Introducing positive pressure ventilation: Three different approaches

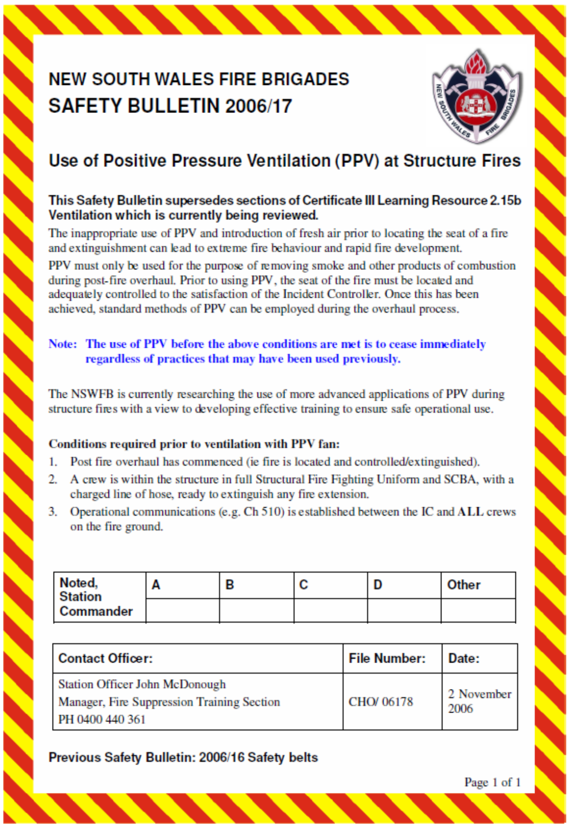
Ventilation is subject that has many forms and meanings. When mechanical ventilation was first introduced in the US, it was met with a lot of resistance. For firefighters it's an unnatural idea to add air to a fire. Because of this it is clear that ventilation comes with certain risks. The common denominator in many papers and articles on ventilation is the recurring warning for those risks that are inherently present when ventilation is used during firefighting. Especially venting before the fire has been tackled, holds many dangers.

November 2006 the New South Wales Fire Brigades (NSWFB) issued a safety bulletin[1] to all firefighters (about 6,500) in their organization. The bulletin prohibited the use of PPV for any other ends than overhaul. The reasoning for this was that use of PPV during firefighting could lead to both extreme fire behavior and rapid fire progress. Three demands were to be met in order to allow the use of PPV during overhaul:

1. The fire has to be put out.

2. Inside there has to be a fire team in full bunker gear (including BA) with a charged hose line at the ready to immediately tackle any possible rekindling of the fire.

3. Communication is established between the IC and all crews on the fire ground.



NEW SOUTH WALES FIRE BRIGADES
SAFETY BULLETIN 2006/17

Use of Positive Pressure Ventilation (PPV) at Structure Fires

This Safety Bulletin supersedes sections of Certificate III Learning Resource 2.15b Ventilation which is currently being reviewed.

The inappropriate use of PPV and introduction of fresh air prior to locating the seat of a fire and extinguishment can lead to extreme fire behaviour and rapid fire development.

PPV must only be used for the purpose of removing smoke and other products of combustion during post-fire overhaul. Prior to using PPV, the seat of the fire must be located and adequately controlled to the satisfaction of the Incident Controller. Once this has been achieved, standard methods of PPV can be employed during the overhaul process.

Note: **The use of PPV before the above conditions are met is to cease immediately regardless of practices that may have been used previously.**

The NSWFB is currently researching the use of more advanced applications of PPV during structure fires with a view to developing effective training to ensure safe operational use.

Conditions required prior to ventilation with PPV fan:

1. Post fire overhaul has commenced (ie fire is located and controlled/extinguished).
2. A crew is within the structure in full Structural Fire Fighting Uniform and SCBA, with a charged line of hose, ready to extinguish any fire extension.
3. Operational communications (e.g. Ch 510) is established between the IC and **ALL** crews on the fire ground.

