Appendix A – Content to be archived

Bibliography [ARCHIVE]

3D Firefighting: Training, Techniques, and Tactics, Grimwood, Hartin, McDonough & Raffel, 2005
5/1994: A Survey of Backdraught - main report, Chitty R, Home Office Fire Research and Development Group UK, 1994
A Guide to Fire Investigation, IFE02, The Institution of Fire Engineers
A Pocket Guide to Arson and Fire Investigation, Edition 3, Factory Mutual System, 1990
A Real Scenario for a Ghosting Flame, Proceedings of the Fifth International Symposium, International Association for Fire Safety Science
Air Moving Systems and Fire Protection, NISTIR 5227, National Institute for Standards and Technology (USA), 1993
An Experimental Investigation of Backdraught, Fire Research Report Number 82, Foster JA and Roberts GV, 2003
An Introduction To Fire Dynamics, 3rd Edition, Drysdale D, 2011
Building Fire Other, Standard Operating Procedure F.07, Kent Fire and Rescue Service
Chemistry A* Study Guide: Study and Revision Guide for GCSE and International GCSE, Frank-Benfield, 2012
Chemistry FAQs and practice for A level, Max Parsonage, 2001
Crime Scene Management, Scene Specific Methods, Sutton ,P. & K, Trueman Wiley & Blackwell, 2009
Design fires for use in fire safety engineering, BRE, 2010
Edexcel AS and A Level Modular Mathematics - Mechanics 1, 2008
Effect of Positive Pressure Ventilation on a Room Fire, NISTIR 7213; National Institute for Standards and Technology (USA), 2005
Euro Firefighter, Grimwood P, 2008
External fire spread: building separation and boundary distances, BR187, BRE, 1991
Fire and Rescue Manual, Volume 2, Fire Service Operations, Incident Command, 3rd Edition, 2008
Fire and Rescue Manual, Volume 2: Fire Service Operations, Environmental Protection, 2008
Fire and Rescue Service Operational Guidance, Generic Risk Assessments, GRA 5.8, Flashover, Backdraught, and Fire Gas Ignitions

Commented [AG41]: Reference to any relevant publications will be included within the guidance

~~Fire and Rescue Service Operational Guidance, Generic Risk Assessments, GRA 3.1, Fighting Fires in Buildings~~
~~Fire and Rescue Service Operational Guidance, Generic Risk Assessments, GRA 3.4, Fighting Fires in Open Rural Locations~~
~~Fire safety engineering: a reference guide, BRE 459, BRE, 2003~~
~~Fire Service Guide, Volume 3, A Guide to Operational Risk Assessment, 1998~~
~~Fire Service Manual, Volume 1, Equipment and Media, Physics and Chemistry for Firefighters, 1998~~
~~Fire Service Manual, Volume 1, Fire Service Technical, Equipment and Media, Firefighting Foam - Technical, 2000~~
~~Fire Service Manual, Volume 1, Fire Service Technology, Equipment and Media, Hydraulics, Pumps and Water Supplies, 2001~~
~~Fire Service Manual, Volume 2, Fire Service Operations, Compartment Fires and Tactical Ventilation, 1997~~
~~Fire Service Manual, Volume 2, Fire Service Operations, Compartment Fires and Tactical Ventilation, 1997~~
~~Fire Service Manual, Volume 2, Fire Service Operations, Firefighting Foam, 1998~~
~~Fog Attack, Firefighting Strategy & Tactics - An International View, Grimwood.P, 1992~~
~~Forest and Moorland Fire Suppression, Murgatroyd, Forestry Commission, 2002~~
~~Fundamentals of Fire Fighter Skills, 3rd Edition, IAFC, 2013~~
~~Fundamentals Of Fire Phenomena, Quintiere JG, 2006~~
~~Gas and Vapor Explosion Hazards - Basis of Safety (Control of Ignition Sources), Chilworth Technology Inc., 2012~~
~~GCSE Physics, AQA, Jim Breithaupt, 2011~~
~~Generic Risk Assessment 1.1: emergency response and arrival at the scene, 2009~~
~~Generic Risk Assessment 3.1: fighting fires in buildings, 2011~~
~~Generic Risk Assessment 3.4: fighting fires in open rural areas, 2011~~
~~Generic Risk Assessment 5.8, Flashover, Backdraught and Fire Gas Ignitions, 2009~~
~~Harrow Court Fire, Reference 00342-2005, Coroner's Office, District of Hertfordshire, 2007~~
~~Ignition Handbook: Principles and Applications to Fire Safety Engineering, Fire Investigation, Risk Management and Forensic Science, Babrauskas, V, 2003~~

International Journal of Heat and Mass Transfer, Elsevier Ltd
Kirk's Fire Investigation (7th Edition), Brady Fire, 2011
Manual of Firemanship, Book 12, Practical Firemanship II, 1989
Manual of Firemanship: Elements of Combustion And Extinction, Book 1, Survey of the Science of Fire-fighting, 1974
Manual of Firemanship: Part 6A: Practical Firemanship: 1, A survey of the science of firefighting, 1971
National guidance document on the provision of water for firefighting, 3rd edition, Local Government Association and Water UK, 2007
NFPA 921: Guide for Fire and Explosion Investigations, National Fire Protection Association, 2014
Pollution prevention guidelines - Controlled Burn: PPG28, Environment Alliance, 2007
Safe handling of combustible dusts: Precautions against explosions, Health and Safety Executive, 2003
Sfpe Handbook of Fire Protection Engineering, 4th edition, National Fire Protection Association, 2008
Shirley Towers, HM Coroner for the Southampton City and New Forest District, 2013
Smoke Explosions, Fire Engineering Research Report 99/15, University of Canterbury, 1999
Surviving a Disaster, Counter Disaster Planning, Emery, English Heritage
The Usborne Illustrated Dictionary of Science A complete reference guide to physics, chemistry and biology, Usborne Books, 2007
Theoretical Considerations of the Growth to Flashover of Compartment Fires, Fire Research Notes 663, Thomas PH, 1967
Thermodynamics: An Engineering Approach, 7th Edition, Cengal and Boles, 2010

Websites (accessed March 2015):
Evaluation of the Onset of Flashover in Room Fire Experiments
Wind Driven Fires
Boston Fire, Beacon Street
East Sussex Fire and Rescue Service - Black Museum
The Institute of Conservation - The Conservation Register

Devon and Somerset Fire and Rescue Service - High Volume Pump

Warwickshire County Council - Atherstone-on-Stour report

Control measure - Liaise with the responsible person: Fires [ARCHIVE – CONTAINED IN INCIDENT COMMAND]

CONTROL MEASURE KNOWLEDGE

Buildings

Many types of premises, such as industrial or commercial buildings, should have a responsible person who will be accountable for aspects of the site under their control. See National Operational Guidance: Operations for further information.

Open environment

For further information see National Operational Guidance: Operations - Risk Information Gathering

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Refer to the responsibilities of fire and rescue services	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	There are no tactical actions associated with this control measure.	

Control measure - Scene survey: Fires and firefighting [ARCHIVE – ALL CONTENT MOVED TO SITUATIONAL AWARENESS – FIREFIGHTING]

Control measure - Closed-circuit television [REMOVE – IN OPERATIONS]

CONTROL MEASURE KNOWLEDGE

Closed-circuit television (CCTV) systems can assist fire and rescue services at many stages of an incident including:

- Providing fire control rooms or personnel en route to an incident with additional information about its type, size and location
- Providing personnel with information about the area near to the incident, for example:
  - Traffic conditions

- Presence of people
- Presence of animals
- Presence of other emergency responders

- Providing an incident commander with additional information to improve situational awareness, even if they are remote to the incident
- Assisting with post-incident investigation
- Improvement in operational learning

There are many types of CCTV systems, with various capabilities. They are mainly used to ensure the safety and security of premises, people and property, and may be found at locations including:

- Commercial and residential buildings
- Roadways and pedestrian walkways
- Public transport vehicles
- Emergency responder vehicles

CCTV cameras can also be worn by:

- Emergency responders
- Security guards
- Bailiffs
- Military personnel

Cameras may be linked to networks or recording facilities, and systems may be monitored by dedicated CCTV control rooms; these may be located in individual premises or at remote locations. The control room may be able to broadcast live or recorded imagery to other users, regardless of their location. CCTV control rooms are often able to adjust the views of individual cameras.

For larger incidents, or in areas with difficult or dangerous terrain such as wildfire incidents, it may be appropriate to use CCTV equipment attached to aerial vehicles such as helicopters, fixed-wing aircraft or drones (classified as a type of unmanned aircraft by the Civil Aviation Authority).

Some CCTV may be able to provide images in radiation spectrums, including infrared, which could provide helpful information in reduced visibility.

CCTV systems that are fitted to fire and rescue service vehicles, or body worn cameras, may act as a deterrent or be useful in capturing evidence; this could include instances of verbal abuse, physical attacks or road traffic collisions.

Arrangements should be made with local CCTV system operators during pre-incident planning, so that requests for their assistance during an incident can be handled efficiently.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable

	Make appropriate arrangements with CCTV system operators and know how to request their assistance	
	Consider using vehicle and body worn cameras	

TACTICAL ACTIONS

Fire control personnel should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Consider using CCTV to gather additional information about the incident or its location, and pass relevant information to the incident commander	

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Request access to CCTV footage or to the information gathered through use of CCTV systems	
	Consider requesting the assistance of aerial CCTV resources	
	Consider using CCTV to assist with mobilising to the incident	
	Consider using CCTV to inform situational awareness	
	Access and secure CCTV footage for investigations	
	Consider using CCTV footage to help inform operational learning	

Control measure - Personal protective equipment (PPE): Fires and firefighting [ARCHIVE WITH CONTENT RELOCATED]

Hazard - Inaccurate situational awareness: Fires and firefighting [ARCHIVE WITH CONTENT RELOCATED]

From the moment the incident commander and firefighters are notified and mobilised to a fire, information, both factual and predictive, will begin to flow. It is essential for the incident commander to ensure that everyone adopts an approach that enables them to manage the information they receive methodically, so they assimilate the data and begin to assess what can often be a complex, dynamic and chaotic situation.

At any incidents involving fire, information will present itself to the incident commander and firefighters from multiple sources, in numerous forms and not necessarily in an entirely expected order. Some of this will be factual information and some largely predictive information.

Factual information can be defined as accurate data from sources such as:

- Prior knowledge, including information from pre-incident planning Site-Specific Risk Information (SSRI), tactical plans, business fire safety and site visits or /inspections. See National Operational Guidance: Operations for further information.
- Reliable sources, such as information from a responsible person, the owner or /occupier of a building, a building engineer or other agencies
- Directly observed information - time of day, temperature, weather conditions, signs and symptoms of flashover or backdraught.

- Topography

The incident commander and firefighters will, in most situations, rely heavily on fire control rooms as their primary source of factual information. This information will be vital and will support the initial assessment and evaluation of what is likely to be encountered on arrival.

Interpreting data and information from the various sources available will allow crews personnel to identify, negotiate and establish safe approach, and access and egress to and from the proximity of the fire for attending resources.

Reference to the historical knowledge, intelligence, risk information and data gathered by a fire and rescue service and during pre-planning events such as site visits will also be vital.

See National Operational Guidance: Operations for further information.

By the time the incident commander and firefighters arrive at an incident they will have begun to formulate a basic initial plan. However, once in attendance on the fire ground, they will be in a better position to collect further predictive information and verify the facts to help locate the fire. This may come from interviewing and interrogating a range of data sets including:

- The original caller - See National Operational Guidance: Operations for information on call handling and mobilising
- The responsible person - National Operational Guidance: Operations for further information
- An appointed competent person
- Casualties, the public and bystanders - See National Operational Guidance: Incident Command
- Information gathered from fire and rescue service personnel and other emergency responders. See National Operational Guidance: Incident command for information on briefing and debriefing
- Interrogation of systems and technologies including fire detection and fire protection systems – See National Operational Guidance: Fires in buildings for further information
- Mobile data systems

This may also help to give an immediate indication of the size or extent of the fire or help in identifying key hazards such as flashover or backdraught and their inherent signs and symptoms.

Control measure - Building systems and fixed installations [REMOVE – CONTENT CONTAINED IN FIRES IN BUILDINGS]

CONTROL MEASURE KNOWLEDGE

Some premises have systems that can assist the fire and rescue service in obtaining information about the nature of an incident, including:

- Fire alarm systems
- Security systems
- Closed-circuit television (CCTV)

These systems could identify the initial location and time of any actuations, and any subsequent firespread. In some premises there will be a building fire control room that is used to monitor these systems.

