Procedures for Positive Pressure Attack

This section describes safe work procedures for Positive Pressure Attack (PPA). Positive Pressure Attack is the tactical application of positive pressure ventilation (PPV) during offensive fire operations.

This section applies to all staff.

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Policy

RFR personnel will be familiar with and perform the following procedures in order to maximize safe fire ground operations and minimize loss to life and property.

Scope

These Procedures are based on accepted practices for aggressive interior fire attack on incidents where first arriving crews can make a rapid entry into the area involved in fire. Large and complex fires may require a more methodical, less aggressive implementation of Positive Pressure Attack (PPA).

Background Information

Fire naturally moves from areas of higher or positive pressure, to areas of comparatively lower or negative pressure. The largest area of negative pressure during a fire is outside the
structure. The positive pressure area inside and the negative pressure area outside are separated by the walls and roof of the structure.

When a fire is in a free burning stage, firefighters can make an exhaust opening to the outside or improve an existing opening where the fire is already exhausting, then use a Positive Pressure Ventilation Fan (PPV-Fan) to add slightly to the already higher interior pressure from a predetermined entry point. This is called Positive Pressure Attack (PPA). PPA can create a direct, safe path for the fire to travel to the outside and can be controlled to a large extent by the location and size of the exhaust, manipulating interior or exterior openings, or simply turning off the PPV-Fan. The pressure created inside a structure by fire and the steam generated by water application is actually much higher than a PPV-Fan can create.

**Purposes and Benefits**

PPA benefits to fire operations include:

- Heat and smoke are rapidly cleared from the structure, thus reducing the fire's ability to propagate and advance. *Smoke is fuel.*
- Clean, cool air replaces the toxic, super-heated interior atmosphere so victims have a higher probability of survival.
- Improved visibility and conditions aids firefighters in search and rescue.
- Improved visibility and conditions allows firefighters to more quickly conduct attack and extinguishment operations.
- A reduced interior temperature reduces heat stress on firefighters.
- Less exposure to toxic (carcinogenic) products of combustion for both firefighters and victims.
- PPA reduces loss caused by smoke and fire damage to the structure.
- PPA can reduce the need and risk of roof ventilation operations at many fires.
- Ventilation can be controlled by using simple measures such as opening or closing doors or turning off the PPV-Fan.

**Positive Pressure Attack (PPA) Tactical Procedures**

In general, this section applies to single family dwellings, small commercial buildings and other similarly sized intact structures. Larger more complex structures follow similar methodologies, but may require multiple fan deployments and a more comprehensive ventilation plan.

PPA can be broken down into four steps, with 1 and 2 happening at generally the same time.

**Step 1: Identify the ventilation entry point and position the PPV-Fan**

- **Assign** – Task a firefighter to take the fan to the structure as he/she leaves the apparatus.
- **Ventilation Entry Point** - The PPV-Fan should be positioned at the proposed fire attack team's entry point at the "unburned side" of the structure. This will be deemed the ventilation entry point.
- **Position PPV-Fan** - For maximum effectiveness, the PPV-Fan should be positioned 4 to 10 feet away from the ventilation entry point and angled back
approximately 5 degrees. Ventilation can still be of benefit if fan can only be placed closer or further away.

- **Standby Ready** - PPV-Fan should be started as soon as possible and left to idle pointed away from the structure. The airstream should not be directed into the ventilation entry point until the attack team is ready to enter with a charged hose line and the ventilation exhaust opening has been established (see step 3). Ideally, the ventilation entry point should remain closed to limit introduction of oxygen to the fire (anti-ventilation).

### Step 2: Survey the structure exterior and create or improve the exhaust opening

- **Identify the Vent Outlet Point** – During the initial 360 size up, the IC (First in Company Officer) should determine the most appropriate point to vent. This should be as close to the fire area as possible. It is important to know where the fire is. Utilize information from witnesses, occupants and Thermal Imaging Cameras (TICs).
- **Victims at Windows** – PPA is not an option as long as victims are awaiting rescue in windows that have a clear path to the fire.
- **Make Exhaust Opening** – Task a team to make or improve the vent outlet. This opening should be substantial enough to exhaust the products of combustion. Consideration should be given to having a charged hose line with this team for protection of themselves, exposures and extension. An indirect exterior fire attack may be warranted in the event that the interior attack from the unburned side is delayed or abandoned.

