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GRA 3.6
Fighting fires using positive pressure ventilation

Generic Risk Assessment 3.6

Fighting fires using positive pressure ventilation

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Contents

SECTION 1 5

Generic Risk Assessment 3.6
Fighting fires using positive pressure ventilation 5

Scope 5
Introduction 5
- Ventilation 5
- The effects of ventilation 6

Significant hazards and risks 7
- Uncontrolled spread of fire 7
- Worsening of internal conditions 7
- Creating an outlet 7
- Noise 7
- Debris blown from fan 8
- Working at heights 8

Key control measures 8
- Planning 8
- Command and control 11
- Communications 12
- Safety Officer(s) 12
- Ventilation Officer 13
- Personal protective equipment 13

Specific control measures 13
- Uncontrolled fire spread/worsening of internal conditions 13
- Creating an outlet 14
- Debris blown from the fan 14
- Working at height 15
- Burns and scalds 15
- Post incident 15
- Other considerations 16

SECTION 2 18

Summary of Generic Risk Assessment 3.6 18

Fighting fires using positive pressure ventilation 18

SECTION 1

Generic Risk Assessment 3.6 Fighting fires using positive pressure ventilation

Scope

This generic risk assessment examines the hazards, risks and control measures that relate to ventilation. It includes the use of positive pressure ventilation as either a defensive or offensive part of firefighting.

Depending on the nature and scale of the operational incident, a variety of significant hazards may be present. Fire and Rescue Authorities may therefore need to consider the contents of other specific generic risk assessments in this series.

This, as with all generic risk assessments provides a starting point for Fire and Rescue Authorities to conduct their own assessments within the context of local conditions and existing organisational arrangements.

Details of documents that contain technical and supporting information can be found in the technical reference section of this generic risk assessment.

Introduction

Ventilation

Ventilation is defined as:

'The removal of heated air, smoke and other airborne contaminants from a structure, and their replacement with a supply of fresher air'.

NATURAL VENTILATION – describes the techniques of vertical and horizontal ventilation when they are not assisted by mechanical means. This includes the use of existing vents, windows, doors etc, plus wind direction in relation to the building

FORCED OR MECHANICAL VENTILATION – describes the techniques of vertical or horizontal ventilation when mechanical means are used to assist in removing hot gases and smoke, or in providing a supply of fresh air.

In firefighting, there are a number of additional terms that are used:

SELF VENTILATION – occurs when the fire damages the structure so that increased ventilation occurs.

AUTOMATIC VENTILATION – occurs when existing vents are activated automatically, usually in the early stages of the fire, by the fire detection system or fusible link devices.

TACTICAL VENTILATION – requires the intervention of the Fire and Rescue Authority to open up the building (in a controlled and planned manner), releasing the products of combustion and allowing fresher air to enter.

The effects of ventilation

PREVENTING AND REDUCING DAMAGE

The constituents of smoke can be corrosive, oily or injurious. If it is not controlled, it can cause damage to parts of the structure or the contents of a building which the fire itself does not reach. Furthermore, if a building is not ventilated and a fire is large or burns until it becomes partially starved of oxygen, the production of incompletely burned hydrocarbons will increase. These unburnt flammable gases may collect beneath ceilings and roofs and subsequently ignite leading to further fire damage.

PREVENTING FIRE SPREAD

The hot gases will rise via lift shafts, staircases and any other pathway available carrying with them smoke, flame and burning materials. If they cannot escape by way of a vent, they will mushroom out under the ceilings and roofs that confine them. In this way the fire may spread to other unaffected areas. Mushrooming is one of the most common causes of fire spread through roof spaces or from floor to floor. Although other precautions are necessary to prevent fire spread by radiation, ventilation can prevent or reduce fire spread by convection.

ASSISTING FIREFIGHTERS

Heavy smoke, with its irritating properties and reduced oxygen content, always makes working conditions more severe. By reducing visibility it can also hinder the speedy location of the seat of a fire and the assessment of how best it should be tackled.

