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RAPID FIRE PHENOMENA

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Issue 1

What is different about 3D Firefighting as opposed to traditional structural firefighting strategies? Quite simply it involves a 'culture change'. It demands greater attention is paid to the three-dimensional risk - the 'hidden dangers of smoke as it transports throughout a structure to lay in wait for firefighters. The real danger may exist in what you cannot see as opposed to what you can!

The UK has around 112,000 structure fires every year and approximately 50 of these demonstrate 'backdrafts'. However, around 600 of these fires demonstrate other unknown events associated with abnormal rapid fire development; that's once every 187 fires!

In the USA over 50 firefighters were killed by rapid fire progress between 1990 and 2000. A further 50 died through related phenomena. The death rate is increasing annually.

Fire-ground commanders and company officers should adopt a greater appreciation of the when; how; why; and where to deploy; attack; ventilate or isolate fires and gain a more in-depth and practical understanding of what 'coordinating' fire attack with ventilation actually means.

- Flashover
- Backdraft
- Fire Gas Ignitions
- Smoke Explosion
- Flash Fire
- Rollover
- Flameover
- Warning Signs
- Countering Tactics
- Tactical Ventilation
- 3D Water-fog
- Straight Streams

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3D FIREFIGHTING SAFETY BULLETIN 2/2007

Rapid Fire Phenomena

Flashover, Backdraft & Fire Gas Ignitions

A routine fire in a two storey residential structure turns nasty! As firefighters make entry to the first (ground) floor level the fire suddenly erupts and firefighters are suddenly caught and trapped above. Was this a flashover? Was it a Backdraft? Or did a smoke explosion occur?

Either way, we can be certain that when we make openings in a structure, not only are we releasing smoke, fire gases and heat but we are allowing air to flow into the fire compartment. By creating openings, particularly at the lowest levels in a structure, the additional air may cause the fire to suddenly escalate without warning and create havoc on the fireground!

How can we prevent, or reduce the chances of,

such rapid escalations of the fire?

- 3D Door entry procedure that utilises bursts of water-fog to neutralise and cool the fire gases
- Careful selection of vent openings
- Consideration not to vent at all
- 3D Gas-cooling of smoke in the overhead

Rapid Fire Phenomena - Three Basic Types

Flashover

Flashover is generally a heat induced development of a compartment fire although added ventilation may also speed up the flashover process. The breaking of a window or the opening of a door can initiate a flashover.

Backdraft

Backdraft is an event that may occur where a fire has been under ventilated for some period and is not receiving enough air to develop naturally. Any sudden inflow of air may initiate the event. It may not happen instantly!

Fire Gas Ignition

The term 'Fire Gas Ignition' covers a wide range of rapid fire phenomena where accumulations of fire gases and smoke are transported towards an ignition source, or where high energy heat is added to a gas pre-mix.

Learning Outcomes:

1	Rapid Fire Phenomena - Types of Event
2	Hazard Recognition & Warning Indicators
3	Possible Effects of Tactical Venting Actions
4	Countering Actions used to Reduce Risks
5	What might Happen?
6	What Tactical Actions might Cause an Event?
7	What can be Done to Prevent or Alleviate Events

Special points of interest:

- *Inappropriate venting of a fire building, without clear and viable objectives, may cause a sudden escalation of the fire beyond the capability of the hose-line in use*
- *Venting fires at the lowest level, followed by a high level opening, may create a chimney (pathway) for rapid fire spread*
- *Flaming combustion will normally head for a vent opening or open shaft —this effect can be used to advantage to pull fire away from occupants or firefighters*

Hazard Recognition & Warning Indicators

It is a stark fact that firefighters may be taught about the hazard warning signs and fire behavior indicators of potential events associated with rapid development, but rarely do they observe or act on these warnings at real fires! This failing has often cost multiple firefighters their lives.

It is common for compartment & structural fires to demonstrate 'classic warning' signs for the potential of an event but rarely do they actually progress to flashover, backdraft or some form of fire gas ignition.

This makes firefighters somewhat complacent and rarely do they communicate what they have seen to the Incident Commander.

It is absolutely essential that any such warning signs or fire behavior indicators are immediately communicated to the IC and where possible, an immediate action/s should be taken to alleviate conditions whilst the building is evacuated. Rapid Intervention Teams on standby and sector/safety officers should also be made aware of such indicators.

If classic warning signs are observed and any immediate tactical action taken to counter such a situation are ineffective, a defensive firefighting approach should be implemented until conditions improve and warning signs disappear.

It should be noted at this point that in some instances, there may be no warning signs whatsoever of an impending event of rapid fire development. Some events simply just happen without warning! Further still, some events may occur some way into the firefighting operation, even when general fire conditions appear to be improving.

The above 'gravity current' where smoke is seen to be exiting a doorway at high velocity can be taken as a clear warning of a fire that may be heading towards an event of uncontrolled rapid fire development. Entry into such an incident is highly dangerous.