Provision for emergencies and heating, ventilation and air conditioning (HVAC), as well as suppression systems, may provide valuable detail on a building's possible behaviour and the scope of an incident.

Some buildings will have slave control or repeater panels, which could be helpful for gathering information, but may not have all of the functionality of a main control panel.

Building systems may store data that could be used post-incident; this could be of use when trying to establish a timeline of the events leading up to the fire and rescue service's intervention.

Fixed installations may be present, including:

- Firefighting shaft
- Fire mains
- Hose reels
- Firefighting lift
- Sprinklers and drenchers
- Wet or dry risers
- Gas suppression systems

A firefighting shaft should be kept clear of obstructions and smoke, as this is the primary means of egress for firefighters in an emergency.

Hose reels are a fixed firefighting media designed for undertaking first aid firefighting intervention, commonly found in commercial buildings. Hose reels will not provide sufficient flow or pressure to deal with a well-developed compartment fire.

See Hazard – Failure, or inappropriate operation, of fixed installations

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	During fire safety inspections, gather information about fixed installations and building systems installed and ensure they function appropriately	14030

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Check building system indicator, slave control, alarm panels and CCTV to assess the status of facilities	14032
	Identify the presence and effectiveness of fixed installations and where appropriate, take control of their operation	18272
	Consider the use of wet or dry risers and fire mains to supply water to the scene of operations	18910

	~~Identify the presence of any active heating, ventilation, and air-conditioning (HVAC) systems~~	~~19789~~
	~~Review the effectiveness of active, passive and fire engineered protection before handing over the incident~~	~~20373~~
	~~Document any failure of fire safety measures and communicate to relevant department~~	~~14010~~

Control measure - Consider making a forcible entry [ARCHIVE – MOSTLY CONTAINED IN OPERATIONS WITH RELEVANT CONTENT RETAINED AND MOVED]

~~*CONTROL MEASURE KNOWLEDGE*~~

~~Incident commanders should consider the type of construction, possible entry points and the types of securing devices present and establish the most appropriate equipment and techniques for the specific situation. Selecting the right tool and techniques can save valuable time, could save lives and may also assist in mitigating any damage.~~

~~In most fire situations, the level of urgency and the method of entry will, to a great degree, depend on the time-critical nature of events. For example, if rapid entry is needed to save a life or prevent more serious damage or firespread, crews may not have the opportunity to limit any damage.~~

~~However, when the situation appears less urgent, firefighters can take more time and potentially select a less invasive technique to minimise or prevent any unnecessary damage. For example, the activation of an automatic fire alarm in a closed business in the middle of the night is much less likely to be a life-threatening situation than a call where people are reportedly in distress or trapped.~~

~~A huge range, and countless variations, of elements such as doors, windows, locks and security devices may be encountered depending on the type of premises. Firefighters should be familiar with the common styles of windows, doors, locks and security devices in their local area and with those that may be unique to certain types of premises, such as police custody suites, prisons and detention centres, hospitals or secure units.~~

~~The optimum time to build knowledge and understanding of unique sites and specific components is during Site-Specific Risk Information (SSRI) and pre-incident planning visits in compliance with current legislation. Arranging tours or inspections of buildings under construction and renovation is also an excellent way to learn about building construction and examine different security devices.~~

~~See National Operational Guidance: Operations - Risk Information Gathering~~

~~Incident commanders will need to evaluate all the information presented before deciding on a course of action. This includes:~~

- ~~Confirming that firefighters are at the correct address or location: where it is not obvious, it is important to check and establish that the address or location is correct and that crews are forcing entry to the correct premises, room or compartment~~
- ~~Selecting the safest and simplest method of gaining entry. When considering how to make entry, the objective should be balanced with the severity or urgency of the emergency. Crews should generally attempt to enter with the least damage in the shortest amount of time.~~
- ~~Before forcing entry, a simple rule is 'try before you pry'. Always check doors and windows to confirm that forcible entry is actually required. An unlocked door requires no force; a window that can be opened does not need to be broken. Taking a few seconds to check could save several minutes of effort and unnecessary property damage.~~

- Checking for alternative means of entry or entry points can also ensure that crews are not spending time working on a locked door when, for example, a nearby window provides easy access to the same room
- Selecting the most appropriate tools and equipment to effect entry

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop tactical guidance and support and mitigation arrangements for forcible entry by service personnel into areas and buildings	13734
	Develop processes for letting absent occupiers, owners and responsible persons know that forcible entry has been made.	13735
	Provide crews with information, instruction and training in effective methods of making forcible entry	13736
	Make arrangements for securing property where forcible entry has been made	13737

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Gain access to premises, causing minimal damage while having regard to the urgency of the situation	13738
	Consider cutting away to access the seat of the fire, hidden voids and compartments	13739
	Gain access to the fire, compartments and voids using safest and simplest method	18073

Control measure - Appropriate deployment of resources [ARCHIVE – CONTAINED IN OPERATIONS]

CONTROL MEASURE KNOWLEDGE

The uncontrolled arrival and deployment of emergency fire vehicles and crews on the fireground may lead to poor vehicle positioning and insufficient accounting for personnel deployed at the scene. In an explosion, a sudden worsening of fire conditions or structural collapse, failure to follow proper deployment protocol may lead to injury, damage and a delay in locating or failing to locate affected personnel.

Vehicle drivers and commanders need to be aware of the appropriate cordon and safety distances applicable to hazardous materials, the likely development of fire and the nature of building collapse for different types of structure. Other significant hazards and risks include:

- Members of the public who may be distressed, excitable or unaware of the nature of the emergency

- The operational imperative, which may place moral pressure on crews, or the imperative to act in a way that is directed at satisfying that need rather than the operational needs of that particular incident
- The working environment, which may include available light, distance to the scene of operations, terrain and conditions underfoot
- Remote locations, which may lead to poor radio communications, increased workloads on firefighters, difficulties with water supplies and increased attendance times

When deploying resources to the fireground, incident commanders should be aware of the strategic disposition of resources in their service and release or withhold from deployment any resources that are not needed or have become surplus to requirements.

At larger incidents, commanders should consider nominating a rendezvous point (RVP) for emergency fire vehicles to attend before arrival at the incident. At major incidents a strategic holding area (SHA) or tactical holding area (THA) may be necessary, where resources may be held for longer periods, and where welfare arrangements are in place and dedicated enhanced logistical support available.

For further guidance see National Operational Guidance: Operations - Time of alert to time of attendance

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop tactical guidance and support arrangements for the hazards and actions to be taken when considering the appropriate deployment of resources	
	Consider and implement National Operational Guidance: Incident command	

TACTICALACTIONS

Incidentcommandersshould:

Revised, new, archive or no change	Tactical action	Reference No. if applicable

Control measure - Respiratory protective equipment [REMOVE – CONTAINED IN THE OPERATIONS GUIDANCE]

This control measure should be read in conjunction with Personal protective equipment

CONTROL MEASURE KNOWLEDGE

Respiratory protective equipment (RPE) is a type of personal protective equipment designed to protect the wearer from breathing in harmful substances, or from oxygen-deficient atmospheres, when other controls are either not possible or are insufficient on their own.

The use of RPE allows efficient, effective and safe working practices to be adopted at incidents of all sizes and type where an irrespirable atmosphere presents a hazard to personnel. There are two main types of RPE; respirators and breathing apparatus (BA).

Further information about the use of RPE can be found in the British Standards Institution (BSI) publication, ISO/TS 16975-1:2016 Respiratory protective devices – Selection, use and maintenance: Establishing and implementing a respiratory protective device programme.

Respirators

Respirators are filtering devices that remove contaminants from the air being breathed in; non-powered respirators rely on the wearer breathing to draw air through the filter. Respirators are not suitable for use in oxygen-deficient atmospheres.

Breathing apparatus

Breathing apparatus (BA) requires a supply of breathing-quality air from an independent source such as an air cylinder. Breathing apparatus (BA) enables firefighters to breathe safely in otherwise irrespirable atmospheres. The use of BA as a control measures is likely to be applied as part of the incident plan for any incident involving:

- Smoke and fire gases
- Working in confined spaces
- Hazardous materials including:
  - Asphyxiants
  - Dusts
  - Toxic, flammable or explosive substances

Airlines

Airline equipment supplies air to the wearer from a cylinder that is located remotely from them. The technical procedures for the specific airline equipment in use should be followed. Airline equipment should only be used by trained and competent personnel. It be appropriately used and maintained, to avoid the air supply to BA wearers being compromised.

Following an appropriate risk assessment, it may be decided to use airline equipment to provide breathing apparatus capability. Its use may be appropriate:

- If an extended air supply to self-contained BA wearers is required
- If use of self-contained BA is unsuitable
- At incidents in the open, where airlines are used to provide a breathable atmosphere without the weight of a self-contained BA set
- For specialist operations that involve restricted access

Although the use of airline equipment reduces the overall weight carried by a BA wearer and can provide a limitless supply of air, the physiological limitations of the BA wearer should be considered when airline equipment is used.

Face mask fit testing

If RPE is used, it must be able to provide adequate protection for individual wearers; RPE cannot protect the wearer if it leaks.

Face mask fit testing is a method of checking that a tight-fitting face piece matches the wearer's facial features and seals adequately to their face. A face mask fit test should be carried out as part of the initial selection of the RPE and it is good practice to ensure testing is repeated on a regular basis. Further detail on face mask fit testing is provided in the Breathing apparatus foundation material.

Further information is contained in the Health and Safety Executive's publications:

- Respiratory protective equipment at work: A practical guide (HSG53)
- Guidance on respiratory protective equipment (RPE) fit testing (INDG479)

Maintenance

Maintenance is a requirement for all RPE, except for disposable (single use) RPE, and should be carried out by properly trained personnel. Thorough maintenance, examination and tests should be carried out at regular intervals in accordance with the manufacturer's instructions.

Breathing apparatus foundation material

The breathing apparatus foundation material provides the procedures underpinning the planning, use, and command and control of BA. It should also assist fire and rescue services with:

- Developing safe systems of work when deploying BA
- Managing BA operations
- Testing and maintenance of BA equipment
- Defining roles and responsibilities for BA
- Developing BA training
- Readiness of BA wearers
- Pre-planning for intraoperability and interoperability

For more information refer to The Foundation for breathing apparatus.

STRATEGIC ACTIONS

Fire and rescue services must:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Provide personnel with suitable and appropriate RPE that fits and protects the wearer	
	Ensure that personal RPE worn simultaneously is compatible and does not negatively impact other safety measures	

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable

	Specify the type of RPE required for hazards identified through risk assessments and communicate this information to personnel	
	Have suitable arrangements for the provision, testing and maintenance of respiratory protective equipment	
	Ensure personnel regularly undertake face mask fit testing of RPE	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Carry out a risk assessment before deploying personnel wearing RPE	
	Ensure personnel wear the appropriate type of RPE	
	Consider the use of airline equipment	

Control measure - Secure the scene for investigation [REMOVE – IN OPERATIONS]

CONTROL MEASURE KNOWLEDGE

Securing the scene and preserving evidence should commence immediately if doing so does not affect safety or the successful conclusion of an incident. Incident commanders should achieve scene security and evidence preservation by establishing and maintaining cordon controls.

Incident commanders should use cordons to keep the public out and maintain control within the inner cordon. A cordon should start as large as practicable until such a time as resources can be released from a scene and the size of the cordon reduced. The police crime scene investigators may search the inner cordon to ensure that any potential evidence is recovered. Other agencies may wish the cordon to be of a specific configuration; incident commanders should liaise with them and balance safety concerns with the needs of investigating agencies.

Only authorised personnel should enter the scene and a clear common approach path must be used for all authorised personnel to protect physical evidence and prevent cross-contamination. Keeping a record of any 'foreign objects' taken into the scene by personnel may help to eliminate such items from an investigation.

If there are any doubts about the cause, requests (after the operational phase of the incident has been concluded) to allow occupiers or others to enter a property or access a vehicle should be considered carefully. If allowed, the person must be accompanied and supervised and the actions/people/locations recorded.

Personnel need to be aware that scene preservation will be necessary to enable other organisations to investigate an incident fully. Fire and rescue services should ensure that only personnel required to deal with the incident access the site and that any necessary movement of casualties, objects and wreckage is minimised.