As firefighters will be able to see if the smoke is cleared by ventilation, they will face less difficulties and dangers upon entry into a structure. Additionally, a reduction in compartment temperatures will reduce the physiological effect on firefighters extending the time that they can operate, increasing their ability to function at optimal levels and consequently they will be able to fight the fire more effectively and efficiently.

When a compartment or building is totally engulfed by fire, ventilation will not enable firefighters to enter but it can help by ensuring that flames and hot gases flow out through higher vents, while air flows in through the lower openings. This will help to counter the further spread of flame and assist firefighters in their approach.

POSITIVE PRESSURE VENTILATION

Positive pressure ventilation is achieved by forcing air into a building using a fan. This increases the pressure inside relative to atmospheric pressure. Efficiency will be governed by the wind, size of the fan, the proportion of the fan's air entering the building, relative sizes of inlet and outlet vents, and the size of the compartment and the temperature of gases within.

Significant hazards and risks

Uncontrolled spread of fire

A significant risk arising from the offensive use of ventilation is the likelihood that either the occupants of the building involved or fire service personnel become trapped between the fire and the outlet vent by rapid-fire spread.

Ignition of heated smoke as it mixes with air (oxygen) at the outlet vent is a potential hazard to personnel, both from direct contact and from secondary fires caused by ignition. This will only occur if the vented smoke is above its auto-ignition temperature.

Worsening of internal conditions

The result of ineffective/incorrect forced ventilation is likely to increase the intensification of the fire thereby increasing the risk of serious injury to any persons within the building.

Creating an outlet

As the outlet is created there is a risk of ignition of any heated flammable gases present as they mix with air (oxygen) at the outlet vent. This may lead to rapid-fire development/ backdraught conditions resulting in burns to firefighters from direct contact, and/or secondary fires caused by this ignition.

Firefighters may sustain injury from broken glass or other debris caused by the creation of the outlet vent.

Noise

The use of positive pressure ventilation generates high levels of noise that could, if prolonged exposure is sustained over a number of years, cause damage the hearing of firefighters.

Fan operators and anyone working in close proximity to the fan must wear suitable hearing protection (a noise assessment will identify the correct measures to be followed in order to adequately control exposure to positive pressure ventilation noise.) The Ventilation Officer should consider rotation of operators.

Because of the noise generated when a positive pressure fan is in use, fire and rescue personnel should deploy extra vigilance in order to hear distress or evacuation signals.

Further guidance is provided in the Health and Safety Framework for the Operational Environment: www.gov.uk/government/uploads/system/uploads/attachment_data/file/209362/HSFrameworkJunecombined.pdf

The noise of the positive pressure ventilation fan can make the distress signal unit and the evacuation signal inaudible, thereby increasing the risk of injury or death to operational crews within the structure However, the use of a radio distress signal unit can compensate for this and may neutralise this hazard. Additionally, in order to communicate externally the default control measure will be 'closing down' the positive pressure ventilation fan, this will then enable normal fireground communications to be utilised. This action will be coordinated by the Incident Commander who must then ensure that the evacuation signal is resounded in order to give committed crews the opportunity to hear the signal without the interference of background noise from the fan.

Debris blown from fan

Firefighters, walking in front of the fan, may be subject to injury from blown debris. In the event of debris getting caught up in the fan blade, parts of the blade may also shatter and be ejected.

Working at heights

Firefighters run the risk of fall from height if required to work at height whilst attempting to create an outlet for ventilation purposes.

Key control measures

Planning

Planning is key to enhancing the safety of firefighters and others likely to be affected by Fire and Rescue Authority' operations. Each Fire and Rescue Authority's strategic plans will set standards and identify the resources required to ensure safe systems of work are maintained.

Fire and Rescue Authorities should assess the hazards and risks in their area relating to this generic risk assessment. The assessment should include other Fire and Rescue Authority's areas where 'cross-border' arrangements make this appropriate.

Site-specific plans should be considered for locations where the hazards and risks are significant and plans should take into account and specify any variation from the normal operational capability of personnel, appliances and equipment. In particular, recognition should be given to the physical and psychological pressures that an operational incident may apply to fire and rescue personnel.

