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NFCC
National Fire Chiefs Council

National Operational Guidance

National Operational Guidance topic
National Operational Guidance: *Subsurface, height, structures and confined spaces. From this point forward shall be referred to as Subsurface*
Change originator
NFCC Fire Central Programme Office – National Operational Guidance content team
Change requested
The first edition of Subsurface was published in April 2017. National Operational Guidance aims to review each piece of guidance every three years. National Operational Guidance content team compiled feedback, reviewed learning and released a pre-review research survey to establish the opinions of stakeholders on the published Subsurface guidance. 16 responses were received from operational fire and rescue personnel, 82% rated the current guidance as positive. 72% rated the guidance as high quality, 23% neutral and 6% provided no response. Of the responding services 59% had partially implemented existing guidance, 17% had fully implemented, 18% had not implemented and 6% prefer not to say. Of responding services 44% did not find existing guidance challenging to implement, 25% found it difficult to implement, 31% did not respond to this question or it did not apply. Common feedback themes included: 1. Further clarity on the confined space supervisor role 2. Too much repetition of control measures 3. Requests for more pictures or images to support existing guidance *National operational guidance Subsurface second edition version one* has been drafted. The proposed changes are summarised below.

Changes proposed	Rationale for change
Removal of duplicated hazards and control measures that are contained in other sections of guidance and providing links rather than duplicated content	Examples include: • Incident command safety management • Personal protective equipment • Respiratory protection equipment • Establish appropriate cordons

Removal of duplicated hazards and control measures that are contained in this section of guidance	Hazards and control measures have been revised to be specific to the topic it is covering.
Introduction	Revised content and includes content originally included within the associated headings
Header sections removed	This is to ensure consistent approach with update to guidance, some content has been moved to the introduction and within hazard knowledge for that section. Header sections have been removed from recent editions of guidance following feedback from users searching and navigating the framework
Restructure of guidance relating work at height	This includes relocating that hazard and control measures associated with unguarded edges from *Operations NOG*. Combining hazards and control measure to create safe systems of work
Restructure of guidance relating confined spaces to create one hazard and several control measures	This approach prevents repetition of hazards such as explosive atmospheres and allows the content to be specific to that environment.
Control measure – Safe system of work: Atmospheric conditions	The previous control measure - Carry out atmospheric testing and monitoring was specific to confined spaces. However, it used in other sections of guidance, the revised content is more generic to support the use in other sections of guidance
Hazard -– Unstable or collapsed natural or built environments	Reviewed content includes the amalgamation of guidance relating to excavations
Renaming of underground structures to below ground structures	Consistency with the term; above ground structures

Impacts on other guidance and NOG products

Some minor impacts to other pieces of guidance have been identified:

- Industry – Amend the title of the hazard Electromagnetic fields to Non-ionising radiation, and combine content that was contained in Subsurface on the same topic
- Inconsistency with NOG framework for the control measure gain and maintain safe access and egress – Suggest bringing other relevant control measures in line with this title for consistency across framework
- Review of Tunnel and underground structure supplementary information to ensure consistency with terminology

Relevant training specifications and scenarios will be redrafted to reflect approved changes.

Subsurface, height, structures and confined spaces

Review 2020

Draft for consultation

Contents

Introduction

This guidance has been developed to assist fire and rescue services in identifying hazards and implementing control measures for operational incidents that involve the following environments.

These are some of the most complex situations that personnel work in and may involve a combination of these contexts, which can be in the natural or built environment.

Height

Falls from height are one of the biggest causes of workplace fatalities and major injuries. Common causes are falls from ladders or through fragile roofs. Personnel could be exposed to falls in operational or non-operational environments.

The purpose of the work at height regulations is to is to prevent death and injury caused by a fall from height. It places duties on employers, including the fire and rescue service, to ensure that all work at height is risk-assessed, properly planned, appropriately supervised and carried out in a manner that is, so far as is reasonably and practicably safe.

Confined spaces

Fatalities and serious injuries occur every year to people while they are working in a confined space, and to people trying to carry out rescues without appropriate training and equipment.

Legislation clearly defines a confined space; operating in these environments requires core and specialist skills, including techniques for working at height. Other environments that do not satisfy the definition of a confined space may be just as challenging, owing to varying degrees of difficulty in access and egress. Dealing with these environments will require similar skill sets and equipment as those for confined spaces.

The guidance is based on the Health and Safety Executive (HSE) approved code of practice. It describes the preferred or recommended control measures that should be used, in order that fire and rescue services comply with the confined spaces regulations and the duties imposed by the Health and Safety at Work etc. Act.

Above ground and below ground structures

For this guidance, above ground structures generally exclude buildings, unless the condition of the building requires the use of work at height equipment. For example, if stairways or lifts have been compromised, requiring the use of aerial appliances, rope rescue or similar to resolve the incident. Gaining access to structures such as wind turbines and scaffolding will nearly always require specific work at height equipment.

Incidents involving below ground structures may also require specialised techniques and equipment, including those needed for work at height and in confined spaces. In this guidance, underground structures may be referred to as subsurface or below ground structures, depending on the context.

Any of the above may involve a collapsed or unstable structure, and could include a combination of hazards.

Buildings under construction

Large-scale incidents involving any structure, during construction or in use, are uncommon, which makes it difficult for fire and rescue services to gain experience and test procedures. However, the fundamental principles of operational response should remain the same. All personnel who liaise with contractors or infrastructure managers should consider training in the skills and techniques required.

Although certain hazards will be common to all incidents, the environment in which they occur will vary. This is particularly the case during construction, where access and intervention will require specific strategies and procedures.

Unstable or collapsed structures

Fire and rescue services may be called to attend incidents involving unstable or collapsed structures. The National Resilience urban search and rescue (USAR) capability has designated tactical advisers (TacAds) who may be able to provide appropriate advice and resource for these types of incidents.

The issue for attending fire and rescue service personnel is that unstable or collapsed structures are unpredictable. They are also resource intensive and arduous to work in.

Intraoperability and interoperability

When reference is made to working with other agencies, refer to the Joint Emergency Services Interoperability Principles (JESIP) Joint Doctrine for further information.

To make an effective response, each fire and rescue service needs a consistent approach that forms the basis for common operational practices and supports intraoperability with other fire and rescue services, and interoperability with other emergency responders, infrastructure managers and users.

Fire and rescue service boundaries may result in more than one service attending an incident; a joint approach is therefore essential. Understanding the typical hazards faced by incident commanders in these environments and adhering to the relevant control measures will ultimately lead to improved public and firefighter safety.

At an incident, the highest priority for fire and rescue services will always be the safety of the public and emergency responders. Effective and informed action can reduce hazards and help ensure the safety of the public and responders.

During an incident at a fully functioning structure, such as a road or rail tunnel, fire and rescue services may have the additional pressure of maintaining business continuity, especially where the incident has a significant impact and wide disruption is likely. From a fire and rescue service perspective, business continuity should be considered and discussed with other responders taking in to account the impact the incident has on the local community and economy.

At all incidents, it will be necessary to preserve the scene for investigation purposes. Other organisations may have to carry out their own investigations. The police, British Transport Police, Office of Road and Rail, Rail Accident Investigation Branch, as well as local agencies, will all need to be considered when dealing with certain subsurface-related incidents. For further information refer to Operations: Compromised investigations: Poor scene preservation.

Legislation

Civil Contingencies Act

The Civil Contingencies Act (Contingency Planning) (Scotland) Regulations

The Civil Contingencies Act (Contingency Planning) (Amendment) Regulations

Confined Spaces Regulations

Confined Spaces Regulations (Northern Ireland)

Control of Substances Hazardous to Health Regulations

Corporate Manslaughter and Corporate Homicide Act

Dangerous Substances and Explosive Atmospheres Regulations

The Environmental Damage (Prevention and Remediation) (England) Regulations

The Environmental Damage (Prevention and Remediation) (England) (Amendment) Regulations

The Environmental Damage (Prevention and Remediation) (Amendment) (Wales) Regulations

Environmental Permitting (England and Wales) Regulations

Fire (Scotland) Act

Fire and Rescue Services (Emergencies) (England) Order

Fire (Additional Function) (Scotland) Order

Fire and Rescue Services (Emergencies) (Wales) Order

Fire and Rescue Services (Emergencies) (Northern Ireland) Order

Fire and Rescue Services (Northern Ireland) Order

Fire and Rescue Services Act

Health and Safety (Consultation with Employees) Regulations

Health and Safety at Work etc. Act

Health and Safety at Work (Northern Ireland) Order

Lifting Operations and Lifting Equipment Regulations (Northern Ireland)

Lifting Operations and Lifting Equipment Regulations

Management of Health and Safety at Work Regulations

[Management of Health and Safety at Work Regulations (Northern Ireland)]

[Personal Protective Equipment at Work Regulations]

[Personal Protective Equipment at Work Regulations (Northern Ireland)]

[Police and Criminal Evidence Act]

[Provision and Use of Work Equipment Regulations]

[Safety Representatives and Safety Committees Regulations]

[Work in Compressed Air Regulations]

[Work in Compressed Air Regulations (Northern Ireland)]

[Work at Height (Amendment) Regulations (Northern Ireland)]

[Work at Height (Amendment) Regulations]

[Work at Height Regulations (Northern Ireland)]

[Work at Height Regulations]

Risk management plan

Each fire and rescue authority must develop a strategic direction through a risk management plan. To determine the extent of their firefighting and rescue capability, strategic managers will consider their statutory duties and the reasonably foreseeable risk in their areas.

Work to identify risk and prepare operational plans should consider all stakeholders, including local emergency planning groups, and the fire and rescue service risk management plan.

Responsibility of fire and rescue services

Fire and rescue services are responsible, under legislation and regulations, for developing policies and procedures and to provide information, instruction, training and supervision to their personnel about foreseeable hazards and the control measures used to reduce the risks arising from those hazards.

This guidance sets out to provide fire and rescue services with sufficient knowledge about the potential hazards their personnel could encounter when attending incidents. Fire and rescue services should ensure their policies, procedures and training cover all of the hazards and control measures contained within this guidance.

Hazard - Unguarded edges

HAZARD KNOWLEDGE

An unguarded edge is generally defined as a floor, gallery, balcony, roof or area that people can access, where there is no solid wall or raised rail and no intermediate guard rail to offer protection from falling.

Personnel at an incident may encounter unguarded edges around:

- Roofs, including access hatches
- Cliff edges and embankments
- Sinkholes
- Docks
- Quarries
- Loading docks
- Openings around equipment
- On-site machinery
- Pits
- Ramps
- Modes of transport, such as flatbed trailers

Guards around edges may have been severely damaged in an incident, as in the case of a serious fire in a tall building, or they could have been removed to allow for works. The safety of personnel in these situations should be of paramount importance to incident commanders.

Personnel attending heritage buildings need to consider that while these building often have guards to prevent falls, these can be considerably lower than in modern buildings. Inadequate or poorly fitted guards can be present in any area or type of structure.

There can be occasions where personnel can be exposed to multiple hazards that have conflicting control measures such as an unguarded edge near a body of water. Control measures for each hazard would require the individual to wear equipment that may not be compatible; for example a lifejacket for bodies of water and a harness for personal fall protection.

Control measure – Safe system of work: Unguarded edges

CONTROL MEASURE KNOWLEDGE

All personnel have a duty to take reasonable care of their own health and safety, and that of any other person. This can be through identifying and communicating hazards they encounter to other responders and they must inform the incident commander of these hazards so that they can review their tactical plan.

Signage is a good form of hazard indication. Unguarded edge signs include the following image, often supplemented with words such as ‘Drop’ or ‘No edge protection’.

Figure: Warning sign for fall or drop

Incident commanders should inform everyone at the incident of the hazards and the control measures in place.

Where possible, a temporary physical barrier should be erected to provide collective protection to personnel. Where it is not possible to avoid working near an unguarded edge, it is essential that a safe system for work at height is established; refer to safe system of work: Work at height.

Establishing appropriate cordons in the early stage of incident can prevent personnel being unnecessarily exposed to unguarded edges. Incident commanders should establish an inner cordon and consider exclusion zones taking into account:

- Incident type
- Possible objects falling
- Weather conditions

A barrier of any height may not be sufficient to prevent a fall from height, for example if personnel are wearing breathing apparatus (BA) that will raise their centre of gravity. Also, a lower barrier may be sufficient if personnel are able to keep low, lay down or crawl, rather than stand. Ultimately the incident commanders risk assessment should consider if the barrier is sufficient for the person and the task to be carried out.

At any incident, sufficient measures should be identified or established to provide collective and personal fall protection, to minimise the distance or consequences of a fall. Practical examples of collective protection include safety nets and soft-landing systems, such as airbags installed close to the level of the work. Personal protection includes using rope-based systems.

If there are conflicting control measures, the incident commander, following a risk assessment and using professional judgement, should identify the course of action. This could be to wait for specialist teams trained for such circumstances. Alternatively, they could use the control measures for unguarded edges, along with control measures for water rescue if someone enters the water. Refer to

STRATEGIC ACTIONS

Fire and rescue services must:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13317	Make appropriate work equipment available to prevent personnel falling from height	No change

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Consider providing signage and equipment to create temporary barriers	New
	Consider providing appropriate equipment to minimise the impact of a fall from height	New

TACTICAL ACTIONS

All personnel must:

Revised, new, archive or no change	Tactical action
Revised	Use any work equipment or safety device provided in accordance with training and manufacturer's guidelines

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Select the most appropriate work at height equipment for the activities and hazards identified
New	Ensure pre-checks have been carried out of work at height equipment
Revised	Use ladders for short duration tasks and request other equipment, such as an aerial appliance, for other activities

Hazard – Work at height

HAZARD KNOWLEDGE

The need for personnel to work at height falls broadly into two categories:

- Unintentional work at height, where personnel are attending an incident and have to deal with the potential to work at height; this could be, for example:
    - At above ground, below ground or open structures
    - In buildings, either complete, under construction or under demolition
    - At geophysical locations, such as steep ground, cliffs or excavations
- Intentional work at height, where personnel are attending an incident with a predefined requirement to work at height; this could be, for example:
    - Working on an aerial appliance
    - Performing a rescue of a person trapped at height
    - Working near fragile surfaces

Work at height covers all work activities including training, where there is a possibility that a fall from a distance is liable to cause injury. The relevant regulations that cover work at height are:

- The Work at Height Regulations
- The Work at Height Regulations (Northern Ireland)

The regulations state:

'work at height' means -

a) work in any place, including a place at or below ground level;

b) obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace,

where, if measures required by these Regulations were not taken, a person could fall a distance liable to cause personal injury

Personnel will be working at height if they:

- Work above ground or floor level
- Could fall from an edge, through an opening or fragile surface or
- Could fall from ground level into an opening in a floor or a hole in the ground

Work at height does not include a slip or a trip on the level, as a fall from height has to involve a fall from one level to a lower level and does not include using a permanent staircase.

Working at height can be complex and requires:

- Risk assessment
- Planning, including arrangements for emergency evacuation or rescue of responders
- Deployment of competent personnel
- The use of appropriate equipment

- Adequate supervision

Impact of weather

Adverse weather conditions such as lightning, strong wind, rain or extreme temperatures can impact the safety of personnel and potentially hinder working at height activity. Wind speeds are often greater at height than on the ground.

The regulations stipulate that work at height should only be carried out when the weather conditions do not jeopardise the health or safety of those involved in the work. It also provides an exemption from this requirement for responders, to enable them to carry out emergency actions. When the emergency actions have ended, the regulations will apply as normal.

For further information refer to:

- Operations: Weather conditions
- Operations: Lightning

Impact on personnel

Personnel may show signs of stress, anxiety, vertigo or dizziness while working at height. This could happen suddenly, for example due to personnel not knowing they have an inner ear problem or as a side effect of medication.

Personnel may become entangled within the equipment as a result of a piece of PPE such as a glove being trapped within an industrial descender or they slip uncontrollably resulting in the rope becoming wrapped around their body which can lead to crushing, asphyxiation and impact related injuries.

Incorrect operation or use of work at height equipment

Prior to personnel operating any work at height equipment they should receive adequate training on appropriate operating procedures, basic troubleshooting, and best practices for safe equipment use relevant to the work at height system they will be required to set up. However, work at height systems could be incorrectly set up due to lapse in familiarity and regular use, which can result in failure of the systems intended purpose.

If work at height equipment is used for unintended purposes, such as securing loads, it can lead its failure.

Limited capabilities

Some incidents that involve risks associated with falling from height may require actions that are beyond the capabilities of initial responders. In these circumstances, incident commanders should be aware of the restrictions that available equipment and training place on their ability to take offensive action.

Control measure - Situational awareness: Work at height

CONTROL MEASURE KNOWLEDGE

This control measure should be read in conjunction with Incident command - Situational awareness

At incidents that involve working at height there may be instances where the incident commander cannot observe all areas of the incident and may not initially have enough information to maintain situational awareness. It is essential for the incident commander to gather this information, so they can understand and interpret the situation and anticipate what is likely to happen next.