When fire and rescue service operations are complete, the responsibility for the security of an incident, property and contents will pass to the police or statutory investigation team.

Early liaison to establish the requirements of the statutory investigation team is required. However, the control of the scene should not interfere with any lifesaving activities or fire and rescue service statutory duties.

It is important to control the number of people allowed on the incident site so that evidence such as personal effects are not disturbed, or are disturbed as little as possible. When the situation permits, there should be a careful withdrawal of all non-essential personnel and equipment.

The police may be required to take control of cordons after they are established, and maintain scene logs.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Procure equipment or other supplies that may assist with securing the scene	
	Have a record of the equipment issued to personnel, so that it can be eliminated from an investigation	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Secure the scene to ensure evidence is preserved for internal and external investigations	
	Inform all personnel of known or likely areas of interest for fire or criminal investigation, so that these can be avoided	
	Minimise the number of personnel allowed into the scene	
	Minimise the potential for 'foreign objects' to be taken into the scene	
	Preserve the scene for future investigations	
	Hand over responsibility for the security of premises and removed items to the responsible person or the police	

Control measure - Preserve evidence for investigation [REMOVE – IN OPERATIONS]

CONTROL MEASURE KNOWLEDGE

Fires, floods or other emergencies can destroy or significantly alter structures, vehicles and objects; key evidence may be lost before the fire and rescue service arrives.

An ongoing incident and the actions of responders can affect evidence required for an investigation. The aim of personnel should be to ensure evidence is not destroyed or disturbed where possible. On arrival, consideration should be given to:

- How fire and rescue service activity may affect any subsequent investigation
- Identifying and prioritising the preservation of evidence that may deteriorate
- Minimising contamination of the scene

If the scene needs to be examined as part of a criminal investigation, it should be carefully preserved to protect evidence. The unintended consequence of simple actions such as washing down equipment after an incident may destroy or damage evidence.

Where evidence cannot be preserved physically, information to support investigations should be captured in other forms. For example, physical evidence noted on arrival, such as broken windows or suspected remains of incendiary devices, should be documented and photographed if feasible.

Once in attendance, the fire and rescue service can ensure that as much evidence as possible is preserved. Identify potential evidence and take steps to preserve or retrieve it where it may be lost during operations. It may be appropriate for the task of collecting physical evidence to be allocated to a police crime scene investigator or fire and rescue service investigator.

It may be necessary to cover windows, doorways or other apertures that allow people to see into the scene inside a building or other structure. For other types of incident scenes, the use of tarpaulins may help to preserve evidence from exposure to the elements.

The decision to leave identified physical evidence at the scene should be carefully considered. To assist with an investigation, if it is essential to move anything, a record of observations should be kept, including details of actions taken and the reason for doing so.

If evidence may be lost if left in place, the fire and rescue service should consider seizing it. There should be a secure storage area in which to keep it, and service procedures for its collection and handling.

Care is needed where insurance claims may be made, as ownership of the property may transfer to the insurance company.

Incident commanders should confirm:

- All information relating to the incident
- Age, gender, name and contact details of the deceased, casualties and witnesses
- Whether life has been confirmed extinct if there is a deceased casualty at the scene
- Details of any agencies in attendance, such as utility companies
- Information recorded by the entry control operative, if required
- Entry route and tactical methods used to effect entry
- Doors and windows open or broken at the time of the incident
- Emergency fire and rescue service vehicle call signs
- Whether personnel have recently attended similar incidents, in case of cross-contamination

Other sources of information, may include:

- CCTV footage from:
    - Emergency responder vehicles
    - Body worn cameras

- Buildings
- Control rooms

- Fire or intruder alarm systems at the scene, including any remote, offsite recording systems
- Photographs, videos or voice recordings of the incident, including those:
  - Captured by personnel
  - Captured by witnesses
  - Downloaded to local news sites or social media sites

Recovery of casualties and their personal property

If surviving or deceased casualties need to be moved or removed, care should be taken to ensure that their personal property is kept with them. If this is not possible, a record should be kept of the location of items; it may be useful to photograph the items before the casualty is recovered.

The positions of deceased casualties are extremely important for identification purposes and to help establish cause of death. The removal of bodies should only be carried out under the direction of the police or statutory investigation team.

However, removing the bodies before the arrival of investigation teams or medical teams may be necessary to rescue other casualties, or to prevent the bodies being destroyed by fire or other event. Where this is the case, the position of the body and its location should be noted, labelled if possible and reported to the investigation team.

Personnel who have moved bodies should be questioned and make a statement as soon as possible after the incident, to improve the accuracy of their recall. Whenever possible, an officer should be appointed to map out as accurately as possible the location and position of bodies, bearing in mind that some incidents, may result in them being distributed over a wide area.

Any personal property that fall from the casualty or body while they are being moved should be collected, recorded and kept with the casualty or body if possible, as it may prove to be a means of identification.

Bodies that have been badly burnt become brittle and require careful handling by trained personnel so as to avoid vital evidence of identification or cause of death being destroyed.

It may be useful for photographs or video to be taken of the scene of the incident and the position of the bodies. This can also assist in debriefing purposes.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop a joint understanding with other emergency services and agencies regarding the actions required to preserve evidence at the scene of an incident	
	Provide equipment or other supplies that may assist personnel in preserving evidence	
	Have the ability to securely collect and store any seized evidence	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Consider preservation of evidence when planning, communicating and implementing tactics	
	Consider requesting assistance from a police crime scene investigator or fire and rescue service investigator for collecting physical evidence	
	Consider moving physical evidence to a safe place, away from the effects of the fire or firefighting	
	Consider seizing evidence if it may be lost if left in place	
	Avoid movement of dials, valves and controls or record original position for investigation purposes	
	Gather and record information about physical evidence	
	Note issues relating to cordons or physical evidence in the decision log	
	Notify investigators if personnel have recently attended similar incidents, which could result in cross contamination of an investigation scene	

Control measure - Incident handover [ARCHIVE – CONTENT IN OPERATIONS]

This control measure should be read in conjunction with Operations - Make an effective handover to the responsible person

CONTROL MEASURE KNOWLEDGE

The handover phase of an investigation may take place directly at the scene or at a later stage, once all the scene work has been completed. The nature of a handover will be influenced by the scene or the nature of the investigation and may range from a formal and documented handover to a verbal briefing.

Where a statutory body is taking over, an appropriate level of formality should be employed and all reasonable effort should be taken to avoid the compromise of any evidence recovered.

For non-statutory agencies, local protocols or an assessment of each incident on its own merits will determine the extent to which the fire and rescue service can assist with an on-site handover or maintenance of scene security. Most commonly, this category includes investigators employed by, or acting on behalf of, insurers.

When the party taking over the scene does not have a statutory role, the fire and rescue service should be able to satisfy itself that it is the appropriate body or person to take responsibility for the scene.

The physical transfer of the scene between agencies, notably after fire and rescue service operations, is an important stage. It is very easy for scene management practices to be reduced or lapse during the transition. The fire and rescue service may be keen to remove any equipment still deployed and have a last walk round the scene. The organisation taking over may want to view the scene, either escorted by the fire and rescue service or not. Good cordon and scene management will limit the potential for valuable evidence to be lost or compromised.

The handover should include:

- Incident history (the incident and actions of the fire and rescue service, members of the public or other first responders)
- Facts relevant to the investigation (methodology and actions taken so far)
- Safety issues (possibly including risk assessment findings)
- Other issues that may have had an impact on the scene or be of relevance to the investigation (e.g. witness details)

For formal handovers, it may be useful to record the names and signatures of the responsible individuals from each agency.

It is important to remember that, where a scene is handed back to the owner or occupier, some of this information may be provided.

Handing over the scene or investigation may not be the end of fire and rescue service involvement and the fire and rescue service may continue to play a supporting role. In this case, fire and rescue service personnel should make themselves familiar with the working protocols of the lead agency.

Liaison

Scene-based liaison will often tie in to existing local protocols and incident management systems, particularly with statutory partners who will be familiar with this type of working.

Maintaining liaison away from the scene can be more difficult and the principle of providing single or named points of contact can ensure efficient and appropriate practices. This can be particularly important when managing the exchange or submission of documents, other evidence or where interviews may be requested. Too many informal contacts can compromise the organisations or evidence and result in no one having a full knowledge of the investigation.

Where the details of other parties are not known at the time, it can be useful to have a general contact point for initial enquires that can be readily accessed, for example, through the fire and rescue service website.

In all cases, a managed approach to liaison can ensure that the investigation is progressed effectively; each agency can track their involvement and actions, with decisions set out and explained at a later stage if required.

Having clear protocols for formal and informal liaison processes will assist management of the investigation. Informal processes are particularly open to misinterpretation, where one party may feel they had an 'off the record' conversation only for it to be used subsequently and attributed to them as evidential material.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop tactical guidance and support arrangements for the actions to take to hand over responsibility for a fire scene and/or investigation, in consultation with partner emergency services and agencies	13980

	Ensure appropriate arrangements are in place for handing over a scene	17840

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Hand over responsibility for removed items and security of premises to the responsible person or the police	18321
	Notify investigators if crews have recently attended other incidents where cross contamination may have happened	18015
	Liaise with the police and local authority support teams at incidents involving serious injury and fatalities	19944

Control measure - Written reports [ARCHIVE – PUBLISHED IN OPERATIONS AS 'ACCURATE RECORD-KEEPING']

CONTROL MEASURE KNOWLEDGE

Comprehensive report writing is a key aspect of gathering information and intelligence at an incident.

It is important that reports are accurate, clear and unbiased as they will support further research, formal investigation and/or statistical content.

In addition, witness statements including those of attending personnel should be made. Witness statements are often taken using an electronic template document developed by a fire and rescue service that should be based only on objective and personal recollection of events, not on opinions and unfounded conclusions.

Legislation, such as the Criminal Procedures and Investigation Act 1996 and the Criminal Justice Act 2003 should be referred to regarding the legal standpoint for official report writing and note taking. This includes the need to:

- Record the information as soon as practicable
- Retain the information in its original and complete format
- Reveal the information when requested
- Review the information for accuracy, procedural applications and assessment of corporate or operational risks and threats

Reports can consist of:

- Informal contemporaneous notes:
  - Made at the time of an incident or event, or as soon as practicable, whilst the facts of the situation are still fresh in the mind of the person making the record
  - Where operationally practicable, notes and records should be written in ink
  - Consider creating a permanent record of other notes - for example dry-wipe breathing apparatus (BA) entry control boards can be photographed

- Notes have a legal significance in that they can capture more detail than a person may recall at a later date

- Formally structured data gathering documents
  - Notes made on unofficial materials or papers should be transcribed onto an official form of record as soon as practicable after the event. The original form of the note must be retained and disclosed if required.
- Contemporaneous note books, as issued to officers
- Sketch plans, diagrams and photographs
  - Can include the layout of a building or compartment, positions of people, vehicles or sectors, and are considered to be equivalent to a written record or note
  - The storage and movement of digital images and media is subject to legislation such as the Data Protection Act 1998, the Freedom of Information Act 2000 and the Human Rights Act 1998

All types of records should be signed and dated by the person creating them so as to enable their use within a formal legal context if required.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Keep accurate records of the agencies and individuals involved in the investigation	
	Have policies and procedures that comply with the relevant legislation for note taking, recording information and report writing, for all appropriate levels of investigation	
	Provide appropriate means of recording information to be used in an investigation	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Record all relevant incident information in an appropriate format	

Control measure - Attendance at coroner's court (or equivalent) [ARCHIVE – PUBLISHED IN OPERATIONS AS 'LEGAL PROCEEDINGS']

CONTROL MEASURE KNOWLEDGE

Fire and rescue service personnel may be called to give evidence at an inquest into the death of an individual. The aim of an inquest is to establish the means, cause and circumstances of a person's death. The coroner is also lawfully charged to identify measures to prevent future deaths in similar circumstances.