Site-specific plans should include:

- levels of response
- relevant standard operating procedures

- tactical considerations, including rendezvous points, appliance marshalling areas and access points
- identification and, where necessary, the formal notification to person(s) responsible for the site of any Fire and Rescue Authority operational limitations.
- Planning is underpinned by information gathering, much of which will be gained through inspections or visits by fire and rescue personnel – for example, those covered by section 7(2)d and 9(3)d of the *Fire and Rescue Services Act 2004*.

Further information on information gathering in relation to site-specific risk can be found in the *Fire and Rescue Service, Operational guidance: Operational risk information*: www.gov.uk/government/uploads/system/uploads/attachment_data/file/5914/2124406.pdf

Information should also be gathered and used to review safe systems of work from sources both within and outside the Fire and Rescue Authority, including:

- fire safety audits
- incident de-briefs
- health and safety events
- local authorities
- local resilience fora.

Involving others in planning is an effective way to build good working relations with partner agencies and other interested parties, such as site owners.

Fire and Rescue Authorities should ensure systems are in place to record and regularly review risk information and ensure that new risks are identified and recorded as soon as practicable.

Fire and Rescue Authorities must ensure that the information gathered is treated as confidential, unless disclosure is made in the course of duty or is required for legal reasons.

Fire and Rescue Authorities should consider the benefits of using consistent systems and formats to record information from all sources. Consideration should also be given to how timely access will be provided to inform and support operational decision-making.

Information needs will vary in proportion to the size and nature of the incident. The capacity of fire and rescue personnel to assimilate information will vary in relation to the complexity of the incident. Therefore, arrangements may need to be flexible and be based on more than one system.

When purchasing positive pressure ventilation equipment Fire and Rescue Authorities will need to consider the following:

- suitability of the selected fan
- fan performance

- necessary stowage and maintenance arrangements
- necessary mobilising arrangements
- manual handling implications.

Positive pressure ventilation should not be introduced as an offensive firefighting tactic until firefighters have a clear understanding of the use of ventilation as an offensive firefighting tactic and of its effect on fire behaviour.

Fire and Rescue Authorities will need to determine a suitable level of response where positive pressure ventilation is to be used as part of firefighting operations

Further guidance on planning can be found in the *Fire and Rescue Service Operational guidance – Operational risk information* and any other relevant sources: www.gov.uk/government/publications/operational-guidance-for-the-fire-and-rescue-authorities-operational-risk

When formulating a competence and training strategy, Fire and Rescue Authorities should consider the following points:

- Specific risk assessments for this incident type are suitable and sufficient and those tasked with carrying out the assessment and developing procedures are competent to do so
- Fire and Rescue Authorities must ensure their personnel are adequately trained to deal with hazards and risks at operational incidents associated with this generic risk assessment
- The level and nature of training undertaken should be shaped by informed assessment of operational and individual needs in accordance with the Fire and Rescue Authority guidance on the integrated personal development system, national occupational standards and any internal training plan
- Further guidance is provided in the *Health, safety and welfare framework for the operational environment:* www.gov.uk/government/uploads/system/uploads/attachment_data/file/209362/HSFrameworkJunecombined.pdf

Training and development programmes should:

- follow the principles set out in national guidance documents
- generally be structured so that they move from simple to more complex tasks and from lower to higher levels of risk
- typically cover standard operational procedures as well as ensuring knowledge and understanding of equipment and the associated skills that will be required to use it
- consider the need for appropriate levels of assessment and provide for continuous professional development, to ensure maintenance of skills and to update personnel whenever there are changes to procedure, equipment, etc

- involve personnel involved in other processes that support the emergency response, such as planners devising procedures and people procuring equipment.

Specific training requirements for ventilation and use of positive pressure ventilation will include the standard operating procedure and the equipment to be used.

Firefighters must be fully trained in the use of positive pressure ventilation. This will normally involve fireground training in defensive tactics before offensive tactics are applied.

Firefighters should be aware of the advantages and disadvantages of positive pressure ventilation and that it can be used both as an offensive and defensive firefighting tool.