Specifically, for incidents involving work at height, additional sources for information gathering should be considered, including:

- Information gathered by personnel at the scene of operations
- Information gathered by personnel remote from the scene of operations, such as in adjacent buildings or structures

In some circumstances, the outcome of a risk assessment may be to withdraw temporarily until advice or assistance can be obtained from an appropriate tactical adviser or specialist rescue team. Refer to Specialist resources: Work at height.

PERSONNEL SHOULD NOT BE DEPLOYED IF THEY HAVE MEDICAL CONDITIONS OR ARE TAKING MEDICATION THAT COULD ADVERSELY AFFECT THEM WORKING AT HEIGHT. PERSONNEL WORKING AT HEIGHT SHOULD BE MONITORED FOR ANY PHYSICAL IMPACTS THAT ARE A RESULT OF THIS ACTIVITY.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Identify sites where work at height is most likely to be carried out	New
	Be aware of any medical conditions or medication of personnel, that makes it unsafe for them to work at height	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Assign and brief personnel to carry out reconnaissance if support is needed to inform situational awareness
New	Consider withdrawing until specialist advice or assistance is obtained for work at height

New	Be aware of any personnel who should not be deployed to work at height, due to medical conditions or medication
New	Monitor personnel for signs of stress, anxiety, vertigo or dizziness while working at height

Control measure – Hierarchy of control: Work at height

CONTROL MEASURE KNOWLEDGE

This control measure is based on information provided by the Health and Safety Executive in relation to the hierarchy of control for working at height.

Any work at height must be risk assessed, properly planned, supervised and carried out by competent people with the skills, knowledge and experience to do the task. Personnel must use the right type of equipment for working at height.

If there is a risk of falling that could result in injury and before any work is carried out, the hierarchy 'avoid, prevent, minimise' should be used:

- **Avoid** work at height where it is reasonably practicable to do so
- Where work at height cannot be avoided, **prevent** falls using either an existing place of work that is already safe or the right type of equipment
- **Minimise** the distance and consequences of a fall, by using the right type of equipment where the risk cannot be eliminated

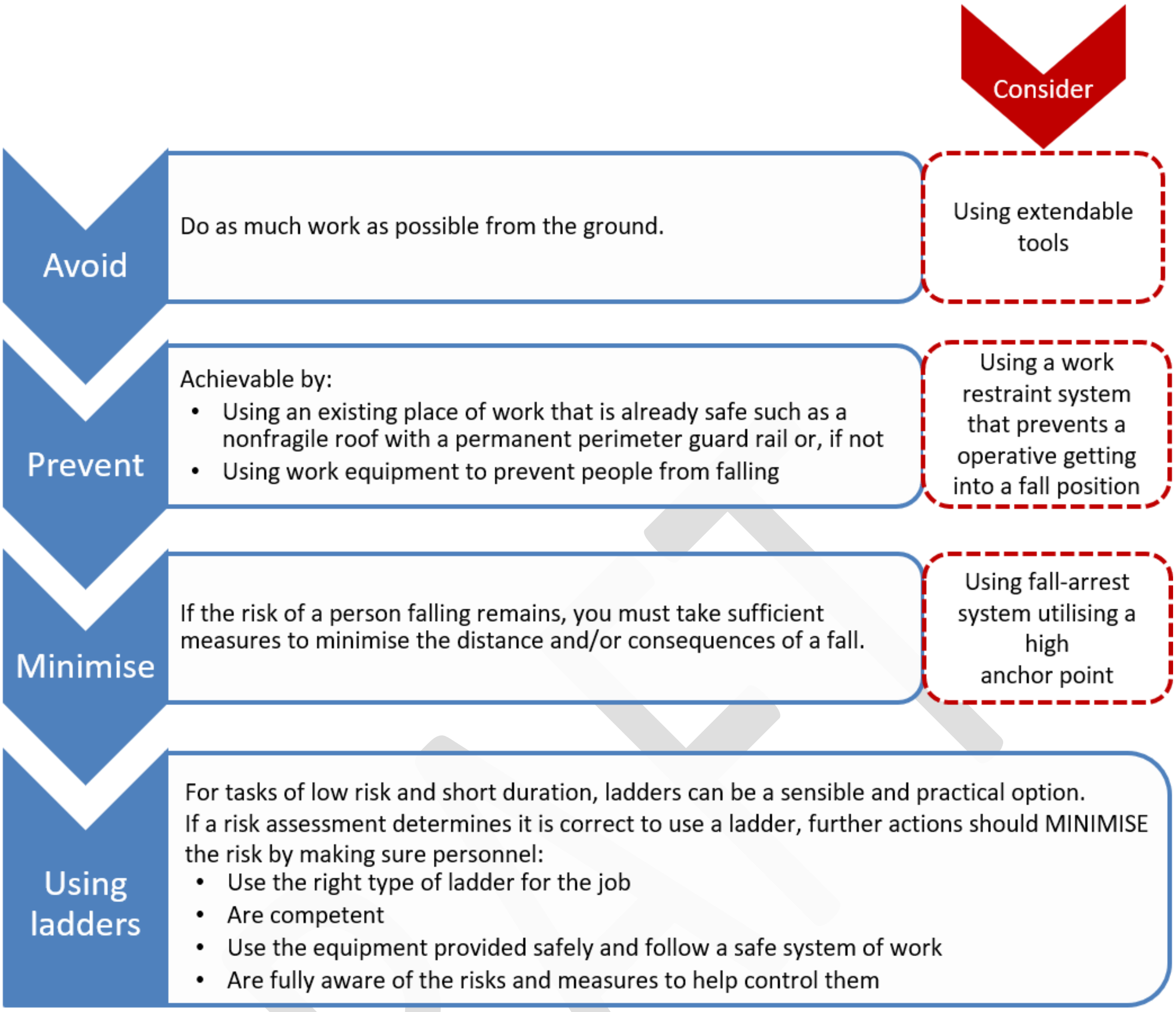

Figure: Diagram providing further guidance and examples for the hierarchy of control

Incident commanders should consider measures that protect everyone who is at risk by considering collective protection systems before measures that only protect the individual such as personal protection measures such as a harness. Ensure when work is being carried out to continually monitor weather conditions.

STRATEGIC ACTIONS

Fire and rescue services must:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide a means of recording the outcome of a risk assessment for work at height	New

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Consider providing appropriate equipment to minimise the impact of a fall from height	New

TACTICAL ACTIONS

All personnel must:

Revised, new, archive or no change	Tactical action
Revised	Use any work equipment or safety device provided in accordance with training and manufacturer's guidelines

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Consider the hierarchy of control for work at height when deciding which control measures to implement
New	Manage risk for work at height using a hierarchy of control approach
No change	Select the most appropriate work at height equipment for the activities and hazards identified
New	Monitor weather conditions when working at height

Control measure - Safe system of work: Work at height

CONTROL MEASURE KNOWLEDGE

This should be read in conjunction with Incident command: Cordon controls

To reduce the risk of injury or damage a safe system of work for work at height should include planning to ensure:

- As much activity as possible should be carried out at ground level
- Personnel can get safely to and from where they need to work at height
- Equipment is suitable, stable and strong enough for the task, and is maintained and checked regularly
- Personnel do not overload or overreach when working at height
- Precautions are taken when working on or near fragile surfaces
- There is protection from falling objects provided
- Procedures for the emergency evacuation and rescue of responders are in place

For more information, refer to the Health and Safety Executive (HSE) guidance for working at height.

Specialist resources

Specialist fire and rescue resources and external specialist resources should be considered to provide support for incidents commanders. In circumstances where it is beyond the capability of the initial responders, specialist and technical rescue teams should be requested to attend the incident for further information refer to:

- Incident command - Specialist resources
- Incident command - Specialist advice

It may be necessary for incident commanders to take appropriate actions to secure the scene and prepare for the arrival of the requested resources. This may include:

- Implementing cordons to restrict general access to the scene
- Identifying best access routes and RVP and communicating this to all control rooms.
- Liaising with on-site staff to:
  - Provide SSRI and rescue plans where available
  - Identify means of isolating non-essential equipment and utilities
  - Clear the area of non-essential site equipment
- Isolating non-essential utilities and machinery

Cordon controls

Aspects of the location and environment, such as the ground condition and weather, will need to be considered when establishing an effective cordon when working at height; these factors could affect the impact of items falling from height. The type and shape of structure can also have an effect on the way that items may fall, for example very tall buildings can create specific wind conditions that can make items move laterally further than expected.

The cordon for a work at height incident should consider factors, such as:

- Objects falling from height may cause injury; personal protective equipment (PPE) should be worn inside the cordon, but may not be enough to protect personnel from injury
- Wind can make objects travel further; for example, a karabiner with a sling attached will travel a considerable distance because the sling acts like a sail in the wind
- Some objects will naturally plane away from a structure
- If objects strike the structure on the way down, it may result in them bouncing outwards
- Protecting equipment such as anchors that could be tampered with if left unattended

Methods for working at height

When essential, work at height can be achieved in various ways.

Method	Description

Ladders	Ladders vary in length and are usually made from aluminium using a riveted and trussed construction. Double or triple extensions are commonly used.
Aerial appliances	Turntable ladder (TL): A self-supporting and power operated extension ladder mounted on a turntable. The ladder assembly is mounted on a self-propelled chassis above the rear axle. The ladder usually consists of a main ladder and three or four telescopic extensions. Hydraulic platform (HP): A platform attached to two or three booms, which are hinged together and assembled on a self-propelled chassis. The lower boom (or booms) pivots in a vertical plane, while the third takes the form of a hinged or telescopic extension arm at the upper end of the second boom. Aerial ladder platform (ALP): These appliances combine the principle features of turntable ladders (TL) and hydraulic platforms (HP) on a single appliance.
Working platforms	A working platform is any platform that can be used as a place of work or as a means of access to or egress from a place of work at height (aerial appliances fitted with a cage are deemed a working platform). Working platforms can also include any place of work on a scaffold, cradle, mobile platform, trestle, gangway, gantry or stairway. All working platforms should be properly supported and provided with guard rails and barriers set at an appropriate height. Working platforms must be used in accordance with manufacturer's instructions.
Rope access and rope rescue	Rope access and rope rescue can be achieved using a variety of systems and with many types of equipment. Systems can be used in isolation or in conjunction with other work at height equipment, including working platforms and aerial appliances.
Specialist wire systems	These systems are generally only used by nationally accredited urban search and rescue (USAR) teams or, in some cases, specialist rope rescue teams. The line access and casualty extrication equipment (LACE) used by USAR teams usually involves wire winches, rather than fabric rope systems, in circumstances where there is an increased risk of damage such as in a collapsed structure or confined space environment.
Collective fall protection systems	Collective protection is equipment that does not require the person working at height to act for it to be effective. Examples are permanent or temporary guardrails, scissor lifts and tower scaffolds.

Personal fall protection systems	Personal protection is equipment that requires the individual to act for it to be effective. An example is putting on a safety harness correctly and connecting it, with an energy-absorbing lanyard, to a suitable anchor point

Protecting personnel when working at height requires different equipment than protecting personnel during normal operations. Work at height personal fall protection systems need to be suitable for the task being carried out and the environment that is being worked in.

The risk of suspension intolerance, formerly known as suspension trauma, during response to an incident involving work at height, should be considered when selecting appropriate personal fall protection systems for responders.

When planning work, the safest practical option should be selected; the systems most commonly used by the fire and rescue service include:

- Work restraint - this stops the user from falling in the first place, by preventing the user from getting into a position where they can fall; often used when working on flat roofs
- Work positioning - this allows a user to work with both hands free by using appropriate equipment and must include full fall arrest equipment; often used on pitched roofs
- Fall arrest - this stops a user after they have fallen; often used in aerial appliances
- Rescue system - enables a user to rescue themselves or others and prevents a free fall
- Rope access - enables the user to get to and from the work place in tension or suspension in such a way that a free fall is prevented or arrested; often used by specialist rescue teams that are trained to a higher level

Safe work at height or rope rescue team typing

A system of team typing has been developed for work at height and rope rescue teams. This system provides assurance of the capabilities of each element deployed, and that all agencies operate to a common standard and specification.

Level 1 - Safe work at height: Personnel will be able to identify and use a selection of appropriate work restraint and fall arrest equipment to work safely at height. This is the minimum standard recommended to provide a safe system of work for personnel working at height in order to perform their duties.

Level 2 - Twin rope access and stabilisation: Selected personnel will be able to identify and use suitable anchors to create rope access and egress systems, enabling individuals to be raised or lowered vertically, to traverse on structures primarily to access and stabilise casualties.

Level 3 - Technical rope rescue: Selected personnel will be able to identify, create and use suitable anchors, construct access and egress systems, which enable both the individual and the team to ascend, descend and traverse while accessing and transporting casualties.

USAR - Line access and casualty extrication (LACE): Selected USAR personnel will be able to identify, use and provide specific wire and rope access systems to meet a range of hazards found within the USAR environment and can support operations at levels 1, 2 and 3.

Note that the USAR LACE equipment and training has been provided nationally to meet the specific hazards found in a USAR environment. This should not be considered as technical rope rescue.

Rope tactical adviser: Individual fire and rescue services may, within the context of overall incident management, consider the use of rope tactical advisers (TacAds). Rope TacAds are competent personnel who can provide a valuable resource at primarily tactical and operational levels.

Equipment

A body holding device or harness must be compatible with any other personal protective equipment (PPE) or respiratory protective equipment (RPE).

The choice of PPE should reflect the expected activities and environmental conditions. When selecting PPE potential hazards and emergency evacuation or rescue of responders should be considered.

The Provision and Use of Work Equipment Regulations (PUWER) require that a thorough examination of equipment and safety-critical parts is carried out by a competent person who must then complete a written report.

The Lifting Operations and Lifting Equipment Regulations (LOLER) apply to lifting equipment and any associated accessories used to lift people. Examination of lifting equipment must be carried out; this should be done:

- Before first use
- After assembly and before use at each location
- Regularly, while in service (at minimum 6 monthly intervals)
- Following exceptional circumstances' which may include:
    - Damage or failure
    - Being out of use for long periods
    - Major changes, which are likely to affect the equipment's integrity such as modifications, replacement or repair of critical parts

For further information refer to Health and Safety Executive (HSE): Thorough examinations and inspections of lifting equipment.

It is essential that all load-bearing elements of work at height equipment are given a thorough inspection before each use, as per the manufacturer's instructions, to ensure that it is in a safe condition and operates correctly.

Details of equipment standards can be found in the BSI publication, Personal fall protection equipment - Personal fall protection systems (BS EN 363).

Anchor points

Personnel should be mindful that, while the equipment they use is regularly inspected, tested and maintained, the areas they traverse and attach to are not.

Anchor points are the foundation for rope work operations and are a critical part of any system where ropes are used. The anchor system needs be ‘unquestionably reliable’. To ensure the anchor system is secure, the following points should be considered:

- All anchors should be assessed by a competent person as to their suitability for the intended load, prior to operations commencing and monitored during use
- Main anchors should be backed up unless considered 'unquestionably reliable', and the load applied to them limited to an acceptable level
- Anchors should be protected against mechanical damage and abrasion
- The angles created by multiple anchors should be monitored and kept as narrow as practicable
- Before committing load to a vertical environment, all slack should be removed from the ropes
- Erratic movement on lines or systems should be avoided, as this can induce high stress loading on anchors
- The area around anchors should be kept tidy, to allow easy monitoring of the system for any possible movement

Whichever system or technique is selected, incident commanders must always carry out a risk assessment, taking into account any additional weight being carried such as RPE and equipment The outcome of the risk assessment by the incident commander should be recorded, including any rational, following their service procedures.

Structural integrity

The suitability of any structure in supporting the use of work at height equipment must be considered. Structures that are not stable, or where there is doubt about structural integrity, should not be considered as platforms for working at height unless additional secondary systems are put in to place to add protection for personnel. For example, a combination of ladders and rope systems may be used to access fragile surfaces.

The suitability of a structure to support ladders and rope or line systems needs to be assessed, along with its ability to withstand forces created by loads and dynamic events.

Establish arrangements to deal with firefighter emergencies

The Work at Height Regulations requires the provisions for an emergencies and rescue.

It is essential that there is a rescue plan and adequate resources in place where work at height is carried out. These should be regularly assessed and updated where necessary. Resources should include not only equipment but also personnel who competent in the use of that equipment.

When planning for rescue, consideration should be given to the type of situation from which the casualty may need to be recovered and the type of fall protection equipment which the casualty would be using.

A distinction may be made between the term's "rescue" and "evacuation". Rescue typically involves the recovery of a casualty by another person either remotely or directly. Evacuation is typically carried out by a stranded user to escape from a remote situation such as an aerial appliance.