Noted, Station Commander	A	B	C	D	Other

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Figuur 0.1 Safety Bulletin of New South Wales Fire Brigades *(Source: NSWFB - John Mcdonough)*

In the UK the home office facilitated the introduction of positive pressure ventilation in several fire services. This was done after doing the necessary research. Documents were published with the necessary information. Mark Yates[2] mentions documents from ´97 and ´99. By providing several documents and studies on PPV the British government created an operational environment in which fire services are able to choose the level of their PPV implementation.

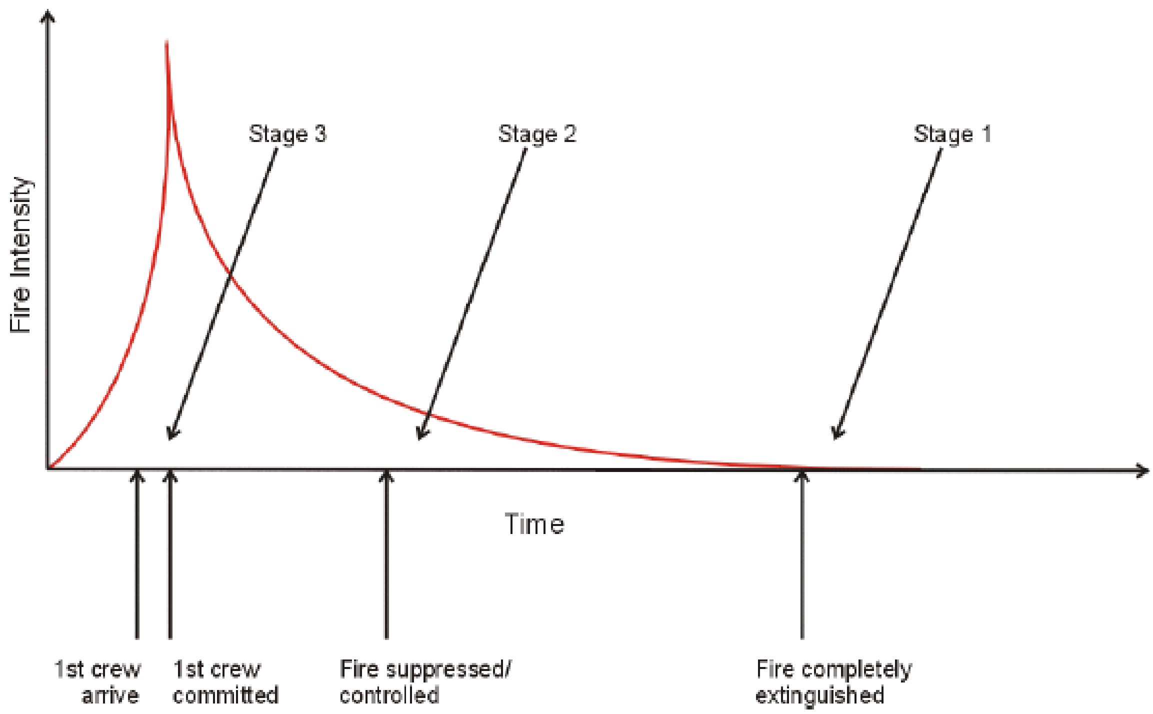
The most important element in the work of our British colleagues is a model in which three steps are introduced. According to the model a fire service can apply PPV on three different levels. The goal is to obtain a phased implementation of PPV. Fire services can also make the choice not to use PPV. When PPV is opted by fire services, the introduction is done in three phases.

- Phase 1: Ventilation after the fire has been extinguished – during overhaul.
- Phase 2: Ventilation after the fire has been controlled.
- Phase 3: Ventilation before the start of extinguishment.

A fire service can opt to only implement phase one.

In several documents published by the Home Office[3] [4] [5], the importance of sufficient education and training is stressed. The Home Offices view is that training has to be provided for each individual phase. At present, there's no real training on the subject of ventilation in Belgium and this explains why PPV is scarcely used.