Training outcomes should be evaluated to ensure that the training provided is effective, current and meets defined operational needs as determined by the Fire and Rescue Authority's integrated risk management plan.

Site-specific tactical exercises may be undertaken with other agencies or staff likely to assist at an actual incident.

Command and control

The Incident Commander should follow the principles of the current national incident command system. Prior to committing personnel into any hazard area, the Incident Commander must take account of the actual information about the incident that is available at the time to make operational decisions in what are recognised as sometimes dangerous, fast moving and emotionally charged environments.

Communication of new or changed risks should continue throughout the incident.

Ventilation is only one element of the overall firefighting strategy and must be co-ordinated with other activities to ensure that differing requirements are not in conflict. The decision to ventilate or use positive pressure ventilation will have implications for safety and resources.

Crews must be aware of the positions of the outlet/inlet vent. Obstruction of either inlet or outlet vents could have serious consequences for personnel supervising the vents or firefighters within the building.

The number of personnel should be kept to the minimum necessary to complete the task.

At incidents where breathing apparatus teams from neighbouring Fire and Rescue Authorities are already committed, positive pressure ventilation operations should not be commenced until personnel have been consulted. There may be a need to explain the effects and benefits that positive pressure ventilation may have on the incident. concerned.

Communications

Good fireground communications are essential where ventilation is deployed as part of firefighting procedures.

If the Incident Commander decides to initiate the use of positive pressure ventilation (or any other form of ventilation) then firefighters inside the building concerned must be informed.

There should be communications between the Incident Commander, the positive pressure ventilation operator and any personnel within the building. This will allow the Incident Commander to monitor the effectiveness of the positive pressure ventilation and the fire conditions within the building.

Safety Officer(s)

The early appointment of one or more Safety Officer(s) will assist in supporting a tactical plan to address risks so they can be eliminated or reduced to an acceptable level.

A safety decision-making model should be used to brief Safety Officers regarding the nature of the incident, the allocated task and prevailing hazards and risks. The Incident Commander should confirm that the Safety Officer understands:

- their role and area of responsibility
- allocated tasks
- lines of communication.

Those undertaking the Safety Officer role should:

- wear nationally recognised identification to indicate that they are undertaking the Safety Officer role
- be competent to perform the role
- ensure personnel are wearing appropriate personal protective equipment
- monitor the physical condition of personnel and/or general or specific safety conditions at the incident, in accordance with their brief
- take any urgent corrective action required to ensure safety of personnel
- update the Incident Commander or senior safety officer regarding any change in circumstances
- not be engaged in any other aspect of operations, unless this is required to deal with a risk critical situation.

The role of a Safety Officer can be carried out by any of the Fire and Rescue Authority roles, but the complexity of the task, size of the incident and scope of responsibility should be considered by the Incident Commander when determining the supervisory level required.

Fire and Rescue Authorities should ensure that training and other measures (such as aide-mémoire) are in place and available to support those staff liable to undertake this role.

Ventilation Officer

Consideration should be given to the appointment of a Ventilation Officer for larger or more complex spaces, their duties will include:

- determining the extent of existing ventilation systems and the possible effects of introducing ventilation
- planning the ventilation strategy using all available information, eg plans, interviews, reconnaissance from breathing apparatus teams within the risk area etc
- liaising with ventilation and firefighting/rescue teams in order to control the ventilation process and monitor its effectiveness
- liaising with the Incident Commander and positive pressure ventilation fan operator.

Personal protective equipment

Fire and Rescue Authorities must ensure that any personal protective equipment provided is fit for purpose and meets all required safety standards. Consideration should also be given to the selection of suitable sizes and gender specific requirements.

All personnel must use appropriate levels of service provided personal protective equipment and respiratory protective equipment as determined by the safe system of work.

Specific control measures

Uncontrolled fire spread/worsening of internal conditions

It is of utmost importance to control the flow of air between the inlet opening and exhaust vent, this may require the closing of existing openings, eg windows and doors both internally and externally.

All personnel should be made aware of the position of the inlet opening and exhaust vent and briefed as to the dangers of impeding them.

