Communities and Local Government

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CHIEF FIRE & RESCUE ADVISER

Fire and Rescue Service Operational Guidance

GRAs
generic risk assessments

GRA 5.8
flashover, backdraught
and fire gas ignitions

Generic Risk Assessment 5.8

Flashover, backdraught and fire gas ignitions

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The Generic Risk Assessments in this series only apply to England.

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SECTION 1

GRA 5.8 Flashover, backdraught and fire gas ignitions

Scope

This generic risk assessment (GRA) examines the hazards, risks and controls that relate to Fire and Rescue Service staff and others who may be affected when the phenomenon of Flashover, Backdraught or Fire Gas Ignition is experienced.

As with all GRAs, this assessment provides a starting point for FRSs to conduct their own assessments within the context of local conditions and existing organisational arrangements.

Significant hazards and risks

Flashover

In a compartment fire there may come a stage where the total thermal radiation from the fire plume, hot gases and hot compartment boundaries (ceilings and walls) causes the radiative ignition of all exposed combustible surfaces within the compartment. Where the compartment is adequately ventilated, this sudden and sustained transition of a growing fire to a fully developed fire is known as a **flashover**.

Backdraught

A backdraught is where limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of partial combustion products and unburnt pyrolysis products. If these accumulate, the admission of air when an opening is made to the compartment can lead to a sudden deflagration. This deflagration moving through the compartment and out of the opening is a **backdraught**.

There are two scenarios of which firefighters must be fully aware:

Scenario 1	If the fire is still burning within a compartment when the door is opened, especially if the combustion gases are not escaping, the incoming air will mix with the gases and create an explosive mixture. If the gases within the compartment are hot enough, they will auto-ignite and flame will spread back into the compartment along with the fresh air. This would result in rapid fire growth, but not necessarily in a backdraught. Alternatively, if the gases are not sufficiently hot they will only be ignited once sufficient oxygen has reached the gases surrounding the fire. The flame will then travel across the compartment towards, and out of the doorway, driven by the expanding gases behind it.

Scenario 2

A more dangerous situation can occur if the fire in the compartment has almost died out. Once the door is opened air flows in and an explosive mixture may be created. There is the potential for ignition of these gases not to occur immediately. Once the firefighters enter the room however, and start to disturb the contents (e.g. turning over), an ignition source may be exposed and result in total flame engulfment. This is defined as a *'delayed backdraught'*.

Fire gas ignitions

Fire gas ignitions occur when gases from a compartment fire are 'leaked' into an adjacent compartment and mixed with the air within this additional area. This mixture may then fall within the appropriate flammable limits that if ignited, will create an increase in pressure either with or without explosive force. Where this process occurs it is not necessary for an opening to be opened for such ignition to take place. If an explosive force is experienced, this is commonly termed a *'smoke explosion'*. Where an ignition occurs with much less pressure, the term *'flash fire'* is more appropriate.

The backdraught, flashover and fire gas ignition phenomena described above can have potentially fatal outcomes. It should be recognised that although their outcomes may be similar the phenomena themselves are in fact significantly different in terms of the following:

- their pre-conditions
- evolution
- recognisable indicators.

At one incident, in the same structure, there may well exist the preconditions for each phenomenon. Further detailed information of the nature and preconditions for backdraught, flashover and fire gas ignitions is provided in the *Fire and Rescue Service Manual Volume 2 Fire Service Operations, Compartment Fires and Tactical Ventilation*.

Experience has shown that standard personal protective equipment (PPE), in itself, will not afford adequate protection against the effects of either flashover or backdraught. Therefore, it is vital that FRSs consider all the key control measures in order to reduce the risk to personnel to a tolerable level.

Key control measures

FRSs should consider how they control the hazards and risks described above. Key measures are as follows.

Recognition of the signs of backdraught and flashover

The first consideration that there is a possibility of a backdraught occurring will be dependant upon the fire history. Therefore, as much information as possible should be gathered in the early stages of the incident.

External signs of backdraught

Fire in a compartment with limited ventilation:

- Fire has been burning for some time
- Fire gases being pushed out under pressure from gaps
- Windows blackened with no visible signs of flame
- Fire gases pulsing out from gaps.

Internal signs of backdraught

Fire in a compartment with limited ventilation:

- Low neutral pressure plane
- Darkening of fire gases
- Inrush of air and fire gases forced out, through the opening
- Pulsation of fire gases through an opening
- Deflagration through the opening.

Signs of flashover

- Flames visible in the fire gases
- Combustible materials gassing off due to pyrolysis
- High temperatures, and increasing rate of combustion
- Neutral plane moving down
- Sudden increase in development of fire
- Pyrolysis at floor level in the compartment.

Training

The level and nature of training undertaken should be based upon an informed assessment of the operational need for each Fire and Rescue Service and within agreed guidance for competency based training (CBT).

Personnel engaged in an operational firefighting role should receive information instruction and training which should include:

- chemistry of combustion
- the effects of walls and the ceiling on the fire plume
- signs and symptoms of backdraught, flashover and fire gas ignitions
- door entry and gas cooling procedures
- safe system of work for dealing with incidents where flashover and backdraught may occur
- physiological stress and its management.

The outcomes of training must be evaluated to ensure that the training is:

- appropriate
- effective
- up-to-date
- meeting the identified operational need.

Pre-determined attendance

FRSs should ensure that the operational response to a building fire will be sufficient to allow relevant safe systems of work to undertake the activity. This will initially be determined by information received from the caller and followed and supplemented by the assessment of the Incident Commander.