STRATEGIC ACTIONS

Fire and rescue services must:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Ensure that work at height equipment is compatible with any other personal protective equipment (PPE) or respiratory protective equipment (RPE)	New
	Ensure that work at height equipment that applies to Lifting Operations and Lifting Equipment Regulations (LOLER) has scheduled recorded examinations and inspections	New

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13313	~~Have arrangements for mobilising technical rescue teams to incidents involving risks of falling from height~~	Archive
	Consider providing equipment and resources to allow personnel to achieve various methods of work at height	New

TACTICAL ACTIONS

Fire control personnel should:

Revised, new, archive or no change	Tactical action
New	Inform available tactical adviser of incidents involving work at height

Incident commanders must:

New	Ensure work at height equipment inspections have been carried after assembly and before use at each location
New	Establish and maintain a recovery system for personnel deployed to work at height and ensure it is in place at all times
New	Ensure that emergency arrangements are maintained and resourced for the duration that personnel are subjected to work at height

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Secure and prepare the scene prior to arrival of specialist work at height resources
New	Establish and control inner cordons, taking into account the incident type, items falling from height and wind conditions
New	Select appropriate method to achieve work at height following a risk assessment
New	Secure any unattended work at height systems to ensure they cannot be interfered with
New	Ensure the suitability of the structure before carrying out work at height activities
New	Ensure that work at height equipment is not subjected to erratic movements

Control measure - Use of secondary systems

CONTROL MEASURE KNOWLEDGE

Using rope-based systems for access and rescue gives additional flexibility in certain operational environments, but they can be vulnerable to damage or failure. This can lead to catastrophic failure.

Poor selection of, or damage to, anchor systems, poor stowage or maintenance, incorrect system selection or operator errors can put personnel and casualties in danger. Using secondary systems to backup any possible system failure is therefore recommended and should be implemented wherever possible.

Redundancy should be built in to rope access and rope rescue systems, to act as a backup in case of failure. This can be done in many ways, but the most usual is to use a two-line system that starts at the anchors and works through the whole system to the operator and casualty.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide equipment for secondary systems to provide redundancy for working at height	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Archive	~~Implement predetermined procedures and emergency arrangements at incidents involving working at height~~

Archive	~~Only deploy personnel trained in the equipment and systems to advise or supervise work at height operations~~
Revised	Consider the use of secondary systems to provide redundancy when working at height

Hazard - Fragile surfaces

HAZARD KNOWLEDGE

A fragile surface is one that will not support the weight of a person and the load they are carrying.

Personnel should be aware of the physical condition of the surfaces they are working on. Structures and buildings or elements of either, may be more fragile or weaker than they appear to be.

Some roof surfaces or elements of a roof structure can be fragile and often cannot support additional weight such as a person. This can lead to the surface giving way without warning, resulting in a person falling through the surface to a lower level or becoming trapped. The following are likely to be fragile:

- Fibre-cement sheets
- Rooflights
- Metal sheets, if corroded
- Glass
- Chipboard, or similar material if rotten
- Materials such as wood, wool, slabs, slates and tiles

Deterioration through exposure to weather and lack of maintenance can cause originally stable surfaces to become fragile, such as a metal sheet roof that has corroded overtime. In such circumstances it is safer to assume all surfaces are fragile.

Collapsed structures can present fragile surfaces due to a structural component being weakened through damaged and being incomplete. Refer to Unstable or collapsed structures.

Fragile surfaces can be found in the natural environment such as around the edges of cliffs or quarries, or where tunnelling has damaged the integrity of a surface. For more information refer to Geophysical hazards (awaiting publication).

Control measure - Safe system of work: Fragile surface

CONTROL MEASURE KNOWLEDGE

Personnel need to be aware of the area and surface they may be operating near or on. Warning signs should be fixed at the approaches to roofs with fragile coverings.

Gaining situational awareness is crucial, with SSRI, signage and information from the responsible person or on-site staff helping to inform the risk assessment and tactical plan if it is necessary to working on or near fragile surfaces.

Figure: Warning sign for fragile roof

A cautious approach should be adopted near fragile surfaces, no matter how short the duration or the task to be carried out.

Where possible personnel should avoid going on or near a fragile surface, unless there are existing suitable and sufficient platforms, coverings, guard rails or similar means of support or protection. If no existing measures are in place, a suitable work platform such, as an aerial appliance, could be used to avoid personnel standing on the fragile surface itself.

If access on or near the fragile surface cannot be avoided, minimise fall distance and consequences by using personal fall protection systems, making sure they have adequate anchorage points and are properly used with appropriate supervision. Refer to Safe system of work: Work at height.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Work with partner agencies to identify and develop SSRI for fragile surfaces in their area	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action

New	Ensure personnel and other emergency responders are informed when fragile surfaces have been identified or are suspected
New	Consider consultation with structural engineers or another appropriate professional when fragile surfaces are identified or suspected
New	Consider the use of specialist equipment such as aerial appliances when fragile surfaces a present or suspected

Hazard - Equipment falling from height

HAZARD KNOWLEDGE

Equipment used when working at height, if not properly handled and secured, may present a hazard if it falls..

Any item of equipment that is allowed to fall, especially if from a substantial distance, could strike someone or something. This could lead to serious injury or death, and has the potential to cause damage to property or equipment.

Depending on the height and location of operations, additional factors should be considered; for example, the swirling wind dynamics found around tall buildings or structures.

Control measure – Safe system of work: Equipment used at height

CONTROL MEASURE KNOWLEDGE

At every work at height incident, personnel will have to select the equipment required. In most cases all equipment will need to be carried manually or hauled by hand. This will mean that personnel will select the minimum amount of equipment required to achieve the task, plus extra equipment to respond to any foreseeable issues.

Every item used at height has the potential to fall; equipment should therefore be secured throughout the operation. Equipment being transported to the scene of operations or to a bridgehead area should always be secured.

The exposed and physical nature of rope access and rescue means that there is increased risk; good procurement, pre-planning and training will mitigate the level of these risks.

The use of loose equipment and objects should be limited and always be controlled using lanyards, a suitable tool bag, harnesses with designated equipment holders, or a separate supporting system.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide personnel with a means of safely transporting and securing equipment when working at height	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Inform personnel to only use essential items when working at height to avoid the risk of equipment falling
Revised	Ensure that items taken and used at height are secured to reduce the risk of equipment falling

Hazard - Contaminated or damaged work at height equipment

HAZARD KNOWLEDGE

Contaminated or damaged work at height equipment can present a significant hazard to operators relying on it to prevent a fall. Contamination may occur as a result of the location of the equipment while in use or being stored, while damage is usually caused through misuse or exceeding working load limits.

Soft textile-type height safety equipment, including ropes and lanyards, is the most susceptible to damage from unprotected edges in the work at height environment. Causes of damage include:

- Sharp edges such as those found on steel work, cable trays, gratings, glass façades or composite panels
- Abrasive edges and surfaces such as coping stones, rock protrusions and corroded structures
- Trapping and cutting areas such as manhole cover, hatches or doorways
- Heat sources and the risk of melting from, for example, hot pipes, exhaust gases or lighting
- Corrosive substances such as chemical deposits or spillages

Control measure - Protect work at height equipment in use or storage

CONTROL MEASURE KNOWLEDGE

Personnel need to regularly check the working area for anything that could present a risk to the integrity of the equipment. They should also avoid placing or storing equipment where it may be subject to contamination or damage.

Sharp or abrasive edges should be controlled using the following hierarchical approach:

- Removing the hazard, where feasible
- Avoiding the hazard
- Protection against the hazard

After hazard removal, the best form of protection for textile equipment is to avoid contact completely. This can normally be achieved by using anchors and rigging configurations that completely avoid, or deviate from, edges or by using other equipment that holds the ropes away from the abrasive or sharp edge. Consideration should be given to the potential consequences of failure and shifts of positions. The access or rescue path of textile equipment must be fully assessed for potential hazards.

Aside from personnel trying to avoid working where edges could compromise operational safety, the key control measure is to use supplementary equipment to protect the ropes when in contact with the edges in question; for example, rope-protecting edge rollers, tripods and cantilever frames.

Personnel should continually try to preserve the equipment and immediately report any damage or contamination.

If equipment is suspected of, or identified as, being compromised, it must be withdrawn, declared defective and managed under a strict quarantine following service procedure.

Equipment may be defective because of a known event or because of identified damage caused by use, misuse or poor storage. It may be that the equipment is contaminated and the substance or effects are unknown.

Quarantined equipment should undergo a thorough examination; the competent person will decide whether the equipment can be reinstated or whether it should be permanently withdrawn and disposed of. A record of the decision and action taken should be made.

STRATEGIC ACTIONS

Fire and rescue services must:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide a means to record, quarantine, examine and reinstate contaminated or damaged work at height equipment	New

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide a means to protect work at height equipment from damage when being transported, in use or in storage	New

TACTICAL ACTIONS

All personnel should:

Revised, new, archive or no change	Tactical action

New	Check that work at height equipment has not been contaminated or damaged while stored
New	Avoid edges that are unprotected and have the risk of damaging work at height equipment
No change	Use equipment and procedures to protect rope and other work at height equipment from damage when in use

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Ensure that regular checks of the surrounding area are carried out for potential risks that could affect work at height equipment
New	Ensure any identified defective work at height equipment is quarantined for the duration of the incident
New	Ensure the reporting and replacement of defective equipment is carried out as per service procedure

Hazard - Confined space environment

HAZARD KNOWLEDGE

It is not possible to provide a comprehensive list of confined spaces. Some spaces may become confined when work is carried out, or during their construction, fabrication or subsequent modification.

The Confined Spaces Regulations and the Confined Spaces Regulations (Northern Ireland) sets out the legal definition of what constitutes a confined space. However, identifying environments that fall within the legal definition is not always that easy, especially when confronted with a rapidly escalating or complex incident.

The associated confined space regulations state a confined space must have both of the following defining features:

- It must be a space that is substantially (though not always entirely) enclosed
- One or more of the specified risks must be present or reasonably foreseeable

The specified risks are:

- Serious injury through fire or explosion
- Loss of consciousness arising from increased body temperature
- Loss of consciousness or asphyxiation arising from gas, fume, vapour or lack of oxygen
- Drowning from an increase in the level of a liquid
- Asphyxiation arising from a free-flowing solid or being unable to reach a respirable environment due to entrapment by a free-flowing solid

Explosive atmospheres

An 'explosive atmosphere' means a mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture.

Whereas a 'potentially explosive atmosphere' means an atmosphere which could become explosive due to local and operational conditions.

The legal definition of a confined space includes a specified risk of 'serious injury due to fire or explosion'. These can arise from:

- Presence of flammable substances
- Excess oxygen in the atmosphere
- Presence of chemicals that can combust or spark in enriched or, in some cases, normal oxygen levels
- Ignition of combustible dusts
- Leaks from adjoining on-site machinery or processes that have not been effectively isolated

- Inappropriate ventilation
- Inappropriate ventilation of a flammable or explosive atmosphere may create additional hazards. For further information refer to Hazardous materials physical hazards Flammable vapours: Unignited

Extremes of temperature or humidity

The legislation refers to the specified risk of 'loss of consciousness arising from increased body temperature'. This could be the result of high atmospheric temperatures, humidity or a range of other factors.

Working in hot conditions can lead to a dangerous rise in core body temperature; in extreme cases, this could lead to unconsciousness. This can be worsened by:

- Wearing personal protective equipment (PPE)
- Highly physical or strenuous work

Excessive heat can occur where:

- Work is being carried out in hot conditions
- The confined space is exposed to a significant heat source
- Processes are being undertaken that generate significant amounts of residual heat

For further information refer to:

- Operations: Heat illness in personnel
- Industry: Extreme heat

Toxic or asphyxiating atmospheres

Also known as irrespirable atmospheres are caused by the presence of toxic gases or vapours, or the lack of sufficient oxygen. Working in this type of atmosphere can lead to asphyxia, unconsciousness or death.

Environments where asphyxiant gases may be present include:

- Where contaminants have been processed or stored
- Where there is sewage, sludge or other deposits, especially if gases are released when it is disturbed
- In spaces where contaminants can enter, or are produced by equipment in use
- Where exhaust gases from engine driven equipment, machinery or vehicles have accumulated
- Where naturally occurring, biological processes produce toxic gases, especially in poorly-ventilated spaces
- Where gases from leaks, failure or damage to machinery, pipes or cylinders have accumulated

- In spaces such as pipes, sewers or manholes

Oxygen deficiency can result from industrial processes or the storage of products, including:

- Purging confined spaces with an inert gas to remove flammable or toxic gases, vapours or aerosols
- Naturally occurring biological or chemical processes that consume oxygen
- Transportation or storage of wood pellets, used as a biofuel, which may consume oxygen and produce carbon monoxide gas
- When spaces are left completely closed or poorly ventilated for extended periods
- Limestone chippings, associated with drainage operations, that can produce increased levels of carbon dioxide when they get wet
- Burning operations and work, such as welding and grinding, which consume oxygen
- Displacement of air during pipe freezing
- The gradual depletion of oxygen as workers breathe in confined spaces, if there is an inadequate supply of replacement air

The intentional reduction of oxygen, to create a hypoxic atmosphere, can be used to:

- Inhibit or suppress fire, using Redox or gaseous systems – for further information refer to the BRE supplementary information
- Extend the shelf life of produce
- Reduce the effects of oxidation
- Ingress of water or other liquids

Water or other liquids

The legislation refers to the risk of drowning from an increase in the level of a liquid. This could be a result of the hazard of ingress of water or other liquids.

Liquids can flow into a confined space and lead to drowning; for example, the ingress of liquid, when working in sewers or from other processes, that has not been adequately isolated in an industrial situation.

Liquids may obscure other hazards, such as machinery, objects, obstructions, changes in levels or openings. Liquids may also obscure access and egress routes.

The presence of a liquid can also lead to death, serious injury, hypothermia or have an effect on health, depending on the nature of the liquid, such as its corrosiveness or toxicity.

Free-flowing solids

The legislation refers to the risk of asphyxiation arising from a free-flowing solid or being unable to reach a respirable environment due to being trapped by such a free-flowing solid. This could be due to the ingress of free-flowing solids.

Free-flowing solids have similar characteristics to liquids and can submerge a person, preventing them from breathing. These solids include grain, sugar, flour, sand, coal dust and other substances in powder or granular form, such as gravel or soil.

In a confined space, the risk is increased because there is no space for the material to flow away.

Some free-flowing solids may form combustible dust clouds when disturbed; this could present a risk of explosion For further information refer to Hazardous materials: Combustible dust.

Ineffective communications

In some confined space environments, distance, interference and barriers may make normal communications ineffective.

Working at height in a confined space

Some confined spaces involve access to the area from above, using work at height access equipment. Personnel may be deployed in areas where there are unprotected edges and therefore a risk of falling.

Some of the above conditions may already be present in the confined space. However, some may arise from the work being carried out, or because of ineffective isolation of industrial sites or processes, or leakage from a pipe connected to the confined space.

Other hazards, not specific to confined spaces, can include:

- Electricity – refer to Utilities and fuel: Electricity
- The build-up of static electricity; most plastic equipment, clothing containing wool or cotton, and water jets are prone to static build-up
- Noise refer to Operations: Noise
- Collapse or subsidence of or within the space – refer to Unstable or collapsed structures
- On-site machinery – refer to Industry: On-site machinery
- Working in the space – refer to Operations: Manual handling
- Biological hazards - refer to Operations: Infectious diseases
- Chemical hazards - refer to Hazardous materials guidance

These should be identified when risk assessing the need to enter or work in a confined space. These hazards are not unique to confined spaces working and are not dealt with in the confined space regulations, however they are covered in other sections of guidance. If these hazards are present in a confined space, the precautions will almost always be more extensive because of the enclosed nature of the confined space.

Personnel should be aware that the physical environment of a confined space can take many forms and that a variety of techniques and skill sets are required to overcome the challenges they may present. Challenges include difficult access and egress, restricted spaces, slopes, gradients, changing levels, narrow apertures, different types of surface and poor lighting.

Control measure - Identify a confined space

CONTROL MEASURE KNOWLEDGE

An assessment must be carried out to identify whether the space is confined. Some spaces will become confined spaces because of the work to be carried out in them or because of changes in their use or changes to the level of enclosure.

Some confined spaces are fairly easy to identify, for example most sewers and closed tanks used to store chemicals. However, identification may not always be simple, as a confined may not be:

- Enclosed on all sides such; some vats, silos and vessel holds may have open tops or sides
- Small or difficult to work in: some grain silos and vessel holds can be very large
- Difficult to get in or out of; some have several entrances or exits, others have quite large openings or are apparently easy to escape from
- A place where people do not regularly work; some confined spaces, such as those used for spray painting in vehicle repair centres are used regularly by people in the course of their work

The Confined Spaces Regulations and the Confined Spaces Regulations (Northern Ireland) contain the following key duties:

- Avoid entry to confined spaces, for example, by doing the work from the outside
- If entry to a confined space is unavoidable, follow a safe system of work
- Put in place adequate emergency arrangements before the work starts

The following figure can help with the decision-making process. It describes the specified risks – there must be at least one of these present or reasonably foreseeable to make any enclosed space a confined space.