All personnel should be briefed as to the dangers of randomly opening doors and windows, as this will reduce the effectiveness of positive pressure ventilation operations, potentially worsening internal conditions for crews committed to the risk area.

Fire and Rescue Authorities should ensure the effective application of sequential ventilation tactics and that there is sufficient fire fighting media.

Creating an outlet

Good practice dictates that the exhaust should be created first and should be positioned as close to the fire as possible, ideally in the affected compartment. Use of the thermal imaging camera may assist in locating the seat of the fire from the outside of the building.

When creating the exhaust vent, fire and rescue personnel should ensure that personnel are positioned below and to the side of the opening to avoid injury from falling glass, debris and escaping hot smoke and gases.

Fire and rescue personnel should be aware of the possibility of backdraught prior to entering the incident area.

It is preferable to open windows rather than breaking them to facilitate best practice with sequential ventilation.

If creating an exhaust vent at high level the Ventilation Officer should consider the use of an aerial appliance.

A covering jet /spray should be maintained at the exhaust vent to combat any ignition of the escaping hot smoke and gases and to prevent any secondary fire spread.

Adverse wind direction and strength (blowing into the exhaust vent), blocking of an inlet opening or an exhaust vent or directing a jet/spray into the opening could negate the effects of the fans leading to a deterioration of internal conditions placing personnel at increased risk.

Noise

The noise of the positive pressure ventilation fan can make the distress signal unit and the evacuation signal inaudible, thereby increasing the risk of injury or death to operational crews within the structure. However, the use of radio distress signal unit can compensate for this and may neutralise this hazard. Additionally, in order to communicate externally the default control measure will be "closing down" the fan, this will then enable normal fireground communications to be utilised. This action will be coordinated by the Incident Commander who must then ensure that the evacuation signal is resounded in order to give committed crews the opportunity to hear the signal without the interference of background noise from the fan.

Debris blown from the fan

It is vital to ensure that debris does not enter the fan, the fan blades are shatterproof to a certain extent but very small parts of the blade can be ejected. It is important that eye protection and personal protective equipment with the helmet visor down is worn by all personnel in the immediate vicinity of the fan.

Some Fire and Rescue Authorities have purchased covers, which are placed on the fan when not in use, this prevents debris entering the fan and being ejected when the fan is started up or causing the blade to shatter.

Some Fire and Rescue Authorities use mats placed under the fan to ensure the area is clear of debris, if mats are not used, the area may need to be swept prior to use.

Working at height

Where possible, work from a ladder or aerial appliance.

Burns and scalds

The fan should not be refuelled whilst in use, nor should it be refuelled in an unventilated area.

Do not touch the hot exhaust, cylinder or engine fins.

Hands and fingers should be kept away from the fan and any hot surfaces.

Post incident

The following measures should be considered to help eliminate or remove risks after an incident, as appropriate to the nature and scale of the incident:

- any safety events; personal injuries, exposure to hazardous substances or near misses should be recorded, investigated and reported in line with legislative requirements such as *Reporting of Injuries Diseases and Dangerous Occurrence Regulations 1995*, etc
- arrangements should be in place to either remove all contamination from personal protective equipment or to ensure it's safe and appropriate disposal and to check that it maintains the agreed levels of integrity and protection for the wearer throughout it's lifecycle
- as appropriate, occupational health support and surveillance follow up
- conduct a de-brief to identify and record any 'lessons learned' from the incident. De-briefs will range in complexity and formality, proportionate to the scale of the incident and in line with individual Fire and Rescue Authority's procedures
- consider any changes required to safe systems of work, appliances or equipment in the light of any lessons learned from debriefs or from safety events
- consider the need to review existing information held on a premises or location, or the need to add a new premises or location into future planning, eg by adding to visit or inspection programme
- staff should be supported and monitored to identify whether they are experiencing any adverse affects and to check whether they would benefit from accessing counselling and support services.

Consideration should be given to arranging for staff to make a contemporaneous written record of their actions. This information may be used to assist in any internal or external investigations or enquiries that follow any incident eg the Coroner's Court, public enquiry, etc.

Other considerations

Fire and rescue personnel should observe correct manual handling techniques when moving the fan.