~~The aim of the inquest is not to apportion blame or to attack the behaviours or actions of key personnel such as the emergency services, but to understand the situation leading up to the event the actions of first responders and the conditions in which the deceased may have been found.~~

~~Fire and rescue service personnel are seen as professional witnesses. Their role is to assist the inquest in understanding the situation that the fire and rescue service faced on arrival at an incident and to explain their professional observations, actions and outcomes.~~

~~The fire and rescue service witness could be presenting evidence as:~~

- ~~An officer in charge or firefighter directly involved in the incident~~
- ~~The fire investigation officer who has investigated the cause, spread and outcome of the incident~~

~~The coroner will take the fire and rescue service witness through their statement and/or report made in relation to the incident. An inquest is a fact-finding process and it is not necessary to remember exactly what was said at a specific time during a dynamic incident. The coroner will give the fire and rescue service witness the opportunity to add, confirm or change their statement. This may be followed with more specific questions or requests for clarification on key points of a technical or professional nature from the coroner or others in court, including family members of the deceased.~~

~~Fire and rescue service witnesses should avoid using technical or working jargon and seek to present evidence in an unambiguous and simple manner. If a witness is asked a question that they cannot give a full or factual answer to, the coroner may direct them not to answer the question and instead seek to resolve the issue through open discussion with the family members in court.~~

~~The aim of the fire and rescue service witness should always be to impart their knowledge and observations from the incident in a clear and informative manner and to add clarity to the inquest's understanding of the incident. The inquest is not necessarily concerned with the specific and individual technical aspects of the activities of any one firefighter during a dynamic incident. Prior to attending those called should:~~

- ~~Ensure they have copies of their statement and/or any report previously provided to the coroner~~
- ~~Review their statement to ensure the contents are accurate. They should check dates, times and key facts in the statement.~~
- ~~Consider discussing the statement and/or report with an experienced fire investigation officer to gain an understanding of the types of questions that may be asked by the coroner and/or family members of the deceased~~

~~Personnel providing witness to a coroner's court are not on trial but are there to assist the court in understanding the circumstances of the incident and should:~~

- ~~Be prepared to discuss their professional observations and immediate actions on arriving at the scene so that the coroner has a clear understanding of the physical condition of the incident~~
- ~~Can explain how, as a fire investigation officer, they arrived at their stated hypothesis for the cause of the fire and spread~~
- ~~Refrain from drifting from their relevant areas of professional knowledge~~
- ~~Answer the questions in a factual manner; the coroner will oversee the inquest and manage the impact on the family members~~

N.B. For ease of publication the terms 'coroner', 'coroner's court' and 'inquest' have been used in this control measure. However, it is recognised that other terminology is used outside of England and Wales; the equivalent of these terms should be applied where appropriate (e.g. procurator fiscal)

Refer to the Ministry of Justice, Guide to Coroners Services for details on the inquest process in England and Wales.

Refer to information and booklets available on the Crown Office & Procurator Fiscal Service for details on the inquest process in Scotland.

Refer to the publication Working with the Coroners Service for Northern Ireland

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop guidance and support arrangements for the actions to take to enable personnel to provide evidence in a court of law, in compliance with relevant legislation and following consultation with partner emergency services and agencies	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Prepare evidence and records to a standard appropriate for scrutiny at any potential future inquest or inquiry	

Control measure - Operational learning [REMOVE – PUBLISHED IN OPERATIONS]

CONTROL MEASURE KNOWLEDGE

Following an incident, fire and rescue services should perform debriefs, investigations and use the assurance process for operational incidents to identify learning, which can:

- Improve public safety
- Improve the safety of fire and rescue service personnel, and others involved during or after fire and rescue service activities
- Share previously unidentified hazards and risks
- Share previously unidentified safe systems of work and control measures

Fire and rescue services should put in place processes and support arrangements for operational learning. This should include the arrangements that would be appropriate for any multi-agency operational learning.

Collecting information

The recording and sharing of significant findings from incidents and investigations helps to inform future practice. This process should start at the incident ground with thorough recording of relevant operational activity, and include a robust incident debrief procedure.

Debriefs should be led in a structured manner and take place at the most practical time following the closure of an incident. They should allow all responders the opportunity to contribute, to highlight good practice or areas of development and to be able to do so in an open and constructive environment. The aim of debriefs is to assist in identifying individual, team or organisational learning.

An incident debrief procedure plays a vital part in both personal and organisational learning. It fulfils a critical or key need for effective learning and development by connecting a root cause with an associated effect. Once identified, this process will enable clear plans or programmes to be agreed, which can be used to address or improve any shortfalls in the fire and rescue service's policies, procedures or information.

Investigation can play an important part in supporting future learning by providing a structured and objective approach to identifying and capturing evidence. This approach should ensure that it withstands scrutiny in its future application and is fit for purpose. Operational learning from any incident type may provide information pertinent to public or responder safety.

Learning opportunities should be identified and shared locally and nationally as appropriate to improve intervention and safety, identify hazards and develop safe systems of work. Any learning should also be shared with National Operational Learning. For further information refer to the Good practice guide for fire and rescue services.

Once the opportunity for future learning has been identified, careful and early consideration should be given to the type and format of information required.

There should be careful consideration about the environment in which the information will be used, as any use of information is subject to legislation and regulations. Refer to Data and information strategy within Data and information management.

Monitoring and highlighting trends

A trend consists of several events that exhibit one or more features in common. This may be geographical, physical or related to other circumstances under which they occur.

Failing to identify trends at the earliest possible stage can risk the possibility of the number or severity of events increasing, so early identification is important. This is particularly true of fire-setting, where a series of small fires may reflect someone's growing confidence before attempting a more serious attack.

Trends in fires or other types of incidents may relate to new products, or changes in the way existing products are used. Investigation can assist when identifying a trend, by establishing its cause, confirming common features and collecting the evidence required to influence a solution.

Identifying and researching a trend should provide a means by which targeted interventions can be taken. Once action has been taken, the impact on the trend should be monitored both remotely and through attendance at scenes. Care will also be required to ensure the problem has been addressed and not just displaced. Effective use of analysis, and fire investigation where appropriate, should help to confirm this.

External liaison and information

Liaison with other fire and rescue services and organisations may help to establish whether the trend is localised or being seen in other areas. This liaison can take place through existing groups and communication networks, or established specifically for the trend depending on the nature of the issue. For example, with fire-setting, close liaison with the police and other agencies that maintain relevant data will be important; they may have additional knowledge about individuals or activities.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Have processes and support arrangements for operational learning	
	Have processes for sharing appropriate learning with National Operational Learning	
	Appoint a single point of contact (SPOC) for receiving and sharing National Operational Learning	
	Have processes and support arrangements for identifying, monitoring and addressing trends	
	Liaise with other fire and rescue services and agencies when identifying, monitoring and addressing trends	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	There are no tactical actions associated with this control measure	

Hazard - Fires involving flammables, explosives and combustible dusts [ARCHIVE – CONTENT RELOCATED TO SITUATIONAL AWARENESS: FIREFIGHTING]

Hazard - Insufficient resources: Fires and firefighting [ARCHIVE – CONTENT RELOCATED OR CONTAINED IN OPERATIONS]

This hazard should be read in conjunction with Incident command - Insufficient resources

HAZARD KNOWLEDGE

Commanders should be aware that any congestion on the fire ground can lead to delays in important resources arriving and the likely impact on any fire development. It may also obstruct the passage of vehicles from other agencies, particularly ambulance service vehicles, where efficient arrival and departure may be key to achieving good patient outcomes.

Hazard - Uncontrolled ventilation [CONTENT DIVIDED BETWEEN FIREFIGHTING GUIDANCE AND FIRES IN BUILDINGS GUIDANCE (AS SHOWN IN APPENDIX E)]

HAZARD KNOWLEDGE

The rate of development of any fire is directly linked to the supply of oxygen available to it. Establishing control over ventilation should form a key part of the overall incident plan.

Incident commanders should be aware that any increase in the supply of oxygen to a fire will accelerate the development of the fire. Experience has shown that where ventilation is not properly controlled or coordinated, firefighter safety has been compromised and serious consequences have followed.

Ventilation is one factor amongst the many tactical considerations that the incident commander will need to consider and implement as part of their overall incident plan. When planned and performed correctly ventilation can contribute to, and assist in, saving lives, improving firefighting conditions to support firefighter safety and reducing damage to property.

The incident commander must balance the benefits of controlled and coordinated tactical ventilation, in line with their service policy and training, with the hazards associated with accelerated fire growth and the introduction of oxygen into under-ventilated fire compartments.

Various natural or mechanical phenomena are associated with ventilation as well as being inherently linked to fire development, which can have an impact on any planned ventilation strategy. It is important that firefighters and incident commanders have an awareness of these phenomena and the potential impact when developing an overall ventilation and firefighting strategy, including:

- Wind-driven fires
- Coandă effect
- Piston effect
- Trench effect
- Stack effect
- Dust explosions

Wind-driven fires

The term 'wind-driven fire' has no formal definition under ISO or in UK fire and rescue service manuals. It is, however, becoming the standard generic term for fires that may also be referred to as force draught, wind-assisted, force vented or blowtorched.

A wind-driven fire may be described as one where external wind (or ventilation-forced) pressure causes strong air movements, affecting the severity of fire spread.

Fires can be affected by wind pressure and high-velocity air movements. The impact can be experienced in open fires or wildfires, while in buildings the greatest impact is usually experienced with fires in high-rise structures. Where windows have failed through exposure to heat, allowing external wind to affect the speed and direction of fire development, firefighters located in the flow path between the air inlet and air outlet are potentially in great danger, as temperature layering balances out across all levels, floor to ceiling.

Coandă effect

The 'Coandă effect' is described as the tendency of a stream of fluid or gas to stay attached to a nearby surface rather than follow a straight line in its original direction. In firefighting terms, this is the tendency of a fast-moving stream of air to deflect to nearby surfaces. The airstream's static pressure tends to decrease, which causes a pressure difference between the wall and areas far from the wall. This bends the stream towards the surface and tends to keep it attached to that surface.

The Coandă effect will influence hot gases escaping from compartments involved in fire. The effects of convection, fire compartment pressurisation and the wind will cause smoke and hot gases to be expelled from an external opening and usually move vertically. In some instances, the Coandă effect also influences downward fire spread.

The Coandă effect will encourage the venting products of combustion to be drawn back towards the face of the building, which will generate fire spread to other compartments or areas of the structure.

While this effect is commonly considered to occur at high-rise incidents, the same effect is often responsible for the spread of fire from ground floor compartments to upper levels when uncontrolled ventilation occurs.

Coanda effect

Source: Building Research Establishment

Post-fire damage illustrating the result of the Coandă effect

Source: Building Research Establishment

Piston effect

The 'piston effect' is a phenomenon that creates a potentially large movement of air in a shaft or tunnel when an object moves in the enclosure. The effect is more pronounced when the object's sides are close to the enclosure walls and if the object moves at speed.

For example, a train, when moving in an unrestricted location, displaces air around it except in the direction of the ground. If the same train enters a tunnel, the displaced air is confined by the tunnel walls. An area of higher pressure is created in front of the train as well as around the sides. Behind the train, an area of lower pressure is created, which is filled by the pressurised air escaping from around the sides of the train and equalised by the flow of air from all sides of the area of low pressure.

As the train exits a tunnel, into an underground station for example, the pressure wave, or movement of air felt by passengers standing on the platform, is the pressure front created by the moving train. This effect is similar to the operation of a mechanical piston in an engine or pump, hence the term 'piston effect'.

The same effect and impacts can be created by the movement of a lift in a lift shaft. The piston effect can influence the movement of air not only close to the lift shaft but also in the wider area of the building or structure. These air movements will affect the ventilation flow paths throughout the structure and can induce undesirable air movement in relation to wind-driven fires, blowtorch effect, flashover, backdraught or fire gas ignitions.

Incident commanders and fire crews should be aware of, and manage, these flow paths to minimise the hazards that may be experienced during a fire where there is the potential for sudden and rapid fire growth.

Trench effect

The 'trench effect' is a phenomenon that can produce a developing fire plume that accelerates up an inclined surface. It is influenced by two separate physical effects, the Coandă effect and flashover.

The trench effect can occur when a fire develops on or close to an inclined surface (approximately 25°). The flames deflect towards the surface (Coandă effect) and heat the combustible materials further up the incline. These materials will begin to be heated, leading to pyrolysis and subsequent ignition. Rapid fire development continues towards the top of the inclined slope until the fuel is depleted.

The trench effect can be exacerbated by flow paths in buildings and structures as well as by prevailing climatic conditions. The piston effect can also intensify the trench effect.