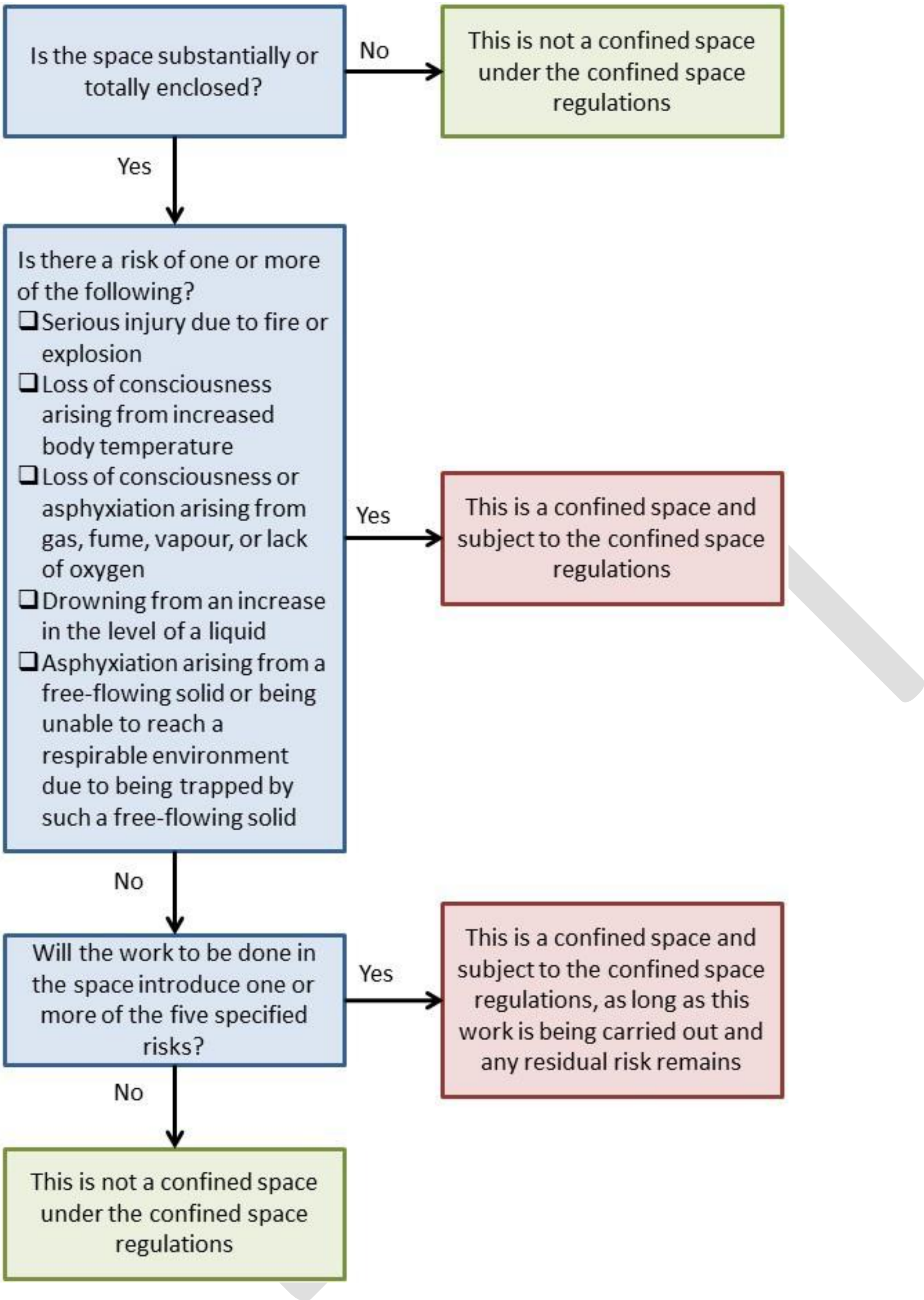

Figure: Flow diagram to assist with identifying confined spaces

It is very important to recognise that some locations that are not considered confined spaces in normal use will become, and must be treated as, confined spaces should conditions worsen. These include:

- Vessel compartments
- Basements
- Tunnels

Not all enclosed workplaces are deemed confined spaces; an enclosed workplace without a 'specified risk' is not a confined space even where there are other risks due to the size or difficulty of working in it. In ceiling voids, lofts and some cellars, if the space is cramped you may need to consider other hazards, such as poor manual handling, or how personnel would be evacuated if they had a fall or injury.

Enclosed spaces will require risk assessing, incident commander should consider using the control measures associated with confined spaces and other relevant control measures such as manual handling techniques.

STRATEGIC ACTIONS

Fire and rescue services should

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Identify, collect and make available SSRI for sites where confined spaces are present	New
	Liaise with industries that provide confined space rescue capabilities within their area to establish working principles should an emergency occur	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Identify whether work is within an enclosed space or confined space and inform personnel if appropriate
New	Liaise with on-site personnel to identify existing or potential hazards for the enclosed space
New	Implement confined space control measures if identified

Control measure - Avoid entry: Confined space

CONTROL MEASURE KNOWLEDGE

The Confined Spaces Regulations and the Confined Spaces Regulations (Northern Ireland) state:

> *'No person at work shall enter a confined space to carry out work for any purpose unless it is not reasonably practicable to achieve that purpose without such entry.'* .

If objectives can be achieved without entering the confined space, the risk of injury to personnel and worsening of conditions, for example, disturbance of sludge, in the confined space are significantly reduced. It is vital to assess the confined space to establish the risks presented by entry in comparison to the benefits of doing so.

All personnel should be aware of the limitations of their knowledge, training and equipment so they can assess the risk and make an informed tactical decision and intervention.

If the full risk assessment indicates that it is not safe enough for attending personnel to be deployed into the confined space, specialist advice or assistance should be requested. For further information refer to

- Incident command – Specialist advice
- Incident command – Specialist resources

If the confined space is in an industrial context, the responsible person or on-site staff may be able to provide the fire and rescue service with details of specialists who are competent to work in confined spaces.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13361	Identify, collect and make available SSRI for confined space risks	Revised
	Maintain a register of specialists from the fire and rescue service or other organisations who are competent to work in confined spaces	New

TACTICAL ACTIONS

Incident commanders must:

Revised, new, archive or no change	Tactical action
Revised	Ensure that nobody enters a confined space unless it is not reasonably practicable to deal with the emergency without doing so

Incident commanders should:

Revised, new, archive or no change	Tactical action
	Evaluate a range of options that avoid committing personnel to work in a confined space
	Consider requesting specialist advice or specialist assistance if the nature of the confined space is not safe for attending personnel to enter

Control measure – Confined space: Risk assessment

CONTROL MEASURE KNOWLEDGE

Because of the nature and severity of the risks faced while working in confined spaces, it is essential that fire and rescue services, taking into account their risk management plan, establish policies on their response to confined space incidents. Policies should define what type and complexity of confined space incidents can be dealt with by initial non-specialist personnel. Policies should also define how more complex confined space incidents will be handled, including details of the specialist resources and equipment that may be required.

Incident commanders should obtain as much information as possible before determining whether to deploy personnel.

All potential hazards within the confined space, as detailed in this guidance, should be identified and evaluated in accordance with the Confined Space Regulations, to assess whether the benefit of entering outweighs the associated risks.

If the decision is made to deploy personnel, the risk assessment and safe system of work should be shared with all those deployed.

The incident commander may be able to seek advice from a competent confined space supervisor or specialist rescue teams; they can provide assistance for dealing with the hazards of working in confined spaces.

Where it is not reasonably practicable to avoid entering a confined space to undertake work, incident commanders or confined space supervisors are responsible for ensuring that a safe system of work is used. Any safe system of work should give priority to eliminating the source of any hazards before deciding what precautions are needed for entry.

A safe system of work will depend on the nature of the confined space and the results of the risk assessment. For example, the risks involved and the precautions needed for accessing a lift machine room will be relatively straightforward compared to performing a rescue from an underground petrol storage tank or sewer. For further information refer to Rescue from confined space (awaiting publication)

Assessment

Incident commanders must assess the risks connected with entering or working in the confined space, taking into consideration their service's policy on confined space work. The assessment should identify the risks to people entering or working there, emergency responders and anyone else in the vicinity who could be affected by the work to be undertaken. The risk assessment needs be carried out by someone competent to do so.

Incident commanders should assess the general condition of the confined space to identify the presence of anything that may present a hazard, such as the concentration of oxygen or evidence of damage or corrosion. Any records relating to the confined space should be checked for relevant information.

The following list provides some of the most common essential elements to consider when preparing a safe system of work. Consideration should be given to:

Previous contents - even if held briefly, can indicate what kind hazard may be expected such as toxic or flammable gases

Residues - chemical residues or scale, rust, sludge or other deposits, such as animal slurry, which can release toxic or flammable gases if disturbed

Contamination - can be from adjacent sites, processes, gas mains or surrounding land, soil or within the rock layers, which can leak liquids or gases

Oxygen levels - atmospheres that are deficient in oxygen, also known as hypoxic environments, are often caused by replacement of another gas; this can lead to unconsciousness or death. Enriched atmospheres pose a high risk of fire; for further information refer to Oxygen-enriched atmosphere.

Physical dimensions - can personnel wearing all the necessary equipment enter, exit, and traverse easily, and provide ready access and egress in an emergency

Hazards arising from work to be carried out - hazards that arise directly from the work to be undertaken in the confined space should be assessed. The work itself may produce the hazard, such as battery-operated rescue equipment can be a source of ignition or increased noise.

Hazards from outside the space - there may be a risk of substances from nearby processes and services entering the confined space. This could be caused by the inadvertent operation of machinery. There may also be a risk of carbon monoxide, carbon dioxide and nitrogen dioxide entering the confined space from the exhaust of nearby combustion engines.

Emergency arrangements - possible emergencies should be anticipated, and appropriate emergency rescue arrangements put in place. The likely risks, and therefore the equipment and measures needed for a rescue by emergency teams, must be identified and the equipment made available for use. For further information refer to:

- Confined space: Health and safety considerations
- Arrangements to deal with firefighter emergencies

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Ensure all personnel are aware of their service's policy on the limitations, capabilities and responsibilities for confined space incidents	New

TACTICAL ACTIONS

Incident commanders must:

Revised, new, archive or no change	Tactical action
Revised	Ensure that personnel do not enter a confined space prior to carrying out a risk assessment
New	Establish a safe system of work and emergency arrangements prior to personnel entering a confined space

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Adhere to their service's policy when responding to confined space incidents

Control measure – Confined space: Supervision, resourcing and communication

CONTROL MEASURE KNOWLEDGE

Prior to commencing operations, incident commanders should consider putting in place appropriate supervision and ensure that personnel are competent to work in confined spaces.

Supervision

The incident commander may decide that a greater degree of supervision is required, based on their risk assessment. They should appoint a manager to supervise confined space operations. This manager, known as the confined space supervisor, should have the appropriate level of managerial authority, knowledge, skills and competence to ensure they can effectively manage the required resources as determined by the incident plan.

A confined space supervisor should ensure that:

- A suitable and sufficient risk assessment process is ongoing and being recorded
- Appropriate control measures are implemented and maintained
- Hazards and risks are communicated to all those involved
- They regularly update the incident commander of the tactical plan, progress and any findings of the risk assessment

A confined space supervisor, where available, can advise incident commanders of the hazards associated with restricted access and egress and with the operational requirements at incidents involving confined spaces.

If the risk assessment requires, it may be necessary to appoint dedicated safety officers to monitor the working environment or specific hazards. Entry control procedures should be used to monitor the safety of personnel if they are committed to work in a confined space environment. Incidents involving confined spaces are more likely to require a greater degree of control and supervision.

Incident commanders should also apply the most appropriate level of breathing apparatus (BA) entry control supervision for a confined space incident. For further information refer to Foundation for breathing apparatus: Breathing apparatus entry control procedures - Breathing apparatus entry control point supervision.

Competent personnel

Competent personnel are those with the necessary knowledge, skills, experience of and familiarity with the relevant processes and equipment, which enables them to understand the risks involved and apply the necessary safeguards.

In line with safe person principles, only competent personnel should be deployed in this environment, and only if they have the appropriate equipment, supervision and personal protective equipment (PPE).

Communications

An effective communication system must be in place and should enable communication:

- Between all personnel working inside the confined space
- Between personnel inside the confined space and those outside
- To request further resources in case of emergency

Adequate fallback arrangements should be in place in the event communications fail.

The equipment used for communication should take account of the other equipment, PPE and respiratory protective equipment (RPE) that is used when working in confined spaces.

Where there is a risk of explosive atmospheres, all communication equipment used in a confined space must be protected so that it does not present a source of ignition. For further information refer to Fireground radios guidance: ATEX-approved radios.

Alternatives to normal communications should be considered, including dedicated urban search and rescue (USAR) capability and existing on-site systems. A leaky feeder system and deploy repeaters should be requested if required and available.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13375	Ensure that communication equipment that meets the appropriate ATEX classification is available to personnel who are competent to work in confined spaces	Revised
13383	~~Ensure that confined space supervisors are deployed to any incident involving confined spaces~~	Archive
17875	~~Ensure that intrinsically safe equipment is available to crews trained to work in confined spaces~~	Archive
	Consider identifying or developing specialist personnel to be confined space supervisors	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Use only communications equipment that meets the appropriate ATEX classification when personnel enter any potentially explosive atmosphere
Archive	~~Ensure communication systems are effective in subsurface and tunnel environments~~
Revised	Conduct regular checks to ensure communication equipment continues to function
No change	Implement fallback arrangements if there is a failure in the communications equipment
New	Consider requesting and appointing a confined space supervisor
New	Commit competent personnel to work in a confined space only following a full risk assessment

Confined space supervisors should:

Revised, new, archive or no change	Tactical action
New	Liaise with the incident commander to establish or verify the safe system of work
New	Ensure an analytical risk assessment is carried out
New	Regular review the risk assessment and the safe system of work
New	Regularly update the incident commander of progress or concerns

Control measure – Safe system of work: Atmospheric conditions

CONTROL MEASURE KNOWLEDGE

The working atmosphere of some incidents may not be safe to operate in without appropriate respiratory equipment (RPE), even if the atmosphere is initially found to be respirable. Portable or fixed on-site equipment can be used to test the atmosphere, to establish if there is sufficient oxygen to support life or if there is a risk of irrespirable gases.

Atmospheric testing and monitoring should be carried out at incidents where there is potential for the atmosphere to be explosive (due to flammable gas), toxic, asphyxiating or hypoxic. Environments can include:

- Confined spaces
- Areas where hazardous materials are present
- Areas surrounding a fire
- Post-fire operations, such as damping down
- Fire investigation sites

Testing should also be carried out if it is known that the atmosphere was previously contaminated and subsequently ventilated, such as an underground petrochemical tank.

Fire and rescue services should consider using atmospheric testing and monitoring equipment that will test and display the:

- Oxygen level in the atmosphere
- Presence of flammable gases
- Presence of toxic gases

Exposure limits

Atmospheric monitoring equipment takes into account workplace exposure limits (WEL) that are produced by the Health and Safety Executive (HSE). WEL is the exposure of employees to hazardous conditions such as gases, dust and noise. The aim is to ensure that levels in the workplace are below the statutory limits. When using some atmospheric monitoring equipment this will be carried out for a 15-minute reference period.

For further information refer to the HSE publication, EH40/2005 Workplace exposure limits

Testing and monitoring the atmosphere

Before operations commence, the atmosphere should be tested. However, if there is a threat to life and it is not possible to carry out atmospheric testing in the timeframe required, immediate life-saving actions can be carried out with the use of breathing apparatus and entry control procedures.

If possible, testing should be carried out while limiting exposure to personnel. Incident commanders should consider using on-site testing equipment, or using extendable equipment or lines to lower portable testing equipment inside the hazard area and withdrawing personnel.

Ideally the atmosphere of every hazard area should be tested prior to entering. To ensure the test is effective personnel should consider:

- Remaining still, as this can assist with:
  - Allowing adequate time for equipment to sample, test and display the results
  - Preventing slips, trips and falls if personnel are on uneven or unstable ground, especially when reading the equipment
- Sampling at various levels due to various densities of gases

Regular monitoring is necessary to identify any changes in the atmosphere; this can be achieved actively or passively. Active monitoring is where personnel use portable detectors, often attached to themselves to monitor the atmosphere they are currently exposed to. Passive monitoring is used to monitor a specific area, such as portable detectors positioned temporarily in one place or fixed on-site equipment.

Atmospheric testing should be carried out by competent personnel who are aware of the limitations of the equipment in use, ensuring the results are regularly recorded.

Ventilation

Ventilation may help to improve conditions for personnel and increase the potential for casualty survival.

The hazard area should be assessed to determine if ventilation would be appropriate and successful. The surrounding infrastructure and what will be released should be taken into consideration, as flammable gases may ignite if there is an ignition source near to the outlet vent.

Ventilation can be achieved naturally, such as by opening windows or inspection holes, or through forced ventilation, such as the use of mechanical fans. The use of fans with combustion engines should take into account their exhaust gases. For further information refer to Consider employing tactical ventilation.

Gas purging of spaces using inert gases is a ventilation technique performed in industry, often within confined spaces, to mitigate the risk of explosive atmospheres. This would be inappropriate if casualties are inside the confined space.

Removal of residues or materials

The removal of residues or materials, such as sludge or chemicals, may reduce the quantity of toxic or asphyxiate gases being released. However, this activity should be subject to a risk assessment as it may release more gases.

Monitoring equipment alarm actuation

On the actuation of atmospheric monitoring equipment alarms, all personnel within the hazard area should withdraw to a safe area and review why the alarm actuated. Personnel should brief the incident commander, providing details of time, location and the actions being carried out when the alarm actuated.

