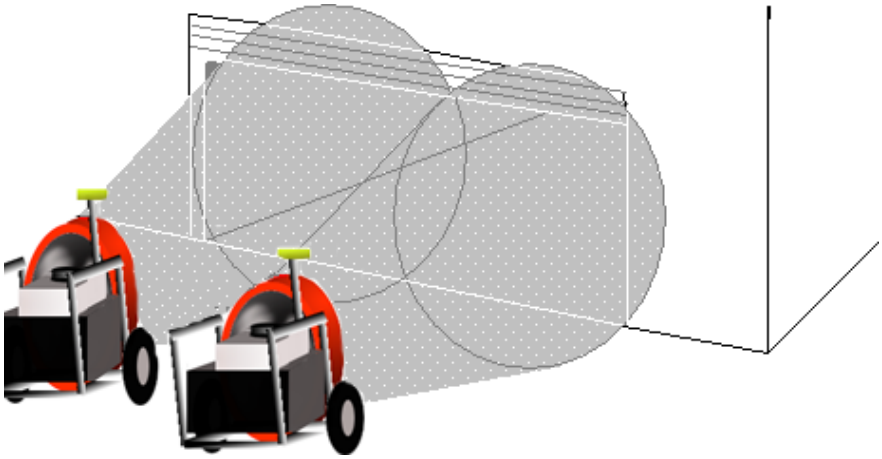

Fig 8: Using two fans on a large opening

Discharge Openings

Ideally the opening should be on the side furthest away from the intake within the affected compartment, but will clearly be dependant on the availability of natural openings, plus the prevailing wind direction and force. The latter can have an adverse influence, so as in any ventilation operation, maximum efficiency will be achieved by utilising the prevailing wind to advantage.
The size of the opening should be slightly less than the size of the intake as this facilitates the build up of positive pressure, the size may be increased if more than one fan is in use.

Sequential Ventilation

Where multiple rooms or floors require ventilation the process of sequential ventilation will achieve the best results. This entails providing maximum volume of pressurised air to vent each area in turn.

The doors to all rooms should be closed initially, then starting with the room nearest the ventilator, open the door and window to maximise the positive pressure available. Once cleared, this room can be isolated and others tackled sequentially in the same manner. The same principle is used for multiple floors starting at the lowest affected area.

Pressurised Staircases

PPV techniques can be used to assist in maintaining the stairwell and bridgehead floor clear of smoke, at high rise incidents. Whilst each situation will need to be tackled differently, depending on the layout and availability of openings, the ideal would be to vent at roof level and deploy crews to ensure openings to the floors above the fire were closed.

6. BASIC FIREFIGHTING TACTICS

The four main tasks involved in using P.P.V. are :

3. Assess the situation

4. Siting of fan

5. Creating exhaust

6. Air flow management

Assessing the situation, key considerations

- Are persons reported? Is their location known?
- What phase is the fire in? Is there a danger of backdraught?
- Is the fire contained or is it spreading? Should ventilation take place away from the fire (defensively to limit fire spread) or near to the fire (offensively to aid fire attack)

Siting of fan

The fan should be deployed in readiness for use at the O.I.C's discretion, the inlet opening should be towards the unburned side of the building to avoid pushing heat or smoke through uninvolved areas. If possible the fan should also be on the windward side, it is appreciated that this will not always be possible.

The cone of air produced by the fan should just cover (seal) the entrance, the

effectiveness of the seal can be checked by feeling for air flow around the opening with the back of the hand. If the fan is too close, the opening will not be sealed and the resulting turbulence may force smoke back out of the opening.

All crews should enter the building via the inlet opening to achieve maximum benefits.

Creating the exhaust vent

For optimum effectiveness, the Thermal Imaging Camera may be used to assist in deciding the location of the exhaust vent, this information should passed on to B.A. crews.

Control of the exhaust vent size and location is critical to the success of PPV and indiscriminate ventilation, e.g. random breaking of windows, should be avoided.
Water should never be directed into an exhaust vent as this will seriously compromise PPV operations.

Airflow management

It is important to control the flow of air between the inlet opening and the exhaust vent. This may require closing windows and doors that are already open, all personnel should be kept aware of the position of the fan and the exhaust vent so as not to, disrupt the flow of air. The potentially negative consequences of randomly opening doors and windows in a building should be stressed during operations, hence the need to co-ordinate the activities between fire attack and ventilation crews.