Diagram of the trench effect

Source: Building Research Establishment

Stack effect

The 'stack effect' is the movement of air into and out of buildings, structures and chimneys and is driven by buoyancy. Buoyancy occurs because of a contrast between external and internal air density caused by temperature and moisture differences. The result is either a positive or negative buoyancy force. The greater the thermal difference and height of the structure, the greater the buoyancy force (stack effect).

Buildings are invariably constructed with provision for natural ventilation. Generally, air in the building is warmer than the external air temperature. This warmer air rises up through the building and exits through open windows, ventilation openings and through other forms of leakage. The rising warm air creates an area of lower pressure in the lower section of the building, allowing cooler external air to be drawn in through open doors, windows or other ventilation openings.

Diagram of the stack effect

Source: Building Research Establishment

Control measure - Consider employing tactical ventilation [CONTENT DIVIDED BETWEEN FIREFIGHTING GUIDANCE AND FIRES IN BUILDINGS GUIDANCE (AS SHOWN IN APPENDIX E)]

CONTROL MEASURE KNOWLEDGE

Ventilation is one factor amongst the many tactical considerations that the incident commander will need to consider and implement as part of their overall incident plan. When planned and performed correctly ventilation can contribute to, and assist in, saving lives, improving firefighting conditions to support firefighter safety and reducing damage to property.

In simple terms ventilation can be defined as:

'The removal of heated air, smoke or other airborne contaminants from a structure or other location and their replacement with a supply of cooler, cleaner air'

In fundamental terms ventilation is something that will occur naturally as part of the fire development/decay process. It will have an impact on the development of a fire both pre- and post-arrival of firefighting crews at an incident scene, where they may encounter or be presented with fires in various phases of development. However, ventilation is also a valuable tactical intervention tool/option that fire and rescue services and incident commanders should consider as part of any overall firefighting strategy.

Historically, the traditional approach to ventilation focused heavily on ventilating after the fire to clear residual smoke and heat from buildings or structures. The subject of ventilation has however seen significant research and development over a number of years with new techniques and technologies becoming available to help improve the understanding and application of ventilation tactics.

When applied and managed correctly, ventilation can provide significant beneficial effects to any firefighting strategy by:

- Replenishing oxygen and reducing carbon monoxide levels
- Controlling temperature and humidity
- Removing moisture, dust and other airborne contaminants
- Improving visibility and aiding navigation

Tactical ventilation is a planned intervention that requires the co-ordination of fire and rescue services to open up buildings and structures to release the products of combustion and can be defined as:

'The planned and systematic removal of heat and smoke from the structure on fire and their replacement with a supply of fresher air to allow other firefighting priorities.'

As part of an overall firefighting strategy, incident commanders should always have a clear and informed objective before commencing any form of ventilation activity. This will ensure that the full range of benefits of ventilating can be realised including:

- Improving conditions for the survivability of building occupants
- Improving conditions for firefighters to enter and search
- Reducing the potential for rapid fire development (flashover, backdraught, fire gas ignition)
- Restricting fire and smoke damage to property

In broad terms ventilation can be separated into two basic types:

Natural ventilation

This is the process of supplying and removing air through a structure or space without using mechanical systems. In firefighting terms this refers to managing the flow of air (flow paths) into and out of a structure or location, using the prevailing atmospheric conditions such as wind strength, speed and direction via structural openings such as windows, doors and vents, to clear any smoke or hot fire gases.

Forced ventilation

This is the process of using fans, blowers or other mechanical means or devices to assist in creating, redirecting and managing the air flow into and out of a structure or location so that heat, smoke and fire gases are forced out.

In both instances, additional factors related to climatic and atmospheric conditions such as temperature and pressure will have an impact on the relative success of any ventilation process.

Type of forced ventilation	Considerations

Positive pressure ventilation (PPV)	This is achieved by forcing air into a building using a fan. Using the fan will increase the pressure inside the building relative to atmospheric pressure. The most appropriate tactic for PPV will depend on whether the inlet vent is also being used for access/egress. If the fan has to be placed further back because of operations at the entrance to a building, the fan may be less efficient. The efficiency of smoke clearance will depend on a whole range of factors including the wind direction and strength, the size, type and number of fans, the proportion of the fan's air that enters the building (fan performance), the relative sizes of inlet and outlet vents, the size of the compartment to be cleared and the temperature of the fire gases (smoke) in the compartment. Firefighters should always be aware of the potential risk of increasing the level of carbon monoxide (CO) in other areas of a building when ventilating, either when directing/forcing fire gases through a premise or, in particular, where using petrol driven PPV fans. Firefighters should ensure that fans are positioned to prevent any build-up of CO.
Negative pressure ventilation (NPV)	Negative pressure ventilation refers to extracting the hot air and gases from the outlet vent. This will reduce the pressure inside the building relative to atmospheric pressure. This can be achieved by fans or water sprays.
Heating, ventilation and air conditioning (HVAC) and Fire Engineered systems	These systems are often engineered into buildings so that, in the event of a fire, they can be operated to ventilate public areas and support safe evacuation as well as improve conditions for responding firefighters. These systems are normally automatic but can also be operated by a manual override.
Powered smoke and heat exhaust systems	These systems are generally operated automatically and are likely to be operating before the arrival of firefighters. They can also be operated manually but this will need careful consideration by incident commanders as part of the firefighting and ventilation tactical strategy.

Figure 7: Positive pressure ventilation

Source: Building Research Establishment

Figure 8: Heating, ventilation and air conditioning system in an atrium

Source: Building Research Establishment

Figure 9: Heating, ventilation and air conditioning system

Source: Building Research Establishment

The success of any ventilation plan or strategy will to a greater degree depend on the techniques employed to effectively plan and manage where air will enter a building, structure or location (inlet vent) and where hot gases and smoke will leave a building, structure or location (outlet vent), including the route that they will take (flow path).

Fire service personnel should be aware that creating a vent in a previously under-ventilated compartment can increase the risk of creating a backdraught.

In broad terms, two basic techniques may be considered, which present both barriers and enablers to the ventilation process:

- Vertical (or top) ventilation: making an opening at high level to take advantage of the natural characteristics of hot gases and smoke - for example, buoyancy - allowing them to escape
- Horizontal (or cross) ventilation: making openings in external walls using doors and windows to aid removal of hot fire gases and smoke

Both of these techniques can be employed using natural or forced means of ventilation.

Strategy

The ventilation strategy implemented at any fire will be affected by a whole range of factors but in broad terms, the strategy should initially be based around either one or a combination of the following:

- Offensive ventilation: close to the fire to have a direct effect on the fire itself, to limit fire spread and to make conditions safer for firefighters
- Defensive ventilation: away from the fire, or after the fire, to remove heat and smoke, particularly to improve access and escape routes and to control flow paths to areas of the building not affected by the fire

Whatever strategy is adopted, an incident commander should always consider the benefits, impact and effects of ventilation in relation to the situation. Many factors will influence an incident commander's decision in this context, including any priority rescues, the presence of hazardous materials, processes or conditions and the effects of any pre-existing ventilation, as well as the design and layout of the building or compartment, climatic conditions and how these may affect any tactical ventilation activities.

It is also important to consider the impact that fire loading will have on ventilation activity in a fire situation. The nature and diversity of the substances and materials that may be encountered in buildings can have an impact on the process of combustion and fire development, which may increase the likelihood for peak temperatures to be reached at a faster rate. This is important from a firefighting perspective, as this can mean that firefighters may be more likely to encounter rapid fire development conditions at an incident.

Fire and rescue services should consider the benefit of information gathering in pre-planning activities and on arrival. This may prove to be of great value in formulating the ventilation strategy as well as any overall firefighting strategy. These information sources may include:

- Site-specific risk information
- Local knowledge
- On-site plans
- On-site responsible person (or appointed competent person)

- Scene surveys
- Fire protection plans and operational information
- Building management and monitoring systems, for example HVAC, CCTV and fire-engineered systems

Once an incident commander has gathered any initial information, a critical decision must be made in developing a plan of attack: whether or not ventilation is to be used or appropriate.

Where an incident commander decides that ventilation activities are not to be used, they may choose to contain or isolate the heat and smoke in the fire compartment (anti- ventilation). For example, this can be achieved simply by closing doors or windows to unaffected routes and protect other areas of a building or structure. This tactic may enable occupants to escape via unaffected routes and limit further damage and limit rapid fire escalation.

Conversely, where the incident commander decides that ventilation or an appropriate tactic is to be used, it is generally most effective when considered or integrated in the early stages of firefighting activity. This allows efficient search and rescue operations to be undertaken and improves the working environment for firefighters.

The incident commander should be aware that any uncontrolled or unplanned movement of smoke and hot fire gases can increase the potential for fire spread. The decision to use or commence tactical ventilation activities must be part of an overall strategy and should invariably be undertaken with a simultaneous combined fire attack or suppression plan. Ensure that the appropriate firefighting media is available, including any supporting media such as covering jets for external fire spread.

Locating the fire

For an incident commander, the process of locating a fire is critical in formulating a robust, safe and effective ventilation strategy. The following factors should be considered:

- Be aware that the location of the fire may be clearly evident on arrival, but it is possible that the fire has developed in unseen areas or that it may not be visible at all. It is vital to identify any routes of potential fire development and any flow paths that may be created, taking into account the impact on firefighting operations and their potential to create or intensify undetected fire development.
- In the majority of incidents, ventilation should only be used when a fire has been located and an assessment of the likely impact of ventilation has been taken into account. However, in circumstances where the location of the seat of fire is difficult for crews to establish, tactical ventilation may be used to clear adjacent compartments, corridors or staircases etc. to assist firefighters in identifying the seat of fire, maintaining safe access and egress routes to and from a risk area and also mitigating or reducing the potential for phenomena such as fire gas ignition.
- In many instances, fire crews will be able to use their human senses, professional judgement and experience to locate the fire. However, monitoring systems such as automatic fire detection systems or CCTV along with thermal scanning with thermal imaging equipment may assist with this process.

When planning and developing any ventilation strategy it is vital that due consideration be given to the impact that any unplanned or poorly considered ventilation can have. This can happen in a number of ways and may be as a result of one or more of the following:

- Self ventilation caused by fire damage to the building or structure

- Fire crews carrying out inadvertent and uncontrolled ventilation, such as unplanned opening of vents, doors, windows
- Failure to take the creation of new flow paths into account when carrying out firefighting operations
- The effect of automatic ventilation systems (HVAC or powered heat and exhaust systems)
- Air movement created by the movement of lift machinery, stock or vehicles
- Air movement created by fire crews or escaping occupants opening internal and external doors and other openings
- Changes in wind speed and direction

The safety of firefighting crews and any building occupants is vital when forming a ventilation strategy and it is important that the impact and effects of the ventilation/fire conditions process are constantly monitored and reassessed and, where appropriate, tactics are adjusted accordingly.