Classic Warning Signs of an Impending Event

- High velocity smoke exiting a doorway or window
- A sudden change in colour of smoke, particularly darkening
- A sudden change in heat conditions, forcing crews to crouch low
- A sudden lowering of the smoke layer
- A repeated rising & lowering cycle of the smoke layer
- Pulsing smoke or smoke seen pushing out of openings, appearing under pressure
- Heavily smoke stained or cracked window glass (see picture on page 1)
- Blue flames seen at the fire's base, or in the overhead or at exit points
- Yellow or orange lames seen in the overhead, possibly as fire 'snakes' detaching themselves from the main fire
- Doors being forced open by air rushing in to feed a fire

The feeling or sound of air rushing in to feed the fire, or the reversal of smoke , causing it to head back into an opening

Making Safe Entry to a Building

Where fire is suspected behind a door it is essential that firefighters make a safe entry by utilising a partially opened door of 3-4 inches to apply 3D bursts of water fog in a controlled manner. This door entry procedure serves to assist in neutralising the heated gases and smoke that may exist within, prior to allowing air to rush in when the door is opened.

Before we open a door we must ask ourselves -

- Is the door hot to touch or blistered by fire?
- Is this a door we need to open?
- Is it our best point of entry?
- How might it affect firefighters or occupants elsewhere in the building
- Is the hose-line charged and firefighters ready in SCBA etc?

Venting & Fighting Basement Fires

In general, most firefighting tactics manuals and standard operating procedures will state that the primary hose-line in a fire building is sited to protect the main point of egress, or the staircase.

Where the fire is in a basement we need to be very careful how we approach and ventilate such a situation. There have been several instances where firefighters were killed during sudden escalations of fire that immediately followed venting actions. In some instances the basement has an entry door to the side or rear of the structure and in others there have been low level windows just above grade.

By making openings at these low level windows or at the exterior entry doorway to the basement, we may be providing an ideal inlet for air to feed the fire. These openings are far more likely to serve as air inlets than smoke or heat outlets!

A firefighter in Seattle lost his life some years ago through the sudden escalation of fire as his crew battled to gain interior entry to the basement stairs. Just as they opened the ground floor doorway into the basement the windows at basement level were vented. The subsequent rapid fire development caused the firefighter to become caught and trapped.

The 1999 Cherry Road fire in Washington DC suddenly escalated as a rear basement sliding glass door was vented. Two firefighters working above the basement fire became caught and trapped by the sudden fire escalation that followed.

In London in 2004 two firefighters died in a basement fire as a doorway was vented at second floor level, causing the fire to flashover.

In Brooklyn 2005, a firefighter was caught and trapped by a sudden development in the fire shortly after an exterior basement doorway and several below grade windows had been vented.

By creating openings at the lowest level in a structure whilst firefighters are working above the fire to protect the stairway, or whilst they are advancing a hose-line down into the basement to complete suppression, may place such crews in great danger .

Tactical considerations for a basement fire should include a primary line to protect the first floor; an attack line through an exterior entrance where one exists; where the interior line becomes the attack line ensure a back-up line is laid in; where casement windows are vented to assist descent of the attack line, first consider an 'indirect' attack or gas cooling application through these windows prior to the descent.

High Ceilings with Large Open-plan Floor Areas

Structures that have high ceilings with large open-plan floor areas below are renowned for rapid fire development and firefighter LODDs.

These buildings often disguise fire development at high-level behind a smoke layer, or suspended false ceiling. Where fire exists in this way, the amount of heat transferred down to firefighters advancing below is often negligible. They may describe light smoke with little heat, without realising a major fire is rapidly developing above their heads. Suddenly they are caught and trapped as they have advanced too far inside to escape quickly.

'These buildings often disguise fire development or dangerous smoke layers existing out of sight at high level'

In situations such as this it is essential to utilise thermal image cameras from the start and to check the ceiling/void for heat before advancing in too far.

Roof ventilation may be a viable option where manning permits but cross ventilation should be avoided a all costs for as long as possible.