Limited capability of atmospheric monitoring equipment

Most atmospheric monitoring equipment is calibrated to detect specific gases, as detailed in the manufacturer's specification. This means that the equipment has limitations for detecting other gases that may be in the area. Some detectors can be changed; however, doing so requires trained personnel and specialist equipment.

If the substance is unknown, the use of a regional detection, identification and monitoring (DIM) officer or other specialist advisers can be requested through the National Resilience Fire Control (NRFC). Due to the limited number of DIM suites and their geographical location, incident commanders should be aware that their attendance may be delayed.

STRATEGIC ACTIONS

Fire and rescue services should:

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

13365	Enable access to suitable atmospheric monitoring equipment that can be used for multiple applications	Revised
22735	Consider providing equipment to ventilate confined spaces	No Change

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Carry out testing and monitoring of the atmosphere and use the results to inform the incident plan
Revised	Consider requesting specialist advice or assistance for atmospheric detection, identification and monitoring
Revised	Consider ventilation to improve internal conditions
Revised	Isolate or limit all ignition sources before ventilating if flammable gases may be present
Revised	Consider the controlled removal of materials, to reduce the quantity of gases being released
Archive	~~Isolate or limit all ignition sources before ventilating a confined space where flammable gases are present~~

Control measure – Confined space: Isolation of hazards

Isolation from gases, liquids, and other flowing materials

When operating in a confined space, the ingress of gas, liquids or flowing materials will affect the environment, which may become hazardous to those inside the confined space.

Personnel should be aware of the environment and any associated processes that may affect the confined space and take all appropriate actions to prevent the ingress of substances.

Confined spaces should be securely isolated from the ingress of substances that could pose a risk to those working within the space.

An effective method used in industry is to disconnect the confined space completely from every potential source. Methods include removing sections of pipe or duct, inserting blanks or a suitable, reliable valve that is locked shut, providing there is no possibility of it allowing anything to pass through when locked, or of being unlocked when people are inside the confined space.

Barriers, such as a single brick wall, a water seal or shut-off valves, or those sealed with sand or loam to separate one section of machinery from another, are sometimes present at a confined space and offer some degree of its isolation. However, these barriers are usually provided for normal working and may not provide the level of safety protection necessary for the high risks often found in confined spaces. A more substantial means of isolation may therefore be needed.

Isolation of liquids may be possible in industrial-type confined spaces, such as vats and silos. However, in confined spaces affected by weather, water distribution or sewerage, it may not always be possible, so personnel should be extra vigilant and take extra precautions.

It may be possible to use appropriate submersible or other pumping equipment to remove liquids or reduce levels, or to insert inflatable bladders. However, such methods can cause back pressure, leading to the bladder being unable to sustain a seal or to suddenly fail releasing the content.

Possible diversion of the liquid can occur which could affect other areas. The level of liquid in the confined space and the liquid being removed or sealed off should be continually monitored while personnel are inside the confined space.

Isolating the flow of a particular material into the space can be achieved in industrial-type confined spaces, such as vats and silos, with the option of shutting down the flow of materials into the space. In other situations, this may not be possible, but personnel may be able to remove the product from the space in question and eliminate the actual hazard.

Incident commanders should be aware that risks associated with free-flowing materials can include crusting of the upper surface, bridging of material and machinery, for example, a screw conveyor.

Whatever means of isolation is used, it must be tested to ensure it is sufficiently reliable by checking for substances to see if isolation has been effective.

Isolation from electrical or mechanical equipment

Some confined spaces contain electrical or mechanical equipment, with power supplied from outside the space.

Power should be disconnected, separated from the equipment, and a check made to ensure isolation has been effective. However, it may be necessary to carry out a risk assessment that allows the power to remain on if necessary, for example:

- To assist with the task being undertaken
- To support vital services, such as:
  - Lighting
  - Communications
  - Firefighting
  - Ventilation
  - Pumping if there is a risk of flooding
- If cables are distributing power to other essential areas or processes

Isolation could include locking off the switch and formally securing the key, in accordance with a permit-to-work, until it is no longer necessary to control access. Lock and tag systems can be useful as each operator has their own lock and key providing self-assurance of the inactivated mechanism or system. There should be a check made to ensure there is no stored energy of any kind left in the system that could activate the equipment inadvertently. For further information refer:

- Industry: On-site machinery
- Industry: Electricity.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
22731	Capture information about the storage or use of gases, liquids or flowing materials in SSRI	No change
13402	~~Ensure that attending personnel are aware of the dangers presented by the inflow of liquids in confined space environments~~	Archive
13403	~~Ensure that those supervising confined space operations are able to recognise and inform attending crews of this hazard~~	Archive

TACTICAL ACTIONS

Incident commander should:

Revised, new, archive or no change	Tactical action
Revised	Refer to information held in SSRI or by the responsible person about the storage or use of gases, liquids or flowing materials in confined spaces
Revised	Investigate the possibility of ingress from gas, liquids or flowing materials into the confined space including surface water
No change	Isolate the confined space or sources to prevent the ingress of gas, liquids or flowing materials
Revised	Identify the presence of materials that may release gases in a confined space, especially if disturbed
Archive	~~Identify the potential for liquids to enter confined spaces,~~
Archive	~~Isolate all sources of liquid ingress to confined spaces where possible~~
Archive	~~Implement suitable contingency arrangements where there is a risk of liquid ingress into a confined space~~
Revised	If isolation or removal of electrical or mechanical equipment is possible, ensure that it occurs before personnel are committed to the confined space
Archive	~~Identify the potential for free-flowing materials to enter confined spaces~~

Control measure – Confined space: Health and safety considerations

Selection and use of suitable equipment

Any equipment provided for use in a confined space must be suitable for the purpose. If there is a risk of flammable gases in a confined space, which could be ignited by electrical sources such as a portable hand lamp, specially protected electrical equipment should be used.

In most confined spaces, it is impossible to classify the atmosphere present. For information about ATEX equipment for fire and rescue service operations refer to ATEX-approved radios. Equipment must meet the appropriate ATEX classification; for more information on ATEX refer to Health and Safety Executive (HSE) information on ATEX and explosive atmospheres.

All equipment should be carefully selected, bearing in mind the conditions and risks where it will be used. In addition to isolation, equipment may need to be secured against free rotation, as people may tread or lean on it, with a risk of trapping or falling.

Personal protective equipment and respiratory protective equipment

Using personal protective equipment (PPE) and respiratory protective equipment (RPE) can make movement more difficult and add to the effects of high temperatures. Any PPE and RPE used should be suitable for a confined space. However, it is accepted that this is rarely possible in fire and rescue service operations.

The type of PPE and RPE to use will depend on the hazards identified; this could include breathing apparatus with work at height equipment. Account should be taken of foreseeable hazards that might arise and the need for emergency evacuation.

Access and egress

The entry point to a confined space is likely to be within the inner cordon, which is under the control of the fire and rescue service. Access and egress routes should be identified and monitored. However, if these routes present intolerable risks or become unsuitable during the incident, alternative routes should be identified and used if required.

Whenever entry is made to a confined space, the access and egress route should be maintained to ensure that all personnel working in the space are able to withdraw as quickly as possible should the need arise.

Where the size of openings to, or in, confined spaces is not sufficient, consideration should be given to increasing these. This should take into account the need to operate in PPE and RPE, or to use associated equipment in the space.

Confined space supervisors can advise incident commanders of the hazards associated with restricted access or egress, and operational requirements at incidents involving confined spaces.

Lighting

Lighting equipment for use in a confined space needs to be appropriate to the environment it will be used in, with consideration given to the presence of hazards such as explosive atmospheres.

For further information refer to Safe working in reduced visibility.

Be aware of electrostatic build-up

If there is risk of an explosive atmosphere, personnel should be aware that an electrostatic discharge can be a source of ignition.

Industries have a means of earthing equipment and have appropriate clothing and PPE specific to confined space working. It is unlikely that non-specialist personnel will have access to such means of reducing electrostatic build-up, also known as static electricity. Incident commanders should consider seeking advice from specialist rescue teams, confined space supervisors or on-site staff.

Eliminate ignition sources

If gases are within flammable or explosive limits, any ignition source, including smoking and vaping, may cause combustion or explosion. If inherent ignition sources are present and identified, isolating the ignition source will help to reduce the risk; consideration should be given to setting cordons at an appropriate distance beyond the confined space.

Establish arrangements to deal with firefighter emergencies

The Confined Spaces Regulations and the Confined Spaces Regulations (Northern Ireland) state that no person at work shall enter or carry out work in a confined space unless there are suitable and sufficient arrangements for their rescue in an emergency, whether or not that arises from a specified risk. Therefore, a recovery system should be in place for all personnel entering the hazard area.

Personnel may encounter organisations working in confined spaces, with recovery systems that range from simple and immediate systems to more extensive recovery and rescue systems.

Depending on the level of access, recovery systems may involve using rope rescue equipment or dedicated confined space winching systems. An emergency team wearing appropriate RPE and associated equipment should also be available at all incidents, except those with good access, adequate ventilation and low risks of a hazardous atmosphere.

Limiting working time

There may be a need to limit the time period that personnel are allowed to work in a confined space, taking into account:

- Whether BA is being used
- Extreme conditions of temperature or humidity
- If the confined space severely restricts movement
- Extended travel times and possible arduous routes to the hazard area
- Extreme noise
- Loss of structural integrity

While some of these are not specific risks or limited to confined spaces, they should still be considered as part of the risk assessment and tackled as far as reasonably practicable.

For a large confined space and multiple entries without breathing apparatus, a logging or tally system may be necessary to check everyone in and out of the hazard area, and to control duration of work.

STRATEGIC ACTIONS

Fire and rescue services must:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Provide suitable and sufficient equipment to rescue personnel from confined spaces in an emergency	New

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13375	~~Ensure that equipment that meets the appropriate ATEX classification is available to crews trained to work in confined spaces~~	Duplicated
13383	~~Ensure that confined space supervisors are deployed to any incident involving confined spaces~~	Duplicated
13415	~~Consider providing tag line systems to crews with confined space capability~~	Moved to trench collapse
	Provide ATEX approved equipment for working in confined spaces	New

TACTICAL ACTIONS

Incident commanders must:

Revised, new, archive or no change	Tactical action
Archived	~~Establish what recovery systems have been employed before the fire and rescue service arrived~~
No change	Establish and maintain a recovery system for personnel deployed into confined space environments and ensure it is in place at all times
Revised	Ensure that emergency arrangements are maintained and resourced for the duration that personnel are committed to confined spaces

Incident commanders should:

Revised, new or archived	Tactical action
Revised	Identify the appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE) for confined space work
Archive	~~Allocate sufficient personnel to support the use of PPE and RPE that has been implemented for confined space working~~
Revised	Ensure that access and egress is appropriate for the operations being undertaken within the confined space and include contingencies for restricted access and egress
Revised	Account for extended times in the incident plan due to difficulties operating in a confined space
Revised	Use only ATEX approved equipment in confined spaces if there is a risk of an explosive atmosphere

Archive	~~Use only ATEX approved equipment in flammable or explosive atmospheres~~
Archive	~~Use only ATEX approved equipment when crews enter any potentially flammable atmosphere~~
Revised	Consider limiting the time personnel can be committed to working in a confined space
Archive	~~Identify the location of suitable access and egress routes before committing crews to a confined space~~
Moved	~~Consider implementing a tag line system to assist in tracing and locating personnel working in confined spaces~~

Hazard – Unstable or collapsed natural or built environments

HAZARD KNOWLEDGE

Fire and rescue services may be called to many natural or built environments that can be defined as confined spaces, including trenches, excavations and pits.

Personnel should be aware that some of these environments require additional resources and skills beyond the scope of non-specialist responders.

The natural environment, such as a trench, excavation, pit, cliff or steep ground, or free-flowing solids, may be subject to instability due to for example:

- Excessive rainfall
- Vibration from nearby heavy vehicles or machinery
- Severe impact
- Loads, such as vehicles, machinery or building materials, being positioned close to an edge
- Failure of supports

A serious risk of injury exists at incidents involving an unstable natural environment because soil can weigh up to 1.7 tonnes per cubic metre. Even small collapses may be fatal. The hazards to people include:

- Becoming trapped or buried
- Being crushed by the movement of soil and any subsequent loading
- Falling into a trench, pit or opening
- Drowning

Trenches and excavations are present in building works and utilities maintenance, and pits can be found in a variety of locations, such as used or disused mines or quarries, and agricultural or industrial sites. An incident involving a trench or excavation may require shoring or the removal of soil, along with having to relocate heavy machinery or other objects.

Any unsupported trench or excavation may be subject to collapse and there are many factors that will influence stability, such as:

- Height of face

- Angle of face
- Type of soil
- Adjacent loading
- Vibration from nearby machinery or vehicles
- Water content
- Surface water
- Buried services or other obstructions – refer to Utilities and fuel
- Changes in soil type or make-up
- Previously worked-on ground
- Weather conditions
- Length of time the trench or excavation has been exposed

Loading at ground level adjacent to the trench increases the likelihood of unstable faces collapsing, as does vibration from machinery or vehicles; this area should be kept clear.

Signs of collapse may include distortion or deflection of supports, tension cracks or soil movement. The incident may involve:

- Collapse of the sides or roof
- People or objects falling into the opening
- Materials falling onto people working in the opening
- The undermining of nearby structures
- Damage to utilities
- Water ingress

Control measure - Safe system of work: Unstable or collapsed natural or built environments

CONTROL MEASURE KNOWLEDGE

An incident involving an unstable or collapsed opening may require:

- Shoring
- Removal of fallen or collapsed materials
- Isolation of machinery or vehicles
- Relocation of loads, such as vehicles, machinery or building materials
- Reducing movement in the hazard area
- Appropriate location of fire and rescue service vehicles, equipment and personnel

The opening should be assessed at the earliest opportunity. Although the initial assessment can be carried out by first responders, it may be necessary to seek specialist advice.

Specialist advice may be available from a competent person, structural engineer or tactical adviser and should be sought prior to committing personnel to the hazard area.

If personnel need to enter where any of the support system has been compromised, it will be essential to consult with the responsible person or competent person to determine a safe system of work. This could be the contractor or a civil engineer.

The minimum number of personnel should be committed to the hazard area, especially if the assessment or monitoring indicates the potential for further collapse. There should also be emergency procedures in place, which can be initiated if required.

Where it is necessary to work around the opening, appropriate working at height procedures should be adopted. Any additional load placed in the area should be risk assessed and where possible pressure should be reduced by spreading the load, for example by using trench sheets or plywood. For more information refer to:

- Safe system of work: Unguarded edges
- Water rescue and flooding: Spread the load

Other safe systems of work or procedures may be involved in rescue operations, such as those for:

- Confined spaces; for example a trench may collect flammable or toxic vapours or have an oxygen-deficient atmosphere
- Working at height, for example, personal protective equipment (PPE) may be required for unguarded edges
- Access and egress, as this may be restricted

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
22626	Establish arrangements with appropriate agencies to provide specialist advice, assessment and monitoring of excavations	No change
22627	Ensure personnel are aware of local or national arrangements and the specialist advice available for excavations	No change

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action

No change	Avoid applying additional loads to the opening, such as fire and rescue service vehicles, equipment and personnel
No change	Consider requesting specialist advice regarding unstable and collapsed opening
No change	Identify the type of material being excavated and the height and angle of the excavated face
No change	Have emergency procedures in place for unstable or collapsed opening
No change	Ensure that minimum numbers of personnel work in the hazard area
No change	Assess and continuously monitor the opening for indications of further collapse
No change	Liaise with the responsible person or competent person if required
No change	Consider spreading the load of equipment or personnel to reduce the pressure on the opening

Control measure - Shoring

CONTROL MEASURE KNOWLEDGE

Shoring can be described as temporary support to elements of a structure using metal or timber shoring systems and can be provided by urban search and rescue (USAR) teams.

Shoring provides:

- Temporary stability of structures, objects or debris
- Protection from falling debris, secondary collapse to enable search or rescue operations to proceed
- Support to vertical, horizontal or sloping surfaces

Any shoring operation should be carried out by competent personnel with the appropriate level of knowledge and training, using suitable equipment. The shoring should be assessed and monitored.

It may be necessary to use temporary shoring to save life or prevent an incident escalating. However, the equipment immediately available to fire and rescue services, or to urban search and rescue (USAR) teams, may not be of sufficient strength to substitute for excavation support systems.

On-site machinery, vehicles or equipment, such as excavation support systems or materials suitable for use as trench or pit supports, may be available. However, the available equipment may have already failed, requiring a detailed risk assessment prior to further use.

If an excavation support system has been compromised, personnel should seek the advice or assistance of the responsible person or competent person, such as the contractor or a civil engineer.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13426	~~Be aware of how to request National Resilience capabilities and mutual aid resources~~	Archive

13427	Consider providing shoring equipment and materials	No change

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Consider requesting specialist tactical advice and resources for shoring
No change	Assess and monitor the effectiveness shoring
Revised	Liaise with the responsible person or competent person for shoring

Control measure - Cordon controls: Unstable or collapsed natural or built environments

CONTROL MEASURE KNOWLEDGE

To prevent collapse or further collapse of an unstable surface, trench excavation or other natural or built environment, access to the surrounding area should be carefully controlled.

Equipment entering the area should be limited to essential items only.