The incident commander should make the safety of fire crews and any building occupants the primary concern when formulating and implementing a ventilation strategy. The benefits and effects of any planned ventilation must be considered together with:

- Location of the fire
- Location of any occupants, and protection of escape routes
- Access routes for fire crews to fire compartments
- Internal/external layout and design of the structure, including any fire engineered solutions
- Likely fire dynamics and development
- Natural ventilation, local topography that may affect wind effects and pressure differentials
- Effect of HVAC systems incorporating smoke control, sprinklers and design features such as atria and smoke curtains ()
- Impact of natural fire phenomena on fire development/conditions, for example Coandă, stack, trench, piston effects or wind-driven fire
- Potential for a dust explosion:
    - Give due consideration to the possibility of dust explosion when determining the overall incident plan, as well as the ventilation strategy, if an incident occurs in a compartment, building or other structure
    - Identify any potential dust explosion risks as part of information gathering in the initial stages of an incident
    - Pre-planning may have identified this as a potential hazard - it can be reasonably expected that control measures in any industrial processes will be in place and adequately maintained
    - Take the potential for a dust explosion into account in the ventilation strategy - ensure that any ventilation activities do not create movement of air that may agitate dust particles to the extent where an explosion occurs

The Incident commander should re-assess any actions to ensure that safety is maintained and that any planned ventilation activities are supporting the overall incident plan, considering relevant factors including:

- Wind direction, strength
- Whether ventilation is appropriate and/or the correct ventilation tactics
- Whether effective communications are firmly established
- The need to withdraw firefighters whilst ventilation takes place
- Location of outlet vents - ideally downwind and at a high level
- Whether external covering jets are in place
- Whether an inlet vent is created and kept clear (ideally as soon as possible following creation of the outlet vent)
- The requirement to constantly monitor the effects of ventilation

Figure 10: Smoke curtain

Source: Building Research Establishment

Figure 11: Smoke and heat exhaust ventilation system

Source: Building Research Establishment

Post-fire considerations

Consider:

- Using ventilation post-fire to assist in clearing any smoke and other airborne particles as part of the salvage activities.
- Ensuring that bullseyes (hot spots) are identified and fully extinguished before the fire scene is handed over - turning over and damping down will assist in identifying such areas.
- Noting the movement of any items and passing details to a fire investigation officer if in attendance
- Advising the fire investigation officer or other agencies of any ventilation activities undertaken during firefighting operations, as this may have some relevance to the subsequent fire investigation in respect of fire development and post-fire indications

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable

Control measure - Understand signs and symptoms of backdraught [DELETE – CONTENT RELOCATED TO UNDERSTAND SIGNS AND SYMPTOMS OF FLASHOVER, BACKDRAUGHT AND FIRE GAS IGNITION]

Control measure - Close doors [ARCHIVE – CONTENT MOVED TO PROTECT ASSETS FROM FIRE OR FIREFIGHTING DAMAGE

CONTROL MEASURE KNOWLEDGE

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable

Control measure - Appropriate speed and weight of intervention [REMOVE – CONTAINED IN OTHER GUIDANCE]

CONTROL MEASURE KNOWLEDGE

Committing crews to offensive operations requires the adoption of a safe system of work that reduces the risks to firefighters to a level as low as is reasonably practicable. If an incident commander has insufficient personnel present to introduce such a system of work, they may have to adopt defensive tactics until further resources arrive, or until they are reasonably certain that further resources will arrive imminently.

Rescue operations must be the subject of a dynamic risk assessment, balancing the benefits in terms of saveable life against the risk to firefighters.

See National Operational Guidance: Incident Command

See National Operational Guidance: Wildfires

See National Operational Guidance: Incident command - Command decision-making

Control measure - Firebreaks and fuel breaks [REMOVE – CONTAINED IN FIRES IN BUILDINGS]

CONTROL MEASURE KNOWLEDGE

A firebreak can be implemented to present an obstacle to the spread of fire; this tactic can be useful in waste, roof (particularly thatch) and wildfires. If a firebreak is to be effective, it should be a sufficient distance from the fire to ensure that the break can be completed before the fire reaches that point. A firebreak can be complemented by using extinguishing media to further resist the spread of fire in a particular direction.

A fuel break is an existing, planned change or discontinuity in fuel that will reduce the likelihood of combustion, fire intensity and/or the rate of firespread.

In preventing firespread, the position of separating walls and other firebreaks that could help with checking the spread of fire should be considered. In modern buildings with fire-resisting floors, horizontal fire travel is more usual, while in older buildings the spread of fire tends to be in a more vertical direction.

- See also: National Operational Guidance: Wildfire
- See National Operational Guidance: Environmental protection

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop tactical guidance and support arrangements for the hazards that may be encountered and the actions to be taken when implementing a firebreak system	13811
	Consult and liaise with relevant people and/or agencies to obtain advice and support on firebreak information in identified areas of land and specific buildings	13812
	Produce site specific risk information (SSRI) on appropriate firebreaks	13813

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Consider creating a firebreak to prevent firespread, considering the time required to implement	13814
	Monitor the effectiveness of any firebreak and communicate any breach to all personnel	13815

	~~Assess the fuel type, weather conditions, resources and time required to create an effective firebreak~~	~~18061~~
	~~Consider separating burning material from the fire using heavy plant and extinguishing it~~	~~18062~~

Control measure - Eliminate ignition sources [REMOVE – CONTAINED IN HAZARDOUS MATERIALS: PHYSICAL HAZARDS]

~~*CONTROL MEASURE KNOWLEDGE*~~

~~From the smallest to the largest incident, the incident commander and firefighters need to be aware of, and take notice of, possible ignition sources that could create additional hazards.~~

~~At incidents where there may be a release of gases or other flammable atmospheres because features such as storage vessels, tanks or pipework may fail or be damaged, incident commanders should consider this a concern and identify it in the incident dynamic or analytical risk assessments (DRA or ARA) and incident plan.~~

~~The amount of energy required to ignite a mixture of air and flammable gas or vapour (including smoke) is called the minimum ignition energy (MIE) and depends on the characteristics of the gas or vapour, concentration in air, type of oxidant, temperature and pressure.~~

~~An ignition source can be defined as a form of energy that, when added to a flammable mixture, is sufficient for the combustion process to start; an ignition source with energy greater than the minimum ignition energy (MIE) for a particular mixture is sufficient for a fire or explosion to occur. Generally, the energy required to ignite a flammable gas or vapour mixture is relatively low, though some low-energy ignition sources may not be incendiary enough for all flammable mixtures.~~

~~Ignition sources include:~~

- ~~Open flames~~
- ~~General firefighting operations, including cutting~~
- ~~Frictional sparks and localised heating~~
- ~~Impact sparks~~
- ~~Sparks from electrical equipment~~
- ~~Electrostatic discharge~~
- ~~Vehicles~~
- ~~Use of cigarettes or matches~~
- ~~Hot surfaces~~
- ~~Electrical equipment and lighting~~
- ~~Hot processes~~
- ~~Exothermic runaway reactions (water applied to reactive metals such as sodium and potassium)~~
- ~~Heating equipment~~

~~It is often challenging for crews to identify and eliminate every ignition source at an operational incident. The first option for ensuring safety is therefore usually to prevent flammable gas or vapour mixtures being released or formed. All foreseeable ignition sources should also be identified and effective control~~

measures taken.

In industrial premises, depending on the ignition sensitivity of the materials handled, the types of equipment involved and the process parameters (such as temperature and pressure), incident commanders should consult with on-site process safety professionals or the responsible person to address safety issues and provide recommendations to aid the safe resolution of the incident.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
	Develop tactical guidance and support arrangements for the hazards and actions to be taken in eliminating ignition sources	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
	Extinguish the fire and eliminate all ignition sources	
	Prevent escalation, contain and extinguish the fire considering all ignition sources	
	Deal with any immediate fire risk and provide a means of extinguishing fires during the incident	
	Identify all possible ignition sources and eliminate them as far as is possible	
	Control ignition sources that cannot be eliminated as far as reasonably practicable	
	Develop and communicate a firefighting plan and ventilation strategy to all personnel	
	Use the appropriate extinguishing method, media, techniques and equipment	
	Ensure that crews are briefed on all firefighting activities and provide regular updates on progress	
	Consider removing fuel from any source of ignition	

Control measure – Control ventilation [ARCHIVE – COMBINE WITH TACTICAL VENTILATION]

Control measure - Direct firefighting [ARCHIVED – CONTENT MOVED TO FIREFIGHTING TECHNIQUES]

Control measure - Minimal use of firefighting media [ARCHIVE – CONTROL MEASURE KNOWLEDGE RELOCATED TO FIRES IN BUILDINGS, STRATEGIC AND TACTICAL ACTIONS INCORPORATED IN SELECT APPROPRIATE FIREFIGHTING MEDIA]

Control measure - Portable fire extinguishers [ARCHIVE – CONTENT MOVED TO CONTROL MEASURE – FIREFIGHTING EQUIPMENT OR THE FOUNDATION FOR FIREFIGHTING]

Control measure - Hose [ARCHIVE – ALL CONTENT MOVED TO FIREFIGHTING EQUIPMENT]

Control measure - Branches and nozzles [ARCHIVE – ALL CONTENT MOVED TO FIREFIGHTING EQUIPMENT]

Control measure - Foam delivery [ARCHIVE – CONTENT MOVED TO FOUNDATION MATERIAL]

Control measure - Flow rates [ARCHIVE – CONTENT MOVED TO WATER MANAGEMENT AND PLANNING]

Control measure - Employ safe navigation techniques [DELETE – CONTENT COMBINED INTO SAFE SYSTEM OF WORK: FIRE AND PRODUCTS OF COMBUSTION]

Control measure – Planning [DELETE – CONTENT MOVED TO EMERGENCY RESPONSE PLANS FOR HERITAGE ASSETS]

Control measure - Protection of valuables [DELETE – CONTENT COMBINED INTO PROTECT ASSETS FROM FIRE OR FIREFIGHTING DAMAGE]

Control measure - Monitors [ARCHIVE – ALL CONTENT MOVED TO FIREFIGHTING EQUIPMENT]

Control measure -– Mitigation [DELETE – CONTENT COMBINED INTO PROTECT ASSETS FROM FIRE OR FIREFIGHTING DAMAGE]

Appendix B – Content to be relocated

Relocate to Fires in buildings, Hazard - Partial or structural collapse: Fires in buildings (from Control measure – Minimal use of firefighting media)

Water is very heavy - 1,000 litres or one cubic metre weighs one tonne. The weight of this can have a significant impact on the stability of any structure, building or vessel. For example:

- Where a roof is involved in fire and the roof timbers burn through to the degree where they cannot support the weight of the roof covering, the roof will collapse to the floor below and the weight of the roof structure and firefighting water will impose a load that may be too heavy for the floor to support and cause further collapse. ~~See National Operational Guidance: Fires in buildings - Unstable structure: Fire~~
- If water is lying on a lath and plaster or boarded ceiling it can put a strain on the fixings of the laths to the joists and the keying of the plaster to the laths
- In churches and cathedrals, fan-vaulted ceilings have conoids in the roof spaces, which can fill with water and fail catastrophically. Some cathedrals have a weak panel fitted that will fail when water fills the conoid to avoid collapse, but this is not a commonplace feature, so care should be taken to avoid filling them with water.

Relocate to Operations – Preserve evidence for investigation (from Hazard – Compromised investigation and scene preservation)

~~Authorised~~To preserve any fingerprints that may assist an investigation, personnel entering the incident~~fire~~ scene should ~~therefore~~ avoid touching or moving items with bare hands. Items should not be moved or handled until a police crime scene investigator or fire investigator has assessed these items in situ.

Appendix C – New control measure required for Transport guidance

Control measure – Fire prevention: Transport incidents

CONTROL MEASURE KNOWLEDGE

A risk assessment should be carried out to determine the presence, type and quantity of fuel reserves, spillages and vapours. This may require specialist assistance, such as atmospheric detection, identification and monitoring (DIM) if the presence of fuel vapours may present a hazard.

If safe to do so, the power or fuel source for the mode of transport should be isolated. This may be achieved through the correct operation or control of features such as:

- Ignition keys
- Proximity keys, smart keys or keyless entry fobs, which vary in operational range distances
- Cut-off or emergency shut-off switches

For more information refer to Transport – Identify and isolate electrical systems in modes of transport.

It may be appropriate to apply firefighting foam as a blanket to reduce fuel vapours from uncontained or spilled fuel. Ignition sources should be controlled, and care taken to use tools or equipment that have an appropriate ATEX classification. For more information refer to Utilities and fuel – Use intrinsically safe equipment.

Personnel and other emergency responders should avoid walking or driving vehicles across ground that has been subject to a fuel spillage. Fuel spillages will require appropriate environmental protection activities; for more information refer to the Environmental protection guidance.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
New	Have arrangements for obtaining specialist assistance for the detection, identification and monitoring of fuel vapours from a mode of transport	
New	Consider mobilising resources to apply firefighting foam as a blanket to reduce fuel vapours at an incident involving a mode of transport	
New	Ensure that communication equipment that meets the appropriate ATEX classification is available to personnel who respond to mode of transport incidents where fuel vapours present a hazard	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable

New	Carry out a risk assessment of the mode of transport incident to determine the presence, type and quantity of fuel reserves, spillages and vapours	
New	Consider requesting specialist assistance to carry out atmospheric detection, identification and monitoring if fuel vapours from modes of transport may present a hazard	
New	Consider applying firefighting foam as a blanket to reduce fuel vapours from uncontained or spilled fuel to mitigate the hazard of fire in modes of transport	
New	Control ignition sources and use tools or equipment that have an appropriate ATEX classification to mitigate the hazard of fire in modes of transport	
New	Ensure personnel and other emergency responders avoid walking or driving vehicles across ground that has been subject to a fuel spillage from a mode of transport	
New	Carry out appropriate environmental protection if there is a fuel spillage from a mode of transport	

Appendix D – Revised control measure for Incident command guidance

Control measure – Effective communication

CONTROL MEASURE KNOWLEDGE

The aim at every incident is to integrate communications and decision-making between the incident commander, operational personnel and fire control rooms.