Should a service want to apply PPV on the fire ground, it would need to invest in the proper tools. Aside from investment in equipment, training would have to be provided as well. Especially if the goal is to advance to phase three, it's important for crews to be properly and adequately trained.



Figuur 0.2 The English model with three different phases. Fire services can advance from phase one to phase three. *(Drawing: Mark Yates)*

The book Eurofirefighter[6] contains an interesting round table discussion on ventilation. In the discussion Ed Hartin poses that a well-reasoned choice must be made on the fire ground to use ventilation either before, during or after extinguishment. It's a good thing that a fire service has the ability to use phase three. That doesn't mean it has to be used on each and every fire ground. Fire behavior is of critical importance here. It's up to the IC to decide when ventilation should be started. Hartin also advises, regardless of its phase, to combine ventilation with anti-ventilation at the start of operations. He says anti-ventilation is best put in place until the fire attack can be started.

1.1 Phase 1: After the fire has been extinguished – during overhaul

In Belgium this is how ventilation is usually implemented. It's after all the safest way to use ventilation. When the fire has been put out, the risk of ventilation influencing the fire behavior can be dismissed. An exception to this is the Fire Gas Ignition (FGI). The turbulence created by a fan can cause an ignition source to reach a flammable mixture. This means there are still some risks. When a FGI occurs during the venting of smoke, it will probably occur right after the start of ventilation. As soon as the fan has been active for a while, it will become less likely for FGI to happen because of the decreasing concentration of smoke. Fire crews need to be ready for the possibility of FGI happening right after starting PPV. It's always better for FGI to occur when firefighters are prepared for it. A good way to deal with this particular risk, is to wait for about thirty seconds after starting the fan.

When setting up for ventilation, the following question must be asked and answered: "Has the fire been completely put out?" A seat of fire that has remained unnoticed by the attack crew can quickly increase in size when PPV is started.

1.2 Phase 2: During extinguishment but before the fire has been put out.

A fire service that has gained sufficient experience with phase one, can choose to proceed into phase two. Naturally this will require extra training. After all it's more likely now for ventilation to influence the fire behavior. This doesn't necessarily mean it's a problem providing the fire crews on scene are ready any possible changes in fire development.

The most important principle in phase 2 is that the fire has to be controlled by the fire attack crew the moment ventilation is started. The extra air added will make for an increase in power of the fire, but this effect will be countered by the extinguishment capacity of the attack crew. A fitting way to describe the situation is this: the dog is out of its cage, but is chained up. The philosophy is for the attack crew to already be in the right place on the right time (before the start of ventilation) to react if something goes wrong. The goal of phase two is to support the attack crew. As soon as extinguishment starts on the seat of the fire, a large amount of steam will be produced. This steam can cause injuries to the attack crew. When ventilation is started, the steam will follow the same way out as the smoke. Fire crews can then continue working without the hindrance of steam. Because the smoke is vented, visibility improves and the seat of the fire can be seen more easily.

This form of ventilation is used in the Brussels fire department and has led to good results. It does hold more risk than phase one, however it's safer and more cautious to use than phase three.

There are situations where it's inadvisable to use this form of ventilation. When dealing with basement or cellar fires, there often is only a single opening available. Both smoke and steam need to exit through the staircase opening. This is both uncomfortable and dangerous for fire crews. Aside from this it is often so that basement fires are ventilation controlled because of the limited amount of air that can reach the seat of the fire. Use of ventilation before the fire has been put out, will make conditions more difficult and more dangerous. Because of this, ventilation on basement fires is not preferred unless a second opening can be created to serve as an exhaust.