An area should be identified a suitable distance away from the hazard area for personnel, equipment, machinery and any items being removed including debris. Material removed from a trench should not be placed above the area where excavation is taking place, but instead moved a safe distance away to prevent slippage or collapse.

Where possible vehicles, machines or equipment creating vibration should be isolated or moved to a safe distance. The movement of redistribution of weight should be risk assessed taking into account the potential for further collapse.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
29078	Ensure personnel have access to appropriate specialist advice and equipment to assess unstable or collapsed natural or built environments	Revised
29080	Consider providing local equipment or access to specialist resources to enable personnel to work safely in the area around unstable or collapsed natural or built environments	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Assess the structural stability of the working environment and establish cordon controls at an appropriate distance from the hazard area
Revised	Identify an appropriate area to locate equipment, personnel and debris to prevent further collapse of an unstable natural or built environment
Revised	Risk assess the movement of any machinery, equipment or vehicles prior to moving them or requesting they are moved away from an unstable or collapsed natural or built environment
Revised	Request that machines, equipment and vehicles are kept isolated or moved to a safe distance away from an unstable or collapsed natural or built environment

Control measure - Use of tag lines

CONTROL MEASURE KNOWLEDGE

Tag lines can be attached to personnel or equipment in order to trace their location in an emergency or loss of communications. Tag lines should not be considered as a recovery system for personnel, but they are a useful physical locating method that can assist if a recovery does become necessary.

The management of tag lines needs to ensure they will not compromise the use of other equipment, including personal protective equipment (PPE) and respiratory protective equipment (RPE); they need to be easily released in the event of an emergency.

Procedures and systems should be put in place to operate tag lines in a consistent and uniform way, so that all teams at the incident work in the same manner.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13415	Consider providing tag line systems to assist with tracing personnel when working in unstable or collapsed natural or built environments	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Consider implementing a tag line system to assist in tracing and locating personnel working in unstable or collapsed natural or built environments
New	Manage the use of tag lines to ensure they do not compromise other equipment and can be released in the event of an emergency

Hazard - Above ground structures

HAZARD KNOWLEDGE

Above ground structures in the built environment can be divided into the following classes:

- Framed and unframed buildings (not included in this section of guidance)
- Non-building structures
- Temporary structures, such as:
- Scaffolding
  - Temporary fairground rides
  - Temporary stands

Non-building and temporary structures may be involved in any fire and rescue service activity and may present personnel with unusual and unfamiliar hazards. Hazards and operational considerations for temporary structures are similar to other non-building structures, but there may be additional hazards for personnel.

Depending on the purpose of temporary structures, they may only be in the fire and rescue service area for a short time, may be installed or erected without notice, may not meet required standards, or the fire and rescue service or other authorities may not have been given any prior notice of its installation. This makes it less likely that fire and rescue services are able to plan or familiarise their personnel with these structures.

A non-building structure is not normally designed for continuous human occupancy. Some examples are set out below.

Masts, towers and transmission towers (pylons)

The terms 'mast' and 'tower' are often used interchangeably. However, in structural engineering terms, a tower is a self-supporting or cantilevered structure, while a mast is held up by stays or guys. These are typically tall structures designed to support antennas for telecommunications and media broadcasting.

A transmission tower (pylon) is a tall structure, usually a steel lattice tower, used to support overhead power lines. For further information refer to Utilities and fuel supplementary information: Transmission towers (pylons) and wooden poles.

Wind turbines

A wind turbine is a device that converts the wind's kinetic energy into electrical power; the technical description of a wind turbine is an aerofoil-powered generator. Incidents that may require fire and rescue service onshore attendance include rescuing workers or the generator catching fire.

For further information refer to Utilities and fuel supplementary information: Wind turbines.

Tower cranes

Tower cranes are a form of balance crane used in the construction of tall buildings. They are fixed to the ground on a concrete slab and sometimes attached to the sides or top of structures.

For further information refer to Industry supplementary information: Cranes.

Theme parks, Ferris wheels, piers and stadiums

These and other similar structures are frequented by members of the public. They can include public access areas above, below and at ground level. They may also include areas with additional hazards, for example, they may be situated in or above water or have exceptionally restricted space.

For further information refer to Industry supplementary information: Fairgrounds, amusement parks and circuses.

Emergency intervention may also be affected by large numbers of casualties or trapped people. For example, a rescue from a theme park ride could involve many people being trapped at height, being restrained by seatbelts or harnesses, possibly inverted or suspended. Refer to:

- Search, rescue and casualty care: Control measures to be determined (awaiting publication)

Other generic structures

Other generic non-building structures that fire and rescue services may need to plan for include:

- Statues
- Monuments
- Bridges
- Viaducts
- Aqueducts
- Transport infrastructure – for further information refer to Transport incidents

Access

Access to areas of non-building and temporary structures may be difficult, as they are not designed for human occupancy. This presents hazards when gaining access to the scene of operations and makes maintaining safe egress routes difficult.

In some cases, the actual space in or on these structures is very limited, with the minimum room allowed for installation and maintenance. Casualties may be on-site staff who, depending on their condition, may have the best information on specific mechanical and electrical issues.

Large numbers of casualties may be present, particularly in structures designed for public use, such as roller coaster and fairground rides.

Communications

Communication with personnel working on non-building and temporary structures may be ineffective because of distance, interference and barriers. If this may happen, incident commanders must ensure they make provisions to maintain communication. Where this is not possible, they must put in place procedures to withdraw teams if there is a communications failure.

Communication may also be impacted by noise from people, music, on-site machinery and other surrounding activities.

Control measure - Safe system of work: Above ground structures

CONTROL MEASURE KNOWLEDGE

A risk assessment must be carried out before establishing any safe system of work. An incident involving above ground structures can be complex due the size, shape, purpose and surrounding area.

Establishing the type of structure may identify additional hazards and control measures to consider, which can include:

- People
- Electricity
- Non-ionising radiation (Industry, awaiting publication)
- Working near water or other liquids
- On-site machinery
- Noise
- Falling objects

Structures, such as theme park rides, may also be below the ground, including tunnels, with the potential for confined spaces. Understanding the purpose of the structure and the overall layout will assist with identifying potential hazards and associated control measures.

With incidents involving these forms of above ground structures, a range of fire and rescue responses is possible. In general, the following are most likely to be appropriate:

- Aerial appliances
- Rope access and rescue teams
- Specialist urban search and rescue (USAR) teams

Because of the sometimes unique nature of above ground structures, other agencies may become involved or lead in rescue intervention, for example:

- Helicopter search and rescue teams
- Private rescue teams specially employed to provide emergency rescue cover for a structure, for example, the London Eye
- Internal company volunteers who provide emergency cover, such as those at power generation companies

There may be a substantial delay in these agencies arriving and in most cases the fire and rescue service may be called on to attend in the first instance and then to assist.

Access and egress

As part of the information gathering and scene assessment, incident commanders should identify whether there are alternative routes to access the scene of operations.

Access to and egress from these structures may be via a single route. There may be an escape hatch that can be used in conjunction with rope equipment for an emergency exit.

Where an alternative emergency or escape route is not integral to the structure, incident commanders may need to consider not committing personnel and instead requesting specialist resources.

Communication

Communication systems should be appropriate for the environment in which they are used. Radio communications will not always be possible, and the use of 'line' communications or line of sight, hand or whistle signals may be required.

Where possible, line of sight between incident supervisors and operators should be maintained. In some circumstances, using hand or whistle signals will be appropriate. If put in place, all personnel must be aware of the system employed and there must be sufficient personnel for it to be effective.

Whichever method of communication is selected, it needs to be effective. Refer to Incident command: Effective communication.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Identify, collect and make available SSRI for above ground structures	New
13456	Ensure they have appropriate communication systems for foreseeable events involving above ground structures	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Establish the type of structure to identify additional hazards
New	Consider requesting specialist resource if access and egress is limited
No change	Identify and evaluate all potential routes of access and egress before working on a structure

No change	Establish and maintain safe means of access and egress when working on structures
Revised	Account for any extended travel times in the incident plan and establish contingencies
No change	Establish an effective system of communication considering distances and the working environment
No change	Maintain visual contact with responders working on structures and use agreed hand or whistle signals
No change	Implement fall-back procedures if there is a failure in the communications equipment

Hazard - Below ground structures

HAZARD KNOWLEDGE

A below ground structure is either partially or fully under the ground, or under another type of covering, such as concrete. Incidents in these type of structures may present significant hazards for emergency responders and the public.

Below ground structures vary greatly in depth, surface area and design, often presenting hazards such as:

- Restricted access and egress
- Reduced visibility
- Extreme temperatures
- Complex and extensive layouts

Some structures are modern and well-documented. However, older buildings may be lacking in plans; they may also, either due to their design or adaptation, not conform to current building standards. Some may come under heritage designation or be tourist attractions, while others may have no official public access.

Below ground structures include:

- Pedestrian areas
- Waterways
- Road, rail or pedestrian tunnels
- Utility provision
- Car parks
- Mines
- Bunkers and underground storage facilities
- Military installations
- Basements
- Cellars
- Catacombs
- Vaults
- Cold stores

Such environments can be under construction, operational, disused or abandoned. Various types of incidents, either accidental or deliberate, may occur in below ground structures, including:

- Fire in structure

- Fire in vehicles
- Vehicle collisions, including road or rail vehicles
- Derailments
- People trapped by or in vehicles or machinery
- People lost or fallen into below ground structure
- Flooding or inundation
- Hazardous materials
- Explosions
- Collapse

Tunnels

Tunnels include those used for road, rail, waterway and pedestrian travel or for transporting goods and services, and will be of varying size and complexity.

Tunnels used for pedestrian access do not present many incidents for fire and rescue services. However, tunnels that form part of the transport infrastructure systems, including road and rail, more frequently require the assistance of the fire and rescue service. Incidents include vehicle collisions and fires in road tunnels, rail vehicle derailments and fires in rail tunnels, and fires on board vessels in waterway tunnels.

Hazards of working in tunnels include:

- Disorientation, due to:
  - Repetition of features
  - Lack of wayfinder indicators, such as signage or landmarks
- Reduced visibility
- Restricted communication
- Extended access, egress and evacuation distances
- High temperatures

For further information on rail tunnel incidents refer to Transport – Rail-related incidents in tunnels.

Operational mines

Mines present various hazards, including:

- Security features
- Moving vehicles: Industry
- On-site machinery

- Combustible dust
- Irrespirable atmosphere
- Reduced visibility
- Noise
- Explosives
- Complex layouts
- Lengthy travel distances
- Vertical shafts, some hundreds of metres deep
- Traverses and climbs
- Constricted and restricted passages and squeezes
- Static or running water (sometimes completely submerging the passageways)

The incident may also be affected by the impact of adverse weather conditions on the environment below ground.

For further information refer to Industry supplementary information: Mines and quarries

Fire and rescue services may be called to mining-related incidents, such as partial collapse of a building or a person or animal falling into old mine workings. There may be oxygen-deficient atmospheres or gases that are toxic or explosive. Areas around the original collapse may be unstable and subject to collapse.

Caves

The UK has an extensive system of natural caves, coastal and inland, with new caves or extensions to caves always being discovered. Caving, also known as potholing, is the recreational exploration of caves and potholes. Depending on the ability and experience of people participating in this activity, the caves may be well-known to them or previously unexplored. Caves may also be explored for scientific or historical research.

There are also incidents when people accidentally fall into caves, for example due to unstable ground or the cave entrance being obscured.

Disused mines

Some parts of the UK have extensive disused mining systems, some of which are accessible to the public. The exploration of disused mines is sometimes arranged as an activity through caving clubs. Although people may have some knowledge and experience of these environments, it is an uncontrolled, unregulated and dangerous activity.

There are also incidents when people accidentally fall into disused mines or mineshafts, due to unstable ground or where the mine entrance or mineshaft are obscured.

Armed forces and civil protection below ground structures

The use of structures that are under military control is wide-ranging; they are not usually accessible by the general public or emergency services, as they are subject to security protocols.

Below ground armed forces or civilian protection structures have various uses including munition storage, command and control, equipment testing or accommodation. They may have several subsurface levels or be on one level with a single entrance and exit. They may have ventilation and heating systems, be fully self-contained, and have pedestrian or vehicle access.

Decommissioned below ground structures may either be sealed up, or ownership transferred to another organisation to maintain and run for other purposes. One use may be that of historical education, in the form of a museum or historical society, such as the underground tunnels and command facilities at Dover. Others may be sold to private companies for a variety of purposes, such as document storage or housing of remote electronic equipment.

Critical national infrastructure

Some below ground environments may be used as a conduit for critical national infrastructure. An incident adjacent to these systems could have a potentially significant effect on the maintenance of essential services. Consideration should be given to the impact on:

- National transport networks, with local, national and international dependencies, principally involving road and rail use
- Telecommunications and power systems
- Water treatment systems
- Storage of significant items and use by industries
- Potential for widespread flooding resulting from the inundation of tunnels
- Tunnels being put to more than one use, for example a transport tunnel used to carry telecommunications cables, thereby compounding the community impact of a significant incident

For further information refer to the Centre for the Protection of the National Infrastructure: Critical National Infrastructure.

Control measure – Situational awareness: Below ground structures

CONTROL MEASURE KNOWLEDGE

This control measure should be read in conjunction with Incident command – Situational awareness

Incidents in below ground structures may present significant challenges in gathering information and establishing accurate situational awareness. Therefore, it may be beneficial for fire and rescue services to liaise with local organisations or groups to maintain knowledge of below ground structures in their area.

The seriousness of the incident in a tunnel or below ground structure may not be immediately apparent and there is potential for the incident to rapidly escalate. Responding to below ground incidents may present personnel with a range of complex and unfamiliar conditions that may include:

- Long travel distances
- Complex workings and uncharted layouts
- No through access
- Compressed air workings
- Complex and unfamiliar machinery
- Highly restricted working areas

Consideration should be given to the likely resource and time requirements to establish, initiate and maintain an effective intervention and the likely development of the incident during that time. Initial considerations should include:

- Identifying appropriate bridgeheads or equipment staging areas
- The position of any ventilation outlets if the products of the incident may affect people on the surface or remote from the incident
- Direction of any mechanical forced ventilation, so that safe areas for members of the public and operational bridgeheads can be provided
- Gradient of any passageway allowing run-off, liquid contamination or flowing fuel fire to spread, or the potential for inclined surface 'trench effect'
- Method of containing run-off or contaminated liquids, and their environmental impact
- Stability of the structure and its effect on the surface
- Risk of inundation of the infrastructure
- Identifying the possible spread of flood water and its predicted effects on the wider community

Tunnels

Where tunnels have public access, fire and rescue services will normally have prior knowledge and understanding of the hazards presented. There may be pre-planned arrangements for attendance and the actions to be taken in the event of an incident.

Sewers and associated below ground assets

Sewage or wastewater undertakers should have emergency procedures for their employees and subcontracted staff working in those environments. The assistance that fire and rescue services can provide will depend on the knowledge, training, skills and equipment of the individual services. It may be necessary to seek specialist assistance, such as urban search and rescue (USAR). For further information refer to Utilities and fuel - Isolate utility or fuel supply to the premises.

Operational mines

Depending on the type of incident at a mine, first responders may be limited in their ability to deal with the situation. It may be necessary to seek specialist assistance from teams skilled in rope rescue, confined space rescue, mine rescue or urban search and rescue.

The British Geological Survey (BGS) continually monitors the location and nature of active onshore mineral workings in the UK and publishes this information in its Directory of Mines and Quarries. A number of mines are used for other purposes such as tourism and storage of documents, computer records, wine and cheese.

Under the Mines Regulations 2014, the mine operator needs to make suitable arrangements for the escape and rescue of persons from the mine; this may include using safe havens in the mine.

Arrangements for rescue may include using companies that provide specialist rescue training, trained rescue staff at mines, cave rescue teams in locations such as tourist mines and, in some instances, fire and rescue services.

Although large-scale coal mining operations have ceased in the UK, there may be hazards to people, livestock, property and the environment from:

- Collapse of mine entries and shallow coal mine workings (subsidence)
- Emissions of mine gases
- Incidents of spontaneous combustion
- Discharge of water from abandoned coal mines

The Coal Authority manages the effects of past coal mining, including subsidence damage claims that are not the responsibility of licensed coal mine operators. It deals with mine water pollution and other mining legacy issues.

At all mine and mine surface incidents, it is important to consider the need to preserve the scene for investigation purposes. Fire and rescue services need to be aware that other organisations may have to carry out their own investigations. The police, British Transport Police, Office of Road and Rail, Rail Accident Investigation Branch, Coal Authority, Health and Safety Executive and utility companies, as well as local agencies, will all need to be considered when dealing with mine and mine surface-related incidents.

As large-scale incidents involving mine or mine surface hazards are infrequent, fire and rescue services should carry out joint exercises with the mine operator to understand what skills and techniques may be required.

Caves and disused mines

Depending on the type of incident at caves, disused mines or recreational below ground environments, first responders may be limited in their ability to deal with the situation. It may be necessary to seek specialist assistance from teams skilled in rope rescue, confined space rescue, cave rescue or urban search and rescue.