### Step 3: Begin pressurization and fire attack

- **Direct airstream inside** – After the structure has been checked, the exhaust opening ensured and the attack team is in position with a charged hose line, the door or other vent entry point can be opened and the airstream from the PPV-Fan can be directed inside.
- **Enter after pressurization is observed** – Teams must not enter until the PPV-Fan has pressurized the structure for a short time, usually about 30 seconds, or until conditions improve and the interior environment starts to clear. It is extremely important that the PPV-Fan is always “at the backs” of the initial attack team.
- **Ventilation opening as an indicator** – The upper area of the ventilation opening can be utilized as an indicator of the effectiveness of pressurization and interior fire activity, this space is referred to as the “diagnostic space”. Heavy smoke or fire exhausting from the diagnostic space, above the pressure cone could be an indication that the exhaust openings are inadequate, or there is an opposing head wind, and dangerous fire behaviour may result if allowed to continue.
- **Remain aware** – Command and everyone involved in the fire operation must remain aware of fire behaviour and smoke movement.
- **Overhaul aggressively** – Aggressive overhaul must begin as soon as possible. Open up spaces in walls, ceilings and other void areas that have been impinged on by fire or otherwise suspect. Positive pressure will spread fire and pyrolytic material in these spaces.
- **Fire above or below** – Be alert to the possibility of fire in the ceiling above (suspended tiles) or the floor below (crawl spaces). When advancing into an area that has the possibility of fire above or below, open up frequent inspection holes.
The void spaces will become pressurized and deter fire extension from the area of fire origin.

**Step 4: Make sure the fire is out**

- **Continue to overhaul aggressively** – Open impinged areas early and often.
- **Turn off PPV-Fan** – Turn off the PPV-Fan for 10-15 minutes then thoroughly re-examine all involved areas for hidden fire. Be sure to use Thermal Imaging Cameras.

**Positive Pressure Attack (PPA) Example Diagram**
Guidelines for Specific Fire Situations

These guidelines will not apply to all situations or conditions, and good judgement must always play a part in any decision. Search and rescue and firefighter safety are always top priorities.

**Exposure Protection - Positive Pressure Pressurization (PPP) as Confinement Tool**

- Exposures can be a structure, or separate uninolved area within a fire involved structure which is deemed to be at risk.
- First priority should be for a coordinated Positive Pressure Attack (PPA) on the fire involved building/area, and then move to highest risk exposures.
- Set up PPV-Fans in the same manner as any positive pressure operation but do not create exhaust openings in the area being protected.
- The objective is to create a “high pressure” zone around the fire and to force any extension back into the fire area and out the controlled vent outlet established during the PPA sequence.
- If heavy smoke conditions exist, consider creating a temporary opening (i.e., door) to the fire area to allow the smoke to vent back where it came from. Ensure there is adequate exhaust at the vent outlet to allow this.
- Once smoke has cleared, the exit should be closed to seal the area requiring protection, so that it will build and maintain “over pressure”.
- **Avoid** making openings to the outside from the area requiring protection. This can draw more smoke and fire from the involved part of the structure.
- Remember to lift ceiling tiles and/or make openings to the attic and/or crawlspace to pressurize these areas as well.
- Monitor interior and exterior conditions. Open up high risk interior walls or ceilings. Have charged hose lines available for use.
- Personnel working in the Positive Pressure Pressurized (PPP) protected exposure should be in full PPE with SCBA with consideration given to monitoring Carbon Monoxide (CO) levels if a gas powered PPV-Fan is in use for this function.