Personal protective equipment

PPE manufactured to the current accepted standard should be worn.

When choosing suitable protective garments, the standard of clothing worn beneath the PPE should also be considered. Retained and auxiliary personnel may not have sufficient protection afforded by this clothing and therefore appropriate guidance/restrictions should be provided.

Incident command and control

The National Incident Command System should be adopted on arrival at the incident.

Where a high risk of backdraught is identified, consideration should be given to the initial adoption of defensive firefighting tactics.

Detailed guidance on operational tactics is published in the *Fire and Rescue Service Manual, Volume 2, Fire Service Operations – Incident Command, 3rd Edition 2008*.

Ventilation of the premises should be conducted in a controlled and considered manner with due account taken of wind conditions. Effective communications are essential for this to be achieved.

Ventilation points and exposed risks should be covered by water sprays to reduce the risk of external fire spread.

Suitable communications will be needed to ensure that the Incident Commander and sector commanders are able to communicate at all times.

The area outside the building on fire should be controlled (Inner Cordon Management) to reduce the number of persons at risk to the minimum necessary should a backdraught occur. This may include the tactical positioning of breathing apparatus entry control boards and fire appliances.

Additional equipment

An informed assessment of the risks within a FRS area will allow FRSs to consider the provision, and use of any additional equipment. Equipment may include:

- thermal imaging cameras
- ventilation tools
- hose reel spray branches
- PPV fans.

Technical references	
1	Table of contents, Volume 3 Guide to Operational Risk Assessment
2	Fire and Rescue Service Manual – Volume 2 – Compartment Fires and Tactical Ventilation (1997)
3	Fire and Rescue Service Manual, Volume 2, Fire Service Operations – Incident Command, 3rd Edition 2008 – TSO
4	The principles of Operational Training Fire Service Circular 5/96
5	Institute of Occupational Medicine; Home Office, FRDG Fire Research Reports and Memoranda, 18/96
6	Study of the Physiological Effect of Wearing BA (Institute of Occupational Medicine). DFM letter and DCO letter 8/1997 (Management of Physiological Stress)
7	GRA 3.6 Fighting Fires – Using PPV, HMSO 1998
8	BS EN 469 Protective clothing for firefighters & Personal Protective Equipment at Work: guidance on Regulations: Personal Protective Equipment at Work Regulations 1992
9	Dynamic Management of Risk at Operational Incidents, HMSO 1998
10	Home Office Technical Bulletin 1/97 Breathing Apparatus – Command and Control
11	Euro Firefighter – Global firefighting Strategy and Tactics, Command and Control, Firefighter Safety – Paul Grimwood FIFireE

Glossary

Neutral Pressure Plane

Fire in a compartment causes smoke and gases to rapidly expand with the hot gases rising due to their lower density and greater buoyancy. This results in a higher (positive) pressure in the fire room than the areas outside of the compartment. The forces, once fully developed, create an equilibrium whereby negative pressure relative to the outside, exists in the lower part of the room an positive pressure exists in the higher levels.

Where these two zones meet is known as the *'Neutral Pressure Plane'*.

Deflagration

To burn or cause to burn with great heat and intense light.

Pyrolysis

Transformation of a substance produced by the action of heat.

SECTION 2

Summary of GRA 5.8

Flashover, backdraught and fire gas ignitions

Ref. No	Task	Hazard	Risk	Persons at risk	Control Measures
1	Entering an outer compartment potentially affected by a fire gas ignition	Rapid fire spread Total flame engulfment of firefighters within the fire compartment	Burns and scalds Fire and explosion Blast injury	Wholetime Day crewed Retained Volunteers Other emergency service personnel Public	Operational procedures as per FRS policy and supervision Training in identification of indicators and methods of attack PPE manufactured to the current accepted standard
2	Opening up a compartment containing oxygen starved fire	Rapid fire spread/backdraught	Burns and scalds Fire and explosion Blast injury	Wholetime Day crewed Retained Volunteers Other emergency service personnel Public	Operational procedures as per FRS policy and supervision Training in identification of indicators and methods of attack PPE manufactured to the current accepted standard
3	Working in compartment with flammable gases present and exposing a source of ignition	Total flame engulfment of firefighters within the fire compartment	Burns and scalds Fire and explosion Blast injury	Wholetime Day crewed Retained Volunteers Public	Operational procedures as per FRS policy and supervision Training in identification of risks. PPE manufactured to the current accepted standard

Ref. No	Task	Hazard	Risk	Persons at risk	Control Measures
4	Carrying out tactical ventilation	Rapid fire spread/backdraught	Burns and scalds Fire and explosion Blast injury	Wholetime Day crewed Retained Volunteers Other emergency service personnel Public	Operational procedures as per FRS policy and supervision Training in identification of indicators and methods of ventilation PPE manufactured to the current accepted standard
5	Opening up a compartment where the thermal radiation generated by the fire is high, causing the room contents to give off flammable gases.	Rapid fire spread/flashover	Burns and scalds Fire and explosion Blast injury	Wholetime Day crewed Retained Volunteers Other emergency service personnel Public	Operational procedures as per FRS policy and supervision Training in identification of indicators and methods of attack PPE manufactured to the current accepted standard

Explanatory Key

Description
Reference number for the risk
Task – the specific activity being carried out
Hazard – Hazard present giving rise to the risk
Risk – the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious
Persons at risk – this should detail either employee, and / or member of public
Control measures – That could be used by the Service to reduce the risk