Chocks or blocks must *not* be used to increase the angle of the fan.

Technical references	
1	Fire Service manual Volume 2 Fire Service Operations, Compartment Fires and Tactical Ventilation
2	Table of contents, Volume 3 Guide to Operational Risk Assessment
3	Research into Venting FRDG (Research Report 68/96) P.P.V. a study of overseas experiences FRDG (Fire Research Reports & Memorandum 8/96).
4	Assessment of the use of P.P.V. in Domestic Properties FRDG (Fire Research Report & Memorandum 17/96)
5	Research into Venting, News of Home Office Fire Research for the Fire Service, Issue 16 Home Office, winter 1993
6	Chapter 7, Fire Service Manual Volume 2 Fire Service Operations, Compartment Fires and Tactical Ventilation
7	Chapter 8, Fire Service Manual Volume 2 Fire Service Operations, Compartment Fires and Tactical Ventilation
8	The Provision and Use of Work equipment Regulations and Guidance 1998
9	Page 43, Fire Service Manual Volume 2 Fire Service Operations, Compartment Fires and Tactical Ventilation
10	Manual Handling Operations Regulations and Guidance 1992
11	The Fire Experimental Unit's backdraught simulator, Fire Research News: News of Home Office Fire Research for the Fire Service, Issue 21, Home Office, Winter 1997

Further information
Manual of Firemanship Volume 2 and Home Office Video Series Flashover, Backdraught and Tactical Ventilation
DFM & DCO Letter 8/97, Management of Physiological stress
Study of the Physiological Effects of Wearing BA (Institute of Occupational Medicine)

SECTION 2

Summary of Generic Risk Assessment 3.6

Fighting fires using positive pressure ventilation

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
1	Opening of a compartment showing indicators of backdraught	Ignition of flammable gasses	Firefighter fatality or serious injury	Firefighters	Everyone must be aware of their own circumstances and the changing environment Openings will be made in line with current Fire and Rescue Authority procedures in dealing with potential backdraught conditions.
2	Being in a ventilated compartment approaching flashover	Flashover occurring	Firefighter fatality or serious injury	Firefighters	Everyone must be aware of their own circumstances and the changing environment. Firefighting techniques carried out in line with Fire and Rescue Authority policy.
3	Creating an outlet vent	Ignition of the heated flammable gases, as they mix with air (oxygen) at the outlet vent	Firefighter fatality or serious injury	Firefighters	When creating the outlet vent ensure personnel are positioned below to the side and upwind of the opening to avoid injury from falling glass, debris and escaping hot smoke and gases.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
4	Operating of the positive pressure ventilation fan	Automatic distress signalling units and evacuation signals inaudible	Firefighter fatality or serious injury	Firefighters	Effective communications must be maintained between breathing apparatus teams, fan operator and the Incident Commander/Ventilation Officer in order to monitor the effectiveness of the operation and react quickly to any changes Extra vigilance by all personnel will be required in order to hear a distress signal unit or evacuation signals because of the fan noise Use of a radio distress signal unit can be used to neutralise the hazard.
5	Noise from positive pressure ventilation	Damage to hearing	Serious injury	Firefighters	Fan operators and anyone working in close proximity to the fan must wear ear protection (consider rotation of operators).
6	The creation of the outlet	Broken glass or debris	Cuts, penetration injuries or other physical injuries	Firefighters Public	When creating the exhaust vent ensure personnel are positioned below to the side and upwind of the opening to avoid injury from falling glass, debris and escaping hot smoke and gases.
7	Creating outlet vents at a height	Falls from height	Severe physical injuries	Firefighters	Follow working at height procedures.
8	Inadvertent obstructions of the outlet vent	Build-up of heat and reduction of visibility	Severe physical injuries or burns	Firefighters Public	Where practicable appoint safety officers to monitor outlet vents.
9	Positive pressure ventilation fan operating	Accumulation of flammable dust being present giving rise to the potential for a dust explosion	Physical injuries or and severe burns	Firefighters	Where practicable, avoid positive pressure ventilation, as an accumulation of flammable dust may be present.