Effective communication is fundamental to achieving successful and safe resolution of incidents. It provides the incident commander with knowledge about the situation and progress of tasks. Obtaining accurate and timely information is crucial to underpin situational awareness and subsequent decision-making. It helps the incident commander perform the role in a confident and determined manner and thereby assert their leadership and authority.

Communication also plays a vital role in co-ordinating activities, completing tasks and handover of command. Sharing accurate and timely information is also critical for helping others to have a common understanding of the situation, what is happening and what needs to happen next. Even the most effective plans will only work if the people putting them into practice understand them.

As well as exchanging information, good communication helps to build relationships between people. These relationships are important so that people are effective when they carry out their tasks to resolve the incident. Incident commanders should be aware that effective communication is essential for good leadership and makes it easier for people to follow instructions, understand briefings and have confidence in what is being stated.

Effective communication should:

- Provide information that is:
- Clear
- Relevant and concise
- Timely
- Be easily understood
- Be delivered confidently
- Include active listening
- Ensure verbal and non-verbal communications are aligned
- Ensure assumptions are questioned

~~Key principles should be considered w~~When establishing an effective communication strategy, consideration should be given to the structure that will support it, in terms of technology, equipment and systems. The strategy should take into account:

- The ~~communication structure and strategy is appropriate for the~~size, type and location of the incident; communication needs to be supported across the whole of the incident ground, including within buildings and structures
- ~~Communications will be~~The effectiveness and resilience~~t~~ of the communication structure
- The provision of resilience, such as fallback arrangements, to ensure there is no loss of communication during an incident

- The provision of communication equipment with an appropriate ATEX classification if required

When implementing a communication strategy, key principles should be considered to ensure:

- That information received in support of the incident is accurate, appropriate and timely
- That information is obtained from a reliable and credible source, or if not that it is checked and verified
- That appropriate methods of communicating information are used if there are security implications, or the need to relay sensitive or distressing information
- The appropriate recipients are provided with relevant information, via an appropriate method
- The relevance of the information

A good flow of information is one of the most important assets for an incident. An incident commander should ensure they:

- Gather information, issue orders and receive situation reports
- Issue orders to personnel
- Receive situation reports from all areas, including sector commanders
- Assess and provide for the needs of other agencies, and plan to meet with them
- Carry out a risk assessment and add this to the briefing on arrival
- Brief personnel about the tasks they need to perform and the hazards and risks they face
- Thoroughly brief personnel to share any safety critical information

A structured method, such as using an IIMARCH (Information, Intent, Method, Administration, Risk assessment, Communications and Humanitarian issues) template, may help incident commanders when preparing a brief. Further information on this approach, and a Word version of the IIMARCH template, can be found on the JESIP website. The JESIP Mobile App includes a prompt for use of the IIMARCH briefing tool, with the ability to share.

For multi-agency incidents the M/ETHANE message protocol can be used to exchange information about the incident with other responders via the fire control room and other agencies' control rooms.

Incident commanders may also hold briefings on the way to an incident. The extent of the briefing will depend on the type and scale of the incident. If personnel have little experience of the incident type, or there is high risk, a comprehensive briefing should be provided.

It will be necessary to organise safety briefings. As the incident develops, or if the risk of injury increases, those briefings may need to be more comprehensive.

Incident commanders should also establish suitable arrangements for communications. This is usually the role of command support under the guidance of the incident commander, and may include:

- Establishing communication links with fire control rooms
- Ensuring they correctly assign radio channels and call signs
- Establishing communications with other agencies
- The use of talk groups
- Requesting the support of a communications tactical adviser

- Establishing communications with sector commanders and other command support functions to receive regular situation reports
- Ensuring sector commanders can communicate between themselves
- Using local systems; some new and complex buildings and structures, including those extending underground, have communication systems installed for use by emergency services
- Effective handover

Ensuring there is an effective handover between commanders is a crucial step in the handing over of command. It is an important stage in the formation of the new commander's situational awareness, which will be partially based on the situational awareness of the current commander and will be further developed from the range of information that will be gathered. Failure to conduct an effective handover can lead to poor situational awareness and can result in inappropriate or ineffective decisions being made.

Handovers should be conducted in a systematic way. There are a range of methods for handing over, which should include:

- Information on the incident
- Information on the risks
- Information on the resources

The plan, including:

- Objectives
- Tactical priorities
- Operational tactics
- The incident command structure and communication lines

Key decisions, using the decision controls to articulate for each:

- What the goals were
- What they expected to happen
- How the benefits justified the risks

Further information may be found in Incident command: Knowledge, skills and competence: Interpersonal communication.

STRATEGIC ACTIONS

Fire and rescue services should:

Revised, new, archive or no change	Strategic action	Reference No. if applicable
No change	Ensure there is resilience in operational communication strategies and equipment	
No change	Test the compatibility of communications equipment, systems and processes with neighbouring fire and rescue services and other agencies	

No change	Ensure that they have appropriate communications systems in place at incidents	
No change	Have contingency arrangements for reinstating operational communication, in the event of equipment or strategy failure	
New	Ensure that communication equipment that meets the appropriate ATEX classification is available when required	

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action	Reference No. if applicable
No change	Establish and maintain an incident ground communication plan considering other agencies and remote resources	
No change	Exchange information about the incident with fire control rooms in a timely way	
No change	Provide regular situation updates to all responders	
No change	Establish resilient ~~tele~~communications with other responding agencies and consider the use of talk groups	
New	Ensure the communication structure is capable of meeting the needs of the incident	
New	Maintain resilience, such as fallback arrangements, in the communication structure to ensure there is no loss of communication during an incident	
New	Ensure that communication equipment that meets the appropriate ATEX classification is used at incidents if required	
No change	Communicate objectives, priorities and tactics to be adopted in resolving the incident	
No change	Ensure that the location of personnel is accurately reported and recorded	
No change	Deliver clear, concise and timely briefings to crews, command support functions and other agencies	
No change	Provide an effective handover when handing over command	
No change	Receive an effective handover when taking over command	
No change	Maintain an accurate record of information received from the incident ground	
No change	Use the M/ETHANE message protocol to exchange information about the incident with other responders via the fire control room	

Appendix E – Update to Fires in buildings

Hazard – Uncontrolled ventilation: Buildings

This hazard should be read in conjunction with Uncontrolled ventilation

HAZARD KNOWLEDGE

This hazard provides information about an increase in or a lack of control of ventilation in a building or structure, as ~~for information regarding fire development or fire loading, please refer to Fire and thermal radiation.~~

~~T~~the rate of development of any fire is directly linked to the supply of oxygen available.

An increase in the supply of oxygen to a fire can accelerate the development of the fire in a building or structure. If ventilation in the building or structure is not properly controlled and co-ordinated, the safety of personnel or people involved in the fire may be compromised.

Uncontrolled ventilation can result in:

- Accelerated fire development or growth
- Backdraught

Uncontrolled ventilation in a building or structure can occur due to:

- Ventilation caused by fire damage creating openings, for example failure of windows or a fire burning though a roof
- The effect of automatic ventilation systems, such as heating, ventilation, and air conditioning (HVAC) or powered heat and exhaust systems, including:
    - Automatically operating ventilation as part of the building's design; for more information refer to Fires in buildings – Fires in buildings with complex fire engineering
    - Automatically operating ventilation operating incorrectly; for more information refer to Fires in buildings – Fires in buildings that fail

When ~~P~~personnel or other emergency responders gain~~ing~~ access to the building or structure to apply extinguishing media, carry~~ing~~ out searches or perform~~ing~~ rescues, they may create~~ing~~ inadvertent and uncontrolled ventilation, such as the unplanned opening of vents, doors~~,~~ or windows.

People in the building or structure may open~~ing~~ windows or doors ~~in the building;~~, this may be as they evacuate or if trying to attract ~~possibly as part of an evacuation or to draw~~ attention to their location~~mselves~~.

Natural and mechanical phenomena are associated with ventilation, as well as being inherently linked to fire development, including:

- Wind-driven fires; also refer to Uncontrolled ventilation
- Piston effect; refer to Uncontrolled ventilation
- Coandă effect
- Trench effect
- Stack effect

Wind-driven fires

This phenomena in buildings has the greatest impact in a fire in a tall building. If windows are open, or have failed through exposure to heat, external wind can affect the speed and direction of fire development.

The flow path between the air inlet and air outlet is potentially an area of danger, as temperature layering balances out across all levels, floor to ceiling.

Coandă effect

The Coandă effect is described as the tendency of a stream of fluid or gas to stay attached to a nearby surface, rather than follow a straight line in its original direction. In firefighting terms, this is the tendency of a fast-moving stream of air to deflect to nearby surfaces. The airstream's static pressure tends to decrease, which causes a pressure difference between the wall and areas far from the wall. This bends the stream towards the surface and tends to keep it attached to that surface.

The Coandă effect will influence hot gases escaping from rooms or compartments involved in fire. The effects of convection, fire compartment pressurisation and the wind will cause smoke and hot gases to be expelled from an external opening and usually move vertically. In some instances, the Coandă effect also influences downward firespread.

The Coandă effect will encourage the venting products of combustion to be drawn back towards the face of the building, which will generate firespread to other rooms or areas of the structure. This can potentially lead to external firespread. For more information refer to Fires in buildings – External firespread.

While this effect is commonly considered to occur at fires in tall buildings, the same effect is often responsible for the spread of fire from ground floor rooms to upper levels if uncontrolled ventilation occurs.

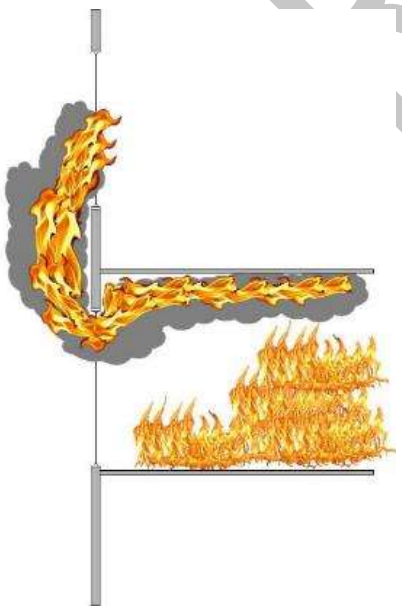

Figure: Diagram showing the Coandă effect, courtesy of the Building Research Establishment

Figure: Photograph of post-fire damage illustrating the result of the Coandă effect, courtesy of the Building Research Establishment

Piston effect

The piston effect and impacts can be created by the movement of a lift in a lift shaft. The piston effect can influence the movement of air, not only close to the lift shaft, but also in the wider area of the building or structure.

These air movements will affect the ventilation flow paths throughout the structure and can induce undesirable air movement in relation to wind-driven fires, blowtorch effect, flashover, backdraught or fire gas ignitions.

Personnel should be aware of and manage these flow paths, to minimise the hazards that may be experienced during a fire if there is the potential for sudden and rapid fire growth.

Trench effect

The trench effect is a phenomenon that can produce a developing fire plume that accelerates up an inclined surface, usually in a building or structure. It is influenced by two separate physical effects; the Coandă effect and flashover.

The trench effect can occur when a fire develops on or close to an inclined surface with a critical angle of approximately 25°. The flames deflect towards the surface (Coandă effect) and heat the combustible materials further up the incline. These materials will begin to be heated, leading to pyrolysis and subsequent ignition. Rapid fire development continues towards the top of the inclined slope, until the fuel is depleted.

The trench effect can be exacerbated by flow paths in buildings and structures as well as by prevailing climatic conditions. The piston effect can also intensify the trench effect.

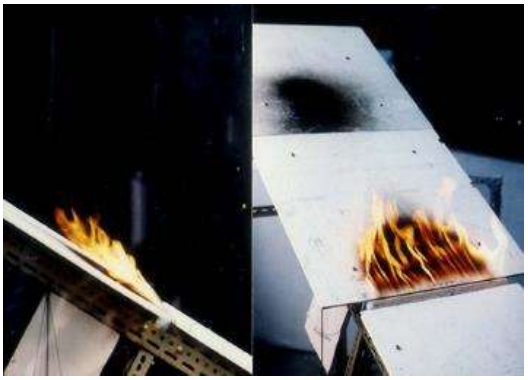

Figure: Photographs demonstrating the trench effect, courtesy of the Building Research Establishment

Stack effect

The stack effect is the movement of air into and out of buildings, structures and chimneys and is driven by buoyancy. Buoyancy occurs because of a contrast between external and internal air density caused by temperature and moisture differences. The result is either a positive or negative buoyancy force. The greater the thermal difference and height of the structure, the greater the buoyancy force or stack effect.