A final important application of ventilation during fire extinguishment is the creation over pressure in rooms/buildings adjacent to the fire. Especially when dealing with large fires in older buildings it often happens that hot smoke is pushed through cracks into neighboring buildings. Once there, this hot smoke will cause problems. For starters, there will be smoke damage, but hot smoke can also lead to fire spread. Once it has fully spread into the adjacent building, the smoke can act as an ignition source for highly flammable materials such as curtains and so on. The fire crew can put a fan (or several fans) in place in front of the door of the neighboring building. When there is no vent exit in place, the building will become pressurized. It will become a lot harder for the fire to push smoke into the adjacent building.

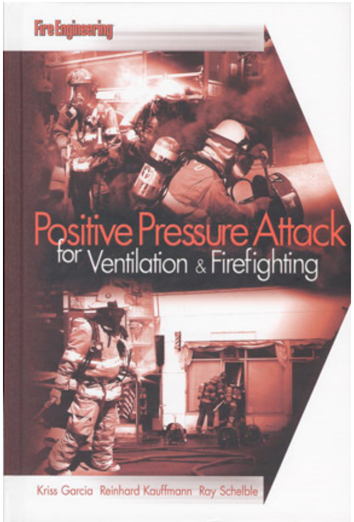
1.3 Phase 3: Before starting fire attack.

Mark Yates[2] performed research in November 2001 into ventilation by the British fire service. This was done about four years after the Home Office made documentation available on the implementation of PPV. This research tried to reach all 61 fire services in the UK of which 53 responded. Of these 53, only 3 testified to using phase 3. About a third of the services had set the goal of reaching phase 3. To achieve this, a training program was developed. About half of these services planned on a time period of two years to make the transition from phase one to phase three. Yates concluded that the importance of both training and the correct implementation of SOP's was not to be underestimated.

When applying phase three on the fire ground, ventilation is set in place before entering the burning building. The influence on fire behavior is enormous. The fire can get out of control really fast upon starting PPV when it's close to flashover or when it's under ventilated. Ventilation will cause the power of under ventilated fires to rise almost immediately. This in turn may lead to ventilation induced flashover or backdraft. For under ventilated fires it isn't even necessary to use a fan. Natural ventilation caused by opening a door is sufficient to cause ventilation induced flashover [7] [8].

The transition from phase one to phase three needs to be slow enough because of the influence on fire development. The two years mentioned by Yates seem to be sufficient for a service to "grow" into phase three. Should management of the fire service decide to implement phase three, a time frame needs to be established. Next to this there also needs to be structural funding to provide realistic (e.g. live fire) training.

Phase three is a tactic that has been developed by several firefighters from Salt Lake City. They named their tactic Positive Pressure Attack (PPA). The best known advocate of PPA is Kriss Garcia. Together with some of his colleagues he wrote an excellent book[9] on the application of their tactic. The goal is to put into place the ventilation setup first. At the same time an inlet and outlet is created. Subsequently the fan is started up. The result of PPA is that heat and smoke are vented out of the building. Firefighters can then advance onto the fire in cool, fresh air. This in turn allows for a faster extinguishment.



Figuur 0.3 Book of Kriss Garcia on PPA

Garcia indicates that PPA also impacts the number of firefighters needed on scene. He poses a number of three firefighters fully involved in ventilation operations. The implementation of PPA in Belgian fire services would also influence the number of firefighters that are sent out to respond to a fire.

Yates recommends that fire services research the possibility of PPA in their respective working areas. There is after all an important connection between PPA and type of structure. In the US many residential areas contain housing with two building layers at the most. In such housing it is often possible to quickly create an outlet from the ground level. In Europe we're becoming increasingly confronted with apartment buildings. The creation of outlets requires manual ladder or even ladder trucks. This isn't always possible because a ladder truck can't reach every window. For high rise firefighting, PPA isn't an option.

1.4 And now Belgium?

In Belgium, ventilation is rarely used. As stated in the introduction, a lack of training is partly to blame for this.

On the other hand, it's not wise for each and every service to invest in phase three. In larger cities, PPA will often not be an option because of the type of buildings.

Each department should consider carefully whether it wants to invest in ventilation and which phase it wants to implement. It is advisable however to implement phase one at the least.

1.5 Bibliography

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