Attendance and intervention will often be led by attending cave rescue specialists, but there may be occasions when fire and rescue services have the ability and resources to assist. For example, if a person has fallen into a vertical entry point at the start of a cave system, personnel may have the rope rescue capability to immediately access and recover the casualty.

Armed forces and civil protection below ground structures

Some structures in use are fully occupied, while others are remote stations that are only visited occasionally. Some are only visited by staff to check or maintain equipment or to assess the security of the site. Other sites provide resilience and have only occasional use, but there are usually procedures in place to ensure the safety of those who visit.

The Defence Fire and Rescue Service may provide normal emergency response activities for all operational military establishments.

Structures in private or commercial use will be required to maintain a safe system of work for any working staff or visiting public and, depending on the use and levels of commercial security and sensitivity, will include notification and collaboration with local fire and rescue services.

Fire and rescue services should work with the establishment's management to provide additional assistance if required, to establish a structured response plan and arrange regular joint exercises and familiarisation of sites to ensure all partners have a clear understanding of the extent and limitations of their role and responsibilities.

Evacuation and rescue

Some infrastructures will contain large numbers of people, unfamiliar with their surroundings or emergency procedures. The responsibility for their evacuation in an emergency rests with the infrastructure managers; however, fire and rescue services will undertake rescues of staff or members of the public if they are in imminent danger.

Incident commanders should attempt to identify the progress and success of a managed evacuation. If it appears that people are, or may be, imminently exposed to harm personnel will need to take appropriate action. For further information refer to Operations – Evacuation and shelter.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Consider liaising with local organisations or groups to maintain knowledge of below ground structures in their area	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action

New	Establish the conditions present in the below ground structure
New	Identify any fixed installations that are present within the below ground structure
New	Liaise with on-site personnel, including rescue teams, when developing the tactical plan for incidents at below ground structures
New	Confirm the current status of any managed evacuations for below ground structures and take action if required

Control measure – Specialist resources: Below ground structures

This control measure should be read in conjunction with Incident command – Specialist resources

CONTROL MEASURE KNOWLEDGE

Fire and rescue services may need to provide equipment and personnel to assist specialist organisations, rather than directly use fire and rescue personnel to enter and operate as the primary rescuers.

Responders such as urban search and rescue (USAR), hazardous area response teams (HART) or special operations response teams (SORT) have competent personnel to advise and specialist equipment with supporting incident commanders.

The British Cave Rescue Council (BCRC) is the body recognised by the UK government as providing the underground search and rescue service in caves and disused mines. It has a seat on the UK Search and Rescue (UKSAR) operators group, where it meets regularly with other national search and rescue operators.

The responsibility for inland rescue usually rests with the police under their general public order powers and responsibilities. However, if the police are unable to conduct searches or rescues in caves and disused mines, they will rely on the members of the BCRC.

BCRC members are also called on by the police to assist in animal rescues and occasionally to carry out other types of search to assist investigations.

The range of below ground environments that may be accessed for recreational purposes is wide; some will have been formed by erosion within natural geological formations and others will have been created by mining or tunnelling operations. Many of the entry points to these sites will be in locations that are difficult to find and access and that may require approach by specialist vehicles or on foot over significant distances.

The incident may also be affected by the impact of the weather on the environment below ground; cave systems may flood rapidly and with little warning.

STRATEGIC ACTIONS

Fire and rescue services should:

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

	Consider carrying out joint training and exercises with specialist resources for below ground structure incidents	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Request specialist resources for assistance at below ground structure incidents
New	Request advice or assistance from USAR, HART or SORT at below ground structure incidents

Control measure - Liaise with responsible person: Below ground structures

CONTROL MEASURE KNOWLEDGE

Many aspects of below ground structure construction is likely to fall outside the scope of fire and rescue service personnel knowledge and skills. It is the responsibility of experts to ensure that proposals meet statutory duties, legal requirements and standards set out for construction, and that services required to support a fire and rescue service intervention are put in place.

In the event of an incident in a below ground structure, the fire and rescue service should seek expert advice from sources such as:

- Tunnel safety officers
- The contractor
- The appropriate regulator
- The Health and Safety Executive (HSE)
- Regulatory bodies, such as the Office of Rail and Road

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13473	Develop arrangements and procedures for dealing with below ground structure incidents with identified sources of expert advice or assistance	Revised
13474	Maintain the details of any expert adviser for below ground structure incidents and know how to request their advice or attendance	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Request expert advice or assistance based on the extent and urgency of the below ground structure incident
Archive	~~Ensure fire and rescue personnel work in accordance with agreed procedures that comply with contractor arrangements~~
New	Consider the specialist advice received when developing the tactical plan for below ground structure incidents
No change	Liaise and work with on-site staff or the contractor's specialist teams where they are available

Control measure - Monitoring systems: Below ground structures

CONTROL MEASURE KNOWLEDGE

Often below ground structures will be monitored for safety and security reasons. Widespread or complex structures often have control rooms with a range of features and information readily available to an incident commander. An understanding of the information available from those control rooms and how it can be accessed, will help to determine its usefulness when managing an incident.

In some instances, there are protected on-site control rooms, providing facilities to assist in managing an incident. These may include facilities for fire and rescue service personnel to monitor progress of personnel and the safe evacuation of the public. Alternatively, for widespread or complex infrastructure, there may be a central or off-site control room. Features provided by these control room, which may benefit fire and rescue service operations, include:

- Details of alternative access or egress routes
- Close circuit television (CCTV)
- Public address systems
- Ventilation systems and controls
- Fire and rescue service telecommunications
- Site plans
- Traffic management controls
- Refuge communications
- Water inundation protection facilities, including tunnel portal door closers

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13480	Identify the location of control rooms for below ground structures, as part of the SSRI	Revised
13481	Ensure that personnel are aware of the information available from and capabilities of below ground structure control rooms	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Consider using the facilities available in the below ground structure control room to monitor the incident

Hazard - Access and egress: Below ground structures

HAZARD KNOWLEDGE

Fire and rescue service personnel need to consider the possibility of unusually complex access to and egress from the scene of operations. Considerations may include the need for additional and varied entry procedures and routes, extended travel times, various transportation methods to scenes of operations and using unfamiliar equipment.

Gaining access to the scene of operations in a safe and controlled way is a critical part of fire and rescue service operations. The use of the infrastructure will vary depending on type, age and location. Some infrastructures may have facilities built in that accommodate fire and rescue service needs, such as:

- Hard standing areas for emergency vehicles
- Dedicated rendezvous points (RVPs) for emergency vehicles
- Fire and rescue service communications extended to cover the rendezvous points (RVPs), shafts, below ground area or tunnels
- Premises information boxes or security standard boxes with plans, entry codes or keys
- Security doors providing an agreed method of fire and rescue service entry without unreasonable delay, normally using keys, entry codes or remote door release devices
- Firefighting stairs and lifts
- Ventilation system to protect firefighting access from contamination
- Firefighting lobbies
- Raised walkways

Control measure – Gain and maintain safe access and egress: Below ground structures

CONTROL MEASURE KNOWLEDGE

Safe access and egress will need to be gained and maintained for any incident involving below ground structures.. Alternative means of making an entry should be considered and emergency arrangements put in place.

In addition to identifying the most appropriate access point, the precise location of the incident within the infrastructure must be found to:

- Identify the likely travel distances and working duration of personnel
- Identify or anticipate any obstructions that may affect access
- Factor in the effects of fatigue due to extended travel distances to and from the scene of operations, especially when carrying equipment
- If feasible, deploy appropriate vehicles to transport personnel or equipment; this may include on-site machinery or vehicles

Using lights, markers or barrier tape should be considered to indicate the extent of the inner cordon within complex structures, or where there are no distinguishing way finders or location indicators. Similarly, these items should be considered for indicating the door or level that leads to the way out along the route to the surface. This may be particularly important if there is a shaft below ground that is part of a larger above ground building.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13485	~~Establish a periodic review and amendment process to ensure the strict control and accuracy of fire and rescue service guidance. This will be an ongoing process to reflect construction advancement and the subsequent need to revise plans~~	Archive
13486	Assess the need to provide additional equipment for personnel making attending an incident at a below ground structure	Revised
13487	~~Conduct regular site visits to ensure complete awareness of the site access point and access control system~~	Archive

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action

Revised	Identify the location of all potential access and egress routes for below ground structures to inform their tactical plan
Revised	Establish and maintain safe means of access to, and egress from, below ground structures at all times
No change	Only use access lifts and transport approved for fire and rescue service purposes

Hazard - Uncontrolled ventilation: Tunnels

HAZARD KNOWLEDGE

Ventilation is used to supply fresh air, remove fumes, gases and dust, regulate the temperature, and to assist with smoke control in the event of a fire.

Tunnels may quickly fill with poor quality air due to the ventilation system:

- Driving fumes or smoke to unaffected areas
- Assisting the development and spread of fire
- Being impacted due to the incident or operational activities
- Being isolated or failing

Maintaining effective ventilation will be a key consideration for the incident commander.

Control measure – Understand and control ventilation systems in tunnels

This control measure should be read in conjunction with Fires in buildings – Ventilation systems

CONTROL MEASURE KNOWLEDGE

For the purposes of fire and rescue service operations, ventilation systems can be divided into two principal types:

- Natural: caused by the flow of air through the infrastructure's openings
- Mechanical: where a ventilation system serves a specific function, such as cooling, removing fumes or controlling smoke or fire

Ventilation systems are more common in highway tunnels due to high concentration of contaminants. Rail transit tunnels may have ventilation systems in the stations or at intermediate fan shafts, but during normal operations rely mainly on the train pushing air through the tunnel to remove stagnant air. Some rail transit tunnels have emergency mechanical ventilation that operates in the event of a fire.

Mechanical tunnel ventilation systems can be categorised into four main types:

1. Longitudinal ventilation is similar to natural ventilation with the addition of mechanical fans, often used inside rectangular-shaped tunnels that do not have the space to facilitate air circulation above the ceiling or below the roadway. Also, shorter circular tunnels may use the longitudinal system since there is less air to replace; therefore, the need for even distribution of air through ductwork is not necessary. The fans can be reversible and are used to move air into or, in the event of a fire, out of the tunnel from both portals.

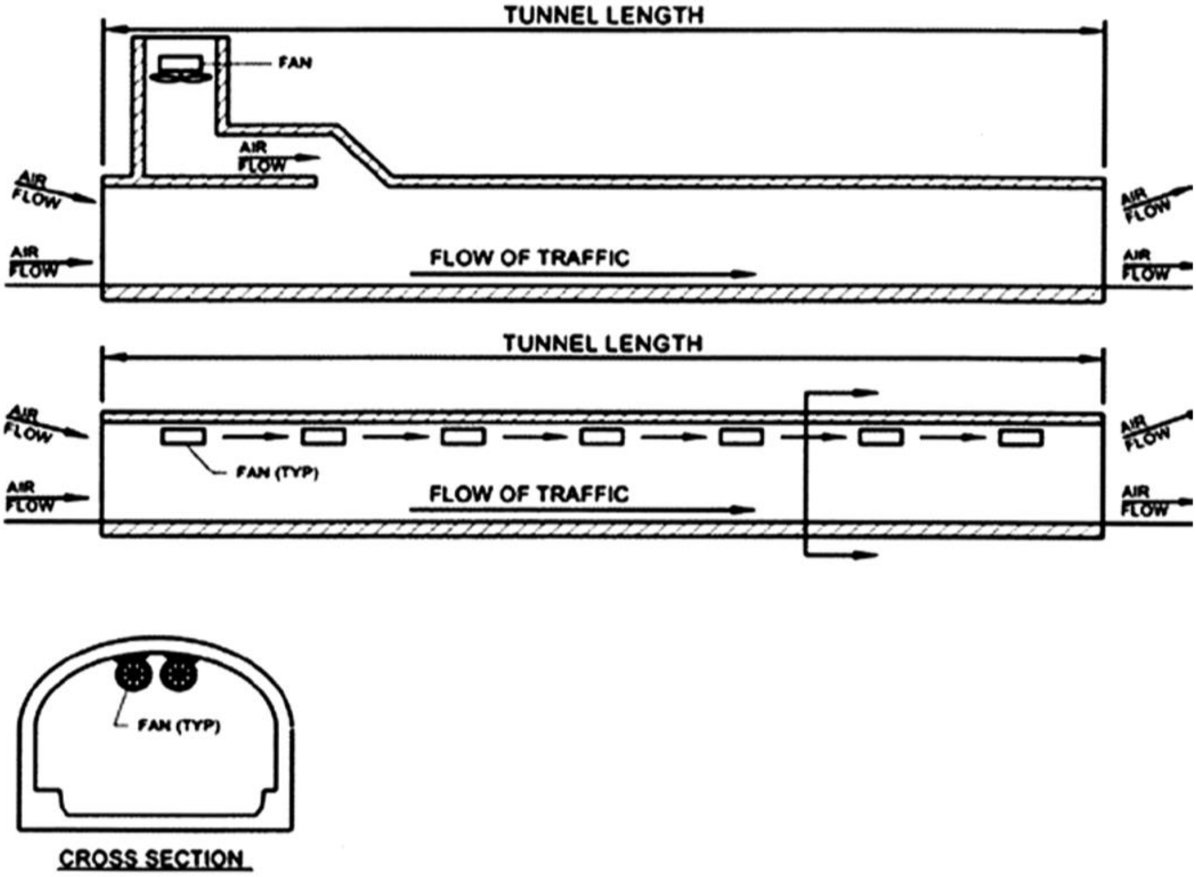

Figure: Diagram showing an example of longitudinal ventilation system used in tunnels

2. Semi-transverse ventilation also makes use of mechanical fans for movement of air. A space to facilitate air circulation is incorporated above or below the tunnel with flues that allow for even distribution of air throughout the tunnel. There are many variations of a semi-transverse system, such as one half of the tunnel to have a supply-air system and the other half an exhaust-air system. Another variation is to have a system that can either be exhaust-air or supply-air by using reversible fans or a louvre system in the ductwork that can change the direction of the air. In the event of a fire the fan can draw air into the tunnel and push smoke or fumes out of the portals.

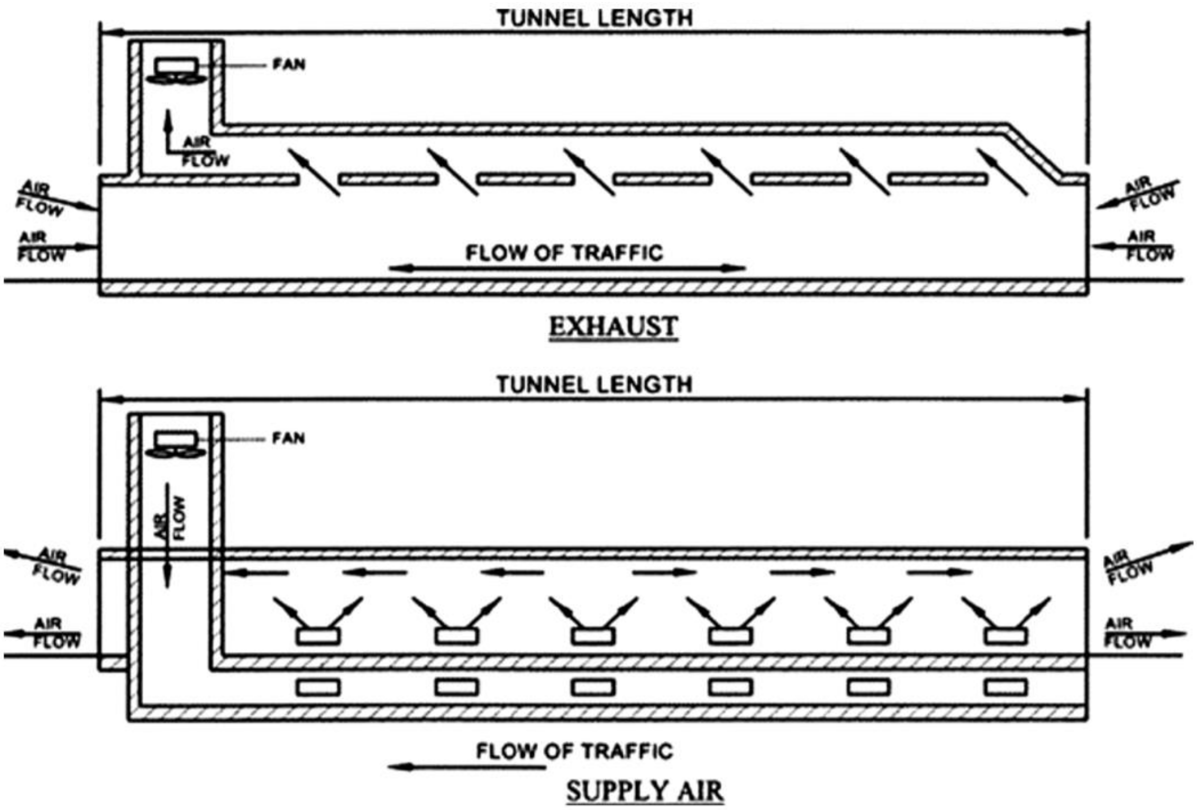

Figure: Diagram showing an example of semi-transverse ventilation system used in tunnels

3. Full-transverse ventilation uses the same components as semi-transverse ventilation, but it incorporates supply air and exhaust air together over the same length of tunnel. This system is used primarily for longer tunnels that have large amounts of air that need to be replaced, or for heavily travelled tunnels that produce high levels of contaminants. The presence of supply and exhaust ducts allows for a pressure difference between the roadway and the ceiling; therefore, the air flows transverse to the tunnel length and is circulated more frequently. This system may also incorporate supply or exhaust ductwork along both sides of the tunnel instead of at the top and bottom.