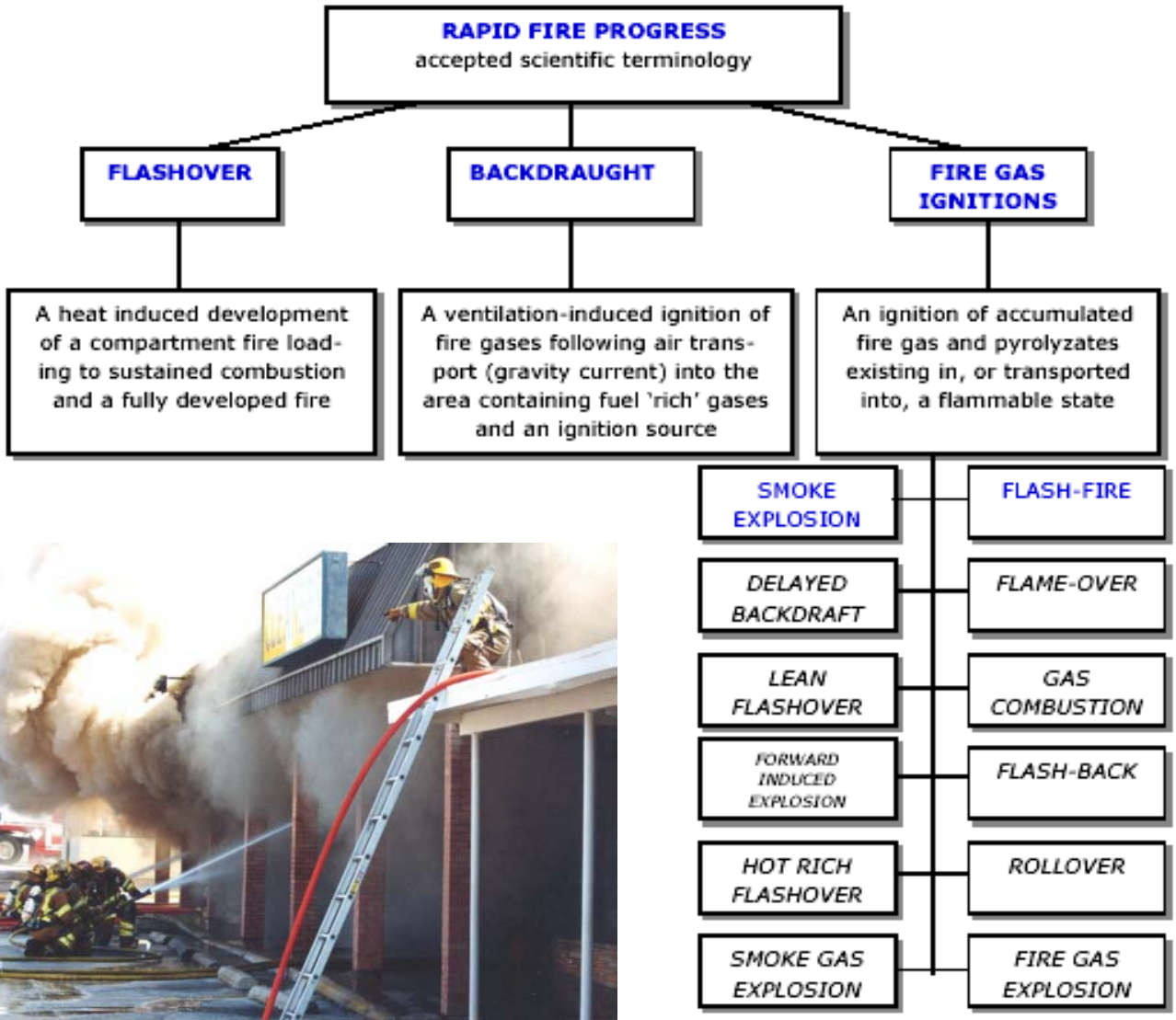
Where cross ventilation is necessary, firefighters should not remain inside the building whilst this is undertaken. In situations of large shop store fronts may be critical.

White Smoke Explosions

A review of previous fire reports and experiences suggests that although smoke colour is often misleading as an indicator of an impending event of rapid fire development or extreme fire behavior, the existence of white smoke in any great amount may be taken as an additional indicator or warning sign.

There have been several fires where large quantities of white smoke were observed just prior to an event that killed multiples of firefighters. It is certain that wood products or wall panels will give off white smoke when heated and this smoke is highly flammable. If allowed to accumulate in a compartment the hazards of entering that compartment should be fully appreciated and addressed in the risk versus gain assessment.

Dangerous accumulations of smoke may transport into rooms, attics, voids and spaces quite some way from the original fire to explode without warning!



'High Pressure' Backdrafts & Blowtorching Fires

Severe instances of rapid fire development are common in situations where an exterior wind is blowing into a fire compartment opening. It might be that smoke and heat is prevented from exiting a fire compartment by an external wind and this then accumulates inside the structure. This build-up of exterior air, smoke and fire gases actually causes internal pressures within the fire compartment to far exceed normally expected values.

A sudden decompression and resulting ignition may occur where an internal door is opened by firefighters making their approach on the fire. This ignition may be devastating and is termed 'high pressure backdraft'.

A slightly different effect may occur where a fire is subjected to a constant or gusting wind. Just as blowing on a barbecue increase the burning rate, an exterior wind will raise the heat release of a room fire. Such effects are particularly common in high rise buildings. If a window should fail whilst firefighters are occupying a compartment then the exterior wind blowing in might create a 'blowtorching' effect as the flames increase dramatically.

The dynamic pressures sometimes existing in stairshafts (natural stack effects) may actually cause windows to be 'sucked' inwards or 'blown' outwards within a few seconds of entering a compartment, allowing an exterior wind to create havoc on the fire floor! It is essential that Incident Commanders take the wind strength and direction into account when doing a 360° and selecting an entry point. If the wind is likely to create difficulties during advancement then always have it on tour back wherever possible. If it is not possible to select an entry point with the wind to your back then serious consideration might be given to a defensive attack on any particular fire.