**Attic Fires**

- Start PPA in the attack entrance to pressurize the area below the fire. An exhaust opening is not necessary if the space below the attic is clear of smoke.
- Use good judgement and building construction size up for light weight truss design and extent of fire involvement before entering. If there is any doubt of safety due to collapse, conduct exterior fire attack (see further below).
- Enter structure with charged hose line and thermal imaging cameras (TIC) to locate suspected fire area by sighting the ceiling.
- Once “hot spot” is found, punch a small hole and introduce a narrow to wide fog into the attic space (steam kill). A step ladder may be useful to access ceiling.
- Consider using a piercing applicator for the attic attack, but also provide a standard hose line for back up in case there is a failure in the ceiling drywall.
- For exterior attack, locate “hot spot” on roof with TIC and by working from a roof ladder or aerial device, use the same principle of making small access opening and inserting fog spray or piercing application.
- Consider flowing Class “A” foam for attack lines in both fog and piercing applications.
- Keeping attic area closed will deprive the fire of oxygen and keep needed heat in the space for steam production.
Once fire has been controlled normal venting and ceiling pulling operations can begin with the continued use of PPV in the living area.

**Chimney Fires**
- Pressurize the interior of the structure and restrict exhaust openings to ensure that the fire and product of combustion will be confined to the fireplace.
- Extinguish fire with small amount of Water, Dry Chem or even CO2.
- Using a TIC, check interior and exterior for extension.
- If no extension is noted, continue to run fan so cool air will continue to pass up the flue and cool the chimney.
- Be mindful of Carbon Monoxide if using a gas PPV-Fan and call for air monitoring to ensure interior atmosphere has returned to a safe level before allowing the occupants back in the home.

**Vehicle and Trash Fires**
- Set up PPV-Fan upwind of fire to provide and enhance general area ventilation.
- Crews attack fire with PPV at their backs. This will minimize dermal exposures to harmful products of combustion associated with vehicle fires and unknowns in dumpsters.

**Large Buildings**
- May require multiple PPV-Fans, perhaps at more than one location both outside and/or inside the structure.
- May be complex and require close coordination with all division and group supervisors.
- A Ventilation Group should be established within the command structure.
- **Do Not** use PPA in large areas where the fire is ventilation controlled. It is unlikely that enough exhaust ventilation can be established to counteract the rapid onset of extreme fire behaviour in these situations.

**Multi-Storey and High Rise**
- Are generally more complex and require close coordination with all division and group supervisors.
- A Ventilation Group should be established within the command structure.
- The fireground ventilation plan must be coordinated with any building ventilation system. Consider shutting down building system if objectives are not being met, so ventilation group can completely control the vent plan.
- Begin by pressurizing stairwells at ground level.
- Multiple PPV-fans may be required and additional fans may be needed on landings below and at the fire floor.
- For vent outlet openings, a window or other opening in the fire area is the best choice.
- The roof hatch in the attack stairwell can be “cracked” slightly to allow smoke build up to escape, but still provide sufficient back pressure to maintain pressure in the stairwell.
- Consideration may be given to venting through adjacent units (wall breaching) or out an opposing stairwell through a roof top exit. **Control** of this stairwell is essential to ensure there are no occupants at risk.
- Vent opening locations must be chosen carefully, as pathways will become conduits for the energy and products of the fire.
- Be cognizant and cautious to the effects of wind on a vent outlet or a window failure. Be prepared to isolate fire compartment by closing doors and withdrawing to a defensive posture.
- Personnel working as stairwell support should be in full PPE with SCBA if a gas powered PPV-Fan is in use either at ground level or interior. Consideration should be given to monitoring Carbon Monoxide (CO) levels where members are working without SCBA.

**Tactical Considerations**

The following tactical considerations can significantly affect the operation and outcome of a positive pressure attack.

**PPV-Fan Configurations**
- Where additional PPV-Fans are required, place two or more in “series” for narrow ventilation points and “parallel” for wider ventilation points.
- If space allows, using PPV-Fans in a V-pattern and angled at the center of the opening yield best results and increases exhaust volume by as much as 30 percent.
- Always try to configure in a V-pattern to optimize PPV performance.
- Regardless of size, PPV-Fans should be placed 4’ – 6’ set back from the doorway and angled back at least 5 degrees for optimum performance. Lesser and greater distances will still offer benefit.