Buildings are usually constructed with provision for natural ventilation. Generally, air in the building is warmer than the external air temperature. This warmer air rises through the building and exits through open windows, ventilation openings and through other forms of leakage. The rising warm air creates an area of lower pressure in the lower section of the building, allowing cooler external air to be drawn in through open doors, windows, or other ventilation openings.

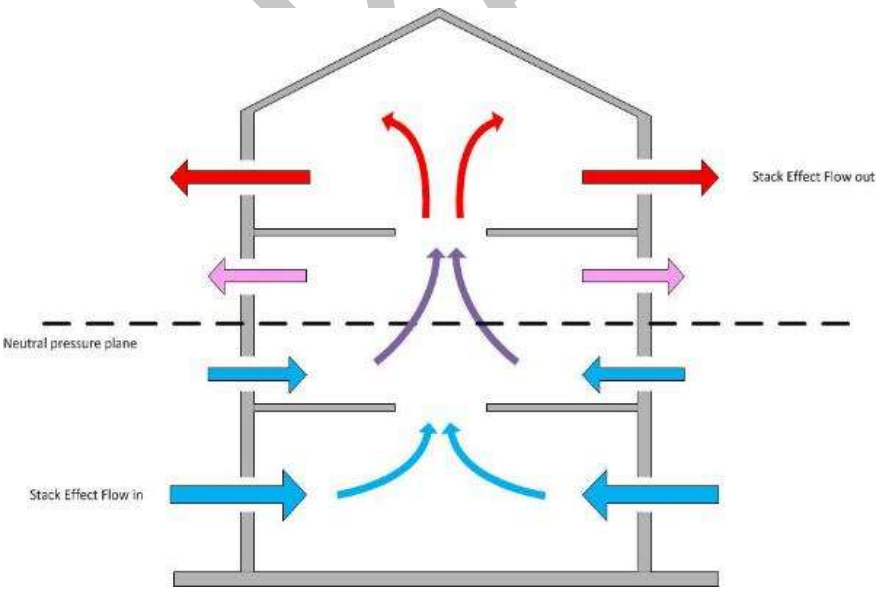

Figure: Diagram of the stack effect, courtesy of the Building Research Establishment

Control measure – ~~Control v~~Ventilation strategy: Buildings

This control measure should be read in conjunction with Ventilation strategy: Fires in compartments

CONTROL MEASURE KNOWLEDGE

The ventilation strategy~~, as well as any overall firefighting strategy,~~ should be informed by ~~available information. S~~sources of information for buildings or structures that may include~~:~~

~~B~~building management and monitoring systems, for example:

- Heating, ventilation, and air conditioning (HVAC) systems
- Closed-circuit television (CCTV)
- Fire-engineered systems

A ventilation strategy will be better informed if the location of the fire is known~~Locating the fire is critical in formulating a robust, safe, and effective ventilation strategy~~. The success of any ventilation plan or strategy will to a greater degree depend on the techniques employed to effectively plan and manage:

- Where air will enter a building, structure, or location (inlet vent)
- Where hot gases and smoke will leave a building, structure, or location (outlet vent)
- The route that they will take (flow path)

Personnel should be aware that creating a vent in a previously under-ventilated area can increase the risk of creating a backdraught.

Forcing entry to a building may be unavoidable but may~~doing so can~~ result in damage that limits ventilation control. It can also allow uncontrolled ventilation of the fire, allowing fire development and firespread. If possible, methods of entry that reduce damage, the use of smoke curtains or managing the door or other entry point to reduce the ingress of air, should be considered.

If natural or forced ventilation is not ~~to be~~ used, flow paths into the fire can be reduced or controlled; this is referred to as anti-ventilation. This can be achieved by ~~simply~~ closing doors or windows, using smoke curtains or other methods of smoke control. This limits the spread of products of combustion~~smoke and fire gases~~ to unaffected routes and protects unaffected areas.

This tactic may enable people to evacuate, improve access and egress for personnel by protecting routes such as stairwells, limit further damage and reduce fire development. If there is no threat to life, isolating the fire and fighting the fire from outside the building may be~~is~~ an effective way of extinguishing the fire, while reducing risk to personnel~~, although this is not always possible~~.

Features of the~~or~~ building~~s~~ or structure should be considered for their impact on the ventilation strategy, including:

- The~~Its~~ use of the building or structure and any processes or conditions inside it~~that may impact the ventilation strategy~~
- The effects of any pre-existing ventilation
- Design and layout of the building, structure or rooms
- Size of the building or structure

- Age of the building or structure
- Passive and active fire protection
- Fire engineering solutions
- Signs of failures in fire compartmentation

As ventilation is introduced or controlled, internal and external conditions should be monitored for signs and symptoms of fire development, flashover, backdraught~~, flashover,~~or fire gas ignition.

The ~~V~~ventilation strategy~~ies~~ should be reviewed continuously to ensure it~~that safety is maintained and that any planned ventilation activities are~~ support~~s~~ing the ~~overall~~ incident plan. It should be~~can be~~ changed if required, as the incident develops ~~and~~ or if conditions change. All relevant personnel should be advised about the ventilation strategy in use and about any changes to it. ~~Factors that will influence this decision, include~~

The ventilation strategy~~considering relevant factors~~ for a building needs to include factors such as~~ing~~:

- Location of outlet vents, which should ideally be downwind and at a high level
- Whether an inlet vent is created and kept clear, ideally as soon as possible following creation of the outlet vent

It may be beneficial to carry out on-site training in buildings with features or systems that can support a ventilation strategy.

STRATEGIC ACTIONS

Fire and rescue services should:

Comment	Strategic action	Reference
Revised	~~Consider p~~Providing appropriate equipment to assist with managing flow paths for a fire~~means of controlling ventilation~~ in~~to~~ a building~~s~~	33934
Revised	Consider providing the means of gaining access and egress that limit damage to the envelope of the building, such as doors and windows	33933
New	Consider the use of on-site training in buildings with features or systems that can support a ventilation strategy	

TACTICAL ACTIONS

Incident commanders should:

Comment	Tactical action	Reference
Revised	Consider the current ventilation profile, including natural ventilation, building systems or other sources of ventilation and how this is affecting the fire	33932
New	Develop a ventilation strategy that supports the incident plan for a fire in a building	
New	Continuously review the ventilation strategy to ensure it supports the incident plan for a fire in a building	
New	Communicate the ventilation strategy for a fire in a building to relevant personnel, including any changes to it	
New	Continuously reassess the factors that may impact on the ventilation strategy for a fire in a building	

All personnel should:

Comment	Tactical action	Reference
New	Be aware of the potential effect of their activities on flow paths, the ventilation profile and any planned ventilation strategy for a fire in a building	

Control measure – Tactical ventilation: Buildings

This control measure should be read in conjunction with Tactical ventilation: Fires in compartments

CONTROL MEASURE KNOWLEDGE

Tactical ventilation is a planned intervention that requires co-ordination and control, to open up buildings and structures to release the products of combustion. It ~~and~~ can be defined as ~~:~~

~~'T~~the planned and systematic removal of heat and smoke from a building or ~~the~~ structure on fire, and their replacement with a supply of fresher air to ~~allow~~ facilitate other firefighting priorities.~~'~~

Ventilation can be performed after the fire has been extinguished or controlled, to clear residual smoke and heat from buildings or structures.

The benefits of controlled and co-ordinated tactical ventilation should be balanced against the hazards associated with accelerated fire growth and the introduction of oxygen into under-ventilated fires in buildings.

If applied and managed correctly, tactical ventilation can provide benefi~~tscial effects~~ to any firefighting ~~strategy~~ activity by:

- Improving conditions for the survivability of people in the building
- Improving conditions for personnel to enter and search for or rescue people
- Reducing the potential for rapid fire development, including flashover, backdraught, or fire gas ignition
- Restricting fire and smoke damage to property

The control measure Tactical ventilation: Fires in compartments contains details about the following types of tactical ventilation:

- Positive pressure ventilation (PPV)
- Negative pressure ventilation (NPV)
- Vertical (or top) ventilation
- Horizontal (or cross) ventilation
- Anti-ventilation

For buildings, the following types of tactical ventilation may be available:

- Heating, ventilation, and air conditioning (HVAC) and fire-engineered systems, which can be operated to ventilate public areas and support safe evacuation, as well as improve conditions ~~for personnel~~
- Powered smoke and heat exhaust systems

These systems are normally automatic but can also be operated by a manual override. Theyse systems ~~are generally operated automatically and~~ are likely to be operating before the arrival of the fire and rescue service. ~~They can also be operated manually but this will need careful consideration by incident commanders as part of the firefighting and ventilation tactical strategy.~~For more information refer to Fires in buildings - Operate or alter fixed installations.

It may be necessary to seek advice about the operation of these systems from a specialist or the responsible person.

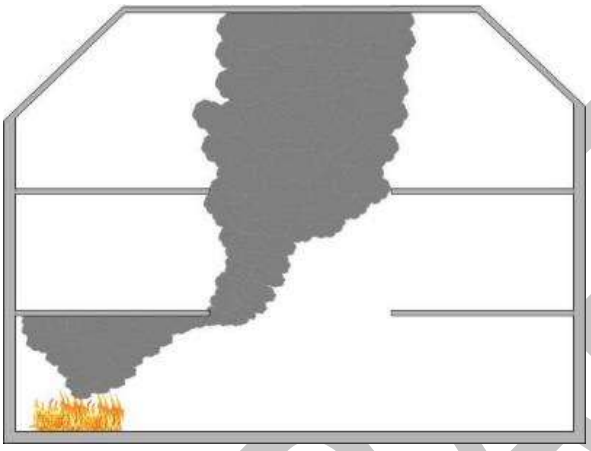

Figure: Diagram showing the effect of a heating, ventilation, and air conditioning system in an atrium, courtesy of the Building Research Establishment

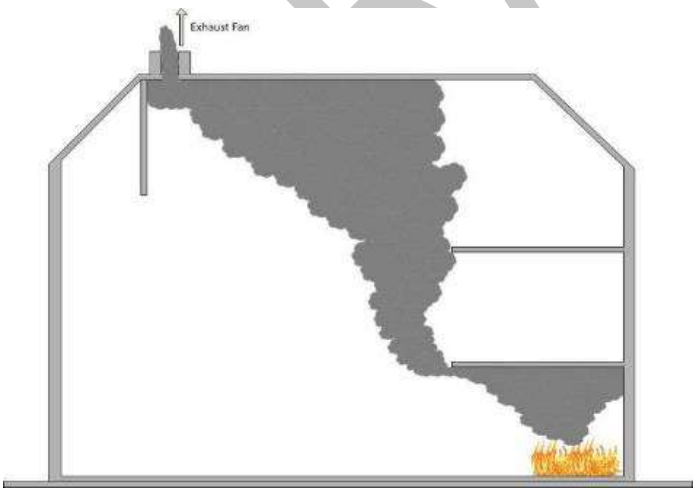

Figure: Diagram showing the effect of a heating, ventilation, and air conditioning system, courtesy of the Building Research Establishment

For a fire in a building or structure, t~~T~~he benefits and effects of any planned ventilation should be

considered together with the:

- Internal and external layout and design; including any fire-engineered solutions
- Effect of heating, ventilation, and air conditioning (HVAC) systems incorporating:
  - ~~s~~Smoke control
  - S~~, s~~prinklers
  - ~~, and d~~Design features, such as atriums and fitted smoke curtains

STRATEGIC ACTIONS

Fire and rescue services should:

Comment	Strategic action	Reference
New	Maintain a directory of specialist who can provide information about the operation of building ventilation systems	

TACTICAL ACTIONS

Incident commanders should:

Comment	Tactical action	Reference
New	Identify if any building ventilation systems are operating, and ensure relevant personnel are aware of them	
New	Consider controlling available ventilation systems to support the tactical ventilation for a fire in a building	
New	If necessary, seek advice about the operation of building ventilation systems from a specialist or the responsible person	