**Vent Outlet Location**
- The fire's approximate position in a structure must first be located.
- A vent outlet must be as close to the fire as possible.
- Windows are better locations than doors as they tend to keep heat and smoke higher. This provides a more survivable condition for victims that may be on the floor. Venting exhaust through doors will tend to drop heat and smoke to floor level.

**Vent Outlet Size**
- The size of the vent opening is critical to the successful operation of PPA.
- The size of the opening should match the energy being created by the fire and increased burn rate of the fire load.
- The outlet size should be a minimum 50% size of the inlet and up to 200% the size of the inlet. This is dependent on head wind, PPV-Fan performance, compartment geometry and size.
- Overpowering the fire compartment and not allowing enough of the combustion products to leave can result in thermal runaway and flashover. Be prepared to reduce the speed of the fan to match the size of the vent outlet opening.

**Controlling Airflow**
- Too many openings or exit points reduce effectiveness of PPA.
- Close unnecessary windows and doors during 360 (anti-ventilation)
- Use sequential venting techniques by shutting interior door as you work towards the fire. This will especially improve pressure in large structures by “zoning” off unnecessary compartments.
- Firefighters must not block airflows in doorways or hallways.

**Ambient Wind**
- An opposing headwind of as little as 10 km/h can disrupt PPA.
- Take wind into consideration and rather choose a vent outlet that is perpendicular to the wind if possible.
• If you have to vent into the wind start with the smaller 50% outlet to inlet opening size ratio. You can always make it bigger, but it is difficult to make it smaller.
• If PPV-Fans are set too far back from the vent entry point (greater than 6 feet), the airstream and cone can be easily deflected by cross winds.

**Burning Rates**

• The burning rates of compartment fires that are subjected to positive pressure ventilation will be up to 60% higher than those supplied through normal windows and doors.
• Ensure adequate fire flow rates on hose lines to deal with the expected increase in BTU production.

**PPV-Fan Noise**

• Noise levels can exceed 100 decibels (dB) near a gas powered PPV-Fan.
• The PPV-Fan will entrain noise into the structure and negatively affect communication for the interior crew.
• Consideration should be given to using “less” noisy electric PPV-Fans when possible.

**Precautions**

• *No* PPA where conditions present warning signs of backdraft.
• *No* PPA where there is presence of combustible dust or flammable vapours.
• *No* use of PPA in large areas where the fire is ventilation controlled.
• *No* use of PPA as long as victims are awaiting rescue in windows that have a clear path to the fire.
• *Always* use PPA from the unburned to the burned side.
• *Always* ensure an adequate vent outlet before directing the airstream into the structure.
• *Always* initiated PPA **before** the attack team has enter the structure and wait approximately 30 seconds or notice improvement in conditions before making the entry.
• *Never* enter the structure if heavy smoke or fire is exiting above the PPV-Fan.
• *Always* monitor fire conditions and if smoke conditions deteriorate and start banking down, immediately recall the attack team.
• *Always* be aware of the “blow torch” effect at the vent outlet and be prepared to protect exposures and extension.
• *Always* staff the PPV-Fan once more resources arrive (it may not be staffed in an initial Fast Attack with first-in Company) and before a second hose line enters.
• *Always* be aware of Carbon Monoxide hazards when using gas PPV-Fans in areas where SCBA isn't being worn (i.e., stairwell support).
• *Never* make a vent outlet facing against a strong headwind.
• *Never* use a PPA outlet point as an entry point.
Summary

Positive pressure attack when utilized correctly can increase the effectiveness of fire fighters and survivability of occupants in structure fires. Command must initiate, coordinate and control the application and deployment of positive pressure attack (PPA) prior to firefighters entering the structure to ensure safety of personnel. As is the case during any aggressive fire attack, ongoing evaluation of conditions is extremely important, as the dynamic effects of PPA can occur rapidly. It is important that all members of the department are properly trained and understand the proper use of this offensive ventilation tactic.

References


Control Information

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Note: This SOP has been reviewed to determine if any City of Richmond Policies/Bylaws apply. None were found at last review date.