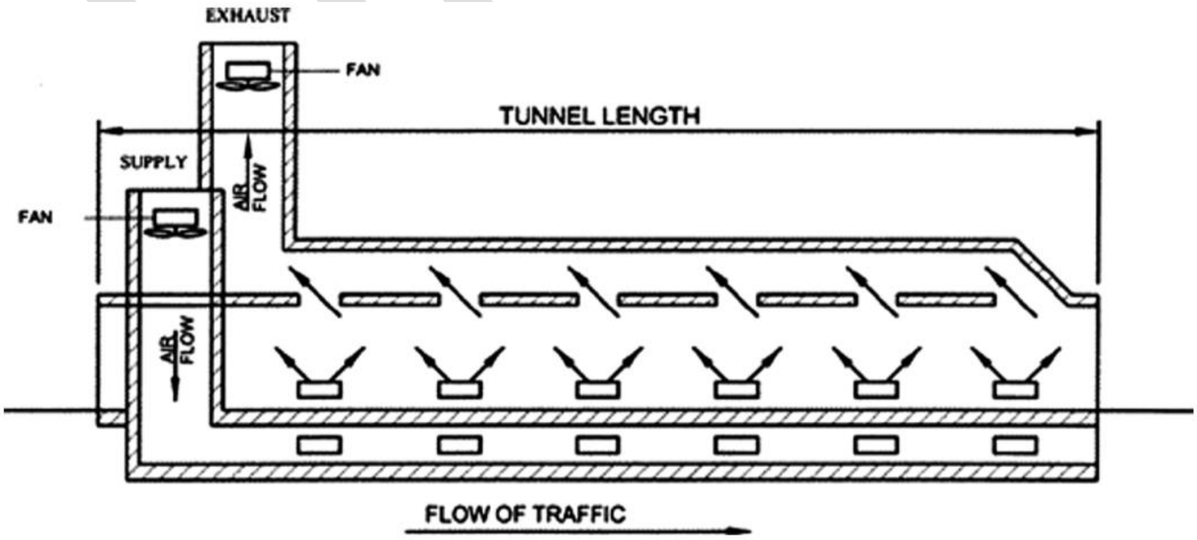

Figure: Diagram showing an example of Fully-transverse ventilation system used in tunnels

4. Single point extraction can be used in conjunction with semi- and full-transverse ventilation systems to increase the airflow potential in the event of a fire in the tunnel. The system works by allowing the opening size of select exhaust flues to increase during an emergency. This can be done by mechanically opening louvres or by constructing portions of the ceiling out of material that would go from a solid to a gas during a fire, thus providing a larger opening. Both of these methods are rather costly and therefore seldom used. Newer tunnels achieve equal results simply by providing larger extraction ports at given intervals that are connected to the fans through the ductwork.

For further information for fire in tunnels please refer to [Fires in buildings: Fires in tunnels]

Whichever system is installed, it should normally be known whether it has been provided, designed and rated for fire and rescue service purposes. If it has been provided to control smoke or fumes in an emergency, the incident commander can initially assume that it will provide adequate protection for those evacuating the premises under the guidance of the infrastructure manager, and for responders being committed.

If mechanical ventilation is unidirectional, or where pre-prepared plans define a default air flow direction, this creates a preferred entry point at the inlet end of the tunnel. Plans should then have responders committed in this direction.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Include details of the type of ventilation installed in risk information for tunnels	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Identify the type of ventilation used within the below ground structure
New	Liaise with responsible person or control room to establish control of the ventilation system

Hazard - Ineffective communications: Below ground structures

HAZARD KNOWLEDGE

Normal fire and rescue service radio telecommunications may be rendered ineffective when operating in subsurface environments and infrastructure.

Fire and rescue services should take care when accepting the use of the infrastructure's own communication equipment, particularly if this is hardwired telephone communications to a control point. The potential implications, including the loss of communication at a critical time, require careful consideration.

Noise can interfere with communication or emergency signals.

Communications with other agencies

Incidents involving below ground structures can present some significant challenges for communications infrastructure. There are no simple rules that can be applied, and the communications problems found at individual locations need to be considered and overcome. This may involve using operational fire and rescue service and multi-agency methods, as well as the fixed systems supplied in many modern structures.

Communications, both internal and external, have been identified as areas of weakness in post-incident investigations and debriefs.

Control measure - Effective communications: Below ground structures

CONTROL MEASURE KNOWLEDGE

Communications used by fire and rescue services at an incident will be greatly enhanced by pre-planning and testing the range and extent of signals, including joint testing with other agencies and infrastructure managers.

Some infrastructures can support communications with fire and rescue service systems. For example, a relatively short tunnel that allows good, uninterrupted radio coverage in all reasonably foreseeable circumstances should not require the additional provision of a fire and rescue service 'leaky feeder' or 'repeaters'.

Incident commanders should carefully consider their methodology for communicating with other responders, including the use of:

- Emergency service radio system, using inter-agency radio channels
- The potential danger of reliance on mobile telephone networks
- Field telephones between emergency service control vehicles
- Runners, if appropriate
- National inter-agency liaison officers (NILOs)
- Communications tactical advisers
- Any mutually agreed method to overcome local communications difficulty
- Multi-agency meetings to confirm the incident situation and inter-service communications structures and limitations

In some circumstances, it may be beneficial for fire and rescue services to enter into local agreements with other responding agencies and organisations that can provide communications support.

Incident commanders should establish resilient telecommunications arrangements and carry out regular testing to confirm that contact has not been lost with personnel operating in below ground structures.

Particularly in older infrastructure, it may be appropriate to mobilise or request an attendance to more than one location. This will assist where:

- There is limited or no smoke ventilation or fire stopping
- There is limited or no effective communication system

The incident commander will need to consider establishing and maintaining:

- Communications with the tunnel operator
- Communications with the fire control room
- Using UHF radios, assigning channels and agreeing on call signs
- Communications with other agencies
- Communications within the subsurface environment

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Establish arrangements with other specialist resources who could provide communications for below ground structures	New
13496	Ensure that they have resilient telecommunication arrangements for any subsurface environments and infrastructure identified as risks within their service area	No change

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Establish and maintain communications with the responsible person for the below ground structure
New	Request specialist resources to establish communications for below ground structures
No change	Establish and regularly monitor the effectiveness of communications with personnel operating in subsurface environments

Hazard - Tunnels under construction

HAZARD KNOWLEDGE

This guidance focuses on the construction and operational use of existing tunnels, but much of the information may be relevant to disused or decommissioned tunnels.

Fire and rescue services should ensure that all reasonable arrangements are made to liaise with those operating the tunnel system and should review Site-Specific Risk Information (SSRI) and response plans so that they reflect the current situation.

As construction nears completion, it will be necessary to re-evaluate information previously collated and to work with infrastructure managers, tunnel user representatives, regulators and other multi-agency partners to ensure that the final emergency plan is validated. Plan validation should take place before commissioning exercises and the official opening, through exercises using the access and systems that are in place.

Many aspects of the construction of a below ground structure fall outside the knowledge and skills of fire and rescue service personnel. It is recommended that fire and rescue services liaise with experts to ensure that proposals fulfil statutory duties, legal requirements and specific construction standards and that the services required to support a fire and rescue service incident are established.

Tunnels under renovation, restoration or construction can present challenging and unusual hazards such as:

- Limited access and egress
- Extreme travel distances
- Compressed air working

Work in compressed air, relates to any activities within any working chamber, airlock or decompression chamber that is used for the compression or decompression of people. This includes a medical lock used solely for treatment purposes, where the atmospheric pressure exceeds 0.15 bar. Access to a pressurised working will involve an airlock. or air washing lock, also referred to as a manlock. Work in compressed air is regulated under:

- The Work in Compressed Air Regulations
- Work in Compressed Air Regulations (Northern Ireland)

Atmospheric pressure at sea level is fractionally above 1 bar pressure, pressure gauges are scaled to read zero at this at normal atmospheric pressure. In a pressurised atmosphere a reading of 1 bar refers to double that of atmospheric pressure. At 1 bar the equivalent volume of air at atmospheric pressure is halved, therefore inhaling the same volume of gas contains double the concentration of air.

Fires involving compressed air workings will involve an accelerated combustion process, due to increased oxygen levels in the pressurised atmosphere.

During construction, tunnels may be pressurised to prevent water ingress, particularly boring under a river or in very wet layer. Regulations under the Health and Safety at Work etc. Act are in place in respect of people employed in pressurised workings.

The Work in Compressed Air Regulations apply to all people employed in tunnelling, pipe jacking and shaft and caisson sinking operations carried out in compressed air, including the use of tunnel boring or shaft excavating machinery and similar operations, as part of construction work.

Health risks

When working in a pressurised atmosphere, the body's internal pressures balance to match the external pressure; therefore, the amount of air inhaled at 1 bar pressure will be double that at atmospheric pressure.

There are various types of health problem (decompression illness) which can be caused by working in compressed air. According to the Health and Safety Executive (HSE) information, About work in compressed air, the most common are:

- Decompression sickness, which predominantly occurs as a condition involving pain around the joints, or, more rarely, as a serious, potentially life-threatening condition that may affect the central nervous system
- Barotrauma, where a change in surrounding pressure causes direct damage to air-containing cavities in the body directly connected with the surrounding atmosphere, principally the ears and sinuses
- Dysbaric osteonecrosis, which is a long-term, chronic condition damaging the long bone joints, such as hips and shoulders

Breathing apparatus

The working duration of self-contained breathing apparatus (BA) is significantly reduced by increased pressure. The balance of the exhale valve and diaphragm controlling the demand valve are likely to be affected by the increase in the external pressure. In addition, the stress and exertion of working in these environments is likely to increase breathing rates.

Personnel need to consider the potentially limited intervention they can make at incidents in tunnels or other below ground structures under construction. The need to wait for additional core and specialist resources will inevitably add moral pressure to personnel and incident commanders to take life-saving action.

Control measure – Establish arrangements for tunnels under construction

CONTROL MEASURE KNOWLEDGE

The notification of any tunnel or below ground structure project should be the starting point for engagement with the client, principal contractor and responders. This will enable the most hazardous phase of the project to be risk-assessed. The outcome of the risk assessment will inform the development of any special procedures, restrictions or limitations to be applied, well before the construction phase commences. The contractor’s risk assessment outcomes and plans must be confirmed in writing.

Special controls and procedures agreed by the contractor must be recorded in the emergency plan and communicated to all partners so they can be implemented quickly and without confusion. Special controls, restrictions or limitations will need to be applied to no through access conditions. These can be created when a tunnel boring machine (TBM) commences boring and the services required to support a fire and rescue service intervention cannot be established for a period of time. In a fire situation, this would mean that the fire and rescue service could only make a limited intervention, as a charged line of delivery hose cannot be dragged for long distances.

A normal control measure applied during these circumstances is for the TBM to be provided with a water mist system to protect walkways, and a rear water curtain to protect the TBM crew, who would remain on-board.

The hand digging of cross passages and the need to enter the cutting head of the TBM both involve working in confined spaces. Such conditions will require the contractor to have special rescue teams available on-scene when work is being carried out, as this responsibility cannot be discharged to the fire and rescue service. Although some fire and rescue service personnel are trained and equipped to work in confined spaces, technical rescue teams are not normally mobilised as part of the fire and rescue service first attendance, resulting in a delay in intervention.

As the tunnel or below ground structure reaches completion, the hazard and risk significantly reduce because the 'as built' environment will include all the design safety features that support an intervention.

Compressed air work

The task of firefighting or rescuing people employed in compressed air workings is principally the responsibility of the contractor on site. The fire and rescue service might respond to sites where compressed air workings are present and stand by to give advice and provide backup facilities as necessary.

However, subject to any prior arrangement between the contractor and the fire and rescue service, the contractor's responsibilities under the Health and Safety at Work etc. Act should make it unnecessary for personnel to deal with an incident within compressed air workings.

Subject to prior agreement and arrangement, it might be reasonably foreseeable that fire and rescue services could be requested to provide some element of a contractor's emergency arrangements. Breathing apparatus (BA) command and control procedures, appropriate to the risk, should be established along with any minimum provisions for a safe system of work.

Pre-planning and familiarisation

To ensure adequate emergency response, site inspection visits will be essential to familiarise and prepare all responders likely to attend and make an intervention in these environments during construction or when completed.

For further information refer to [Tunnels and underground structures supplementary material].

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
	Establish emergency arrangements with the lead contractor and, where applicable, the compressed air work contractor for tunnels under construction	New
	Consider regularly training and exercising any agreed arrangements	New
13511	Conduct regular site inspection visits to tunnels under construction to improve familiarisation	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
New	Adhere to any emergency arrangements for incidents in tunnels under construction
New	Avoid Not commit personnel to tunnels subject to compressed air work
No change	Establish and communicate limits of operation based on identified risks and available resources

Hazard - Ineffective intervention strategy: Below ground structures

HAZARD KNOWLEDGE

For known below ground risks, hazards should be assessed, mitigated or eliminated as part of the pre-planning process, and relevant control measures identified. However, the pre-planned response may not be sufficient and additional control measures may need to be considered to achieve the tactical plan.

The intervention strategy will normally include hazard control by providing fire and rescue service facilities and one or more of the following methods:

- Activation of local or area-wide automated fire or smoke ventilation or suppression systems, normally by the responsible person, on discovery of an incident
- Liaison with on-site representatives and specialist fire and rescue service advisers to identify community impact
- Knowledge of the evacuation strategy and information on its progress
- Discussion with the responsible person confirming the extent to which any control has been implemented; this will assist the incident commander to identify the safe working area for operations to take place
- Use of established procedures for the type of infrastructure to establish appropriate safety measures such as a road traffic or railway incident procedure and to control traffic or

machinery

Control measure - Intervention plan: Below ground structures

CONTROL MEASURE KNOWLEDGE

Confirmation should be sought from the responsible person on the status and operation of systems used to protect members of the public, staff and emergency responders, for example:

- Ventilation systems
- Pressurised escape area or intervention shafts
- Vehicle control systems, for example, road traffic lights set to red at either end of the tunnel
- Current status of high-voltage electricity
- Use of any on-site rescue or recovery teams
- Suitability of equipment to function in a tunnel or below ground environment
- Available communication systems

A risk assessment should be carried to consider the use of available intervention options before implementing any that are appropriate into the tactical plan.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13526	Develop pre-planned intervention strategies for below ground environments identified as risk within the service area	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Confirm the status of protection systems for below ground structures
No change	Co-ordinate the evacuation, ventilation, fixed installation and intervention strategies simultaneously

Hazard - Unstable or collapsed structure

HAZARD KNOWLEDGE

Structural collapses occur because of a loss of stability, where the basic shape and integrity of the structure is significantly changed through being subjected to a combination of forces. As the altered structure or shape is less capable of supporting the imposed forces and loads, it continues to change until it finds a new shape that is more stable.

Structural collapse can be caused in many ways including:

- Naturally, such as:
  - Natural deterioration
  - Earthquake
  - Subsidence
  - Flood water
- Accidentally, such as:
  - Explosion
  - Impact
  - Fire
- Deliberate actions, such as:
  - Terrorist attack
  - Explosive device

Structures may become unstable or collapse due to:

- Construction or demolition work
- Derelict or deteriorated condition, including previous fire related damage
- Involvement in a transport collision
- Substandard or unregulated construction or modification
- Exemption from, or non-conformity with, building regulations
- Operational activity such as moving or cutting structural elements
- Severe weather conditions, such as flooding, heavy snow or high winds
- Geological effects
- Shock due to severe impact or explosion

Poor design or defects can cause weaknesses to parts of a structure, which may subsequently fail if stresses are applied, such as severe weather conditions or abnormal loading by heavy machinery. A building under demolition or renovation may collapse if critical load-bearing walls or floors are removed without considering the effects on the other structural elements.

Low quality materials, or poor building techniques used during the construction phase, can result in a building that is substantially weaker than intended. This increases the likelihood of collapse should the building be exposed to additional forces.

Geological weakness may cause buildings to collapse through movement of the strata on which the foundations are laid, for example, subsidence. This movement can place excessive stress on a structure, overloading it and causing collapse. Alternatively, the ground on which the building is constructed may weaken to such an extent that it is unable to support the weight of the building. Liquefaction, where the water content in the soil increases to such an extent that the soil loses all cohesiveness and strength, resulting in the building sinking into the ground, is the most common form of failure.

There may be occasions when the unstable or collapsed structure may be affected by some form of geological movement, such as earthquakes. This is rare in the UK, but similar types of ground movement within the substrata in and around the area of an unstable structure could occur.

The reasons for this movement may not be known and may not be noticeable, but the history of the initial cause of the structure's instability or collapse may indicate a need to be aware of potential ground movement. For example, in areas of known mining, the cause may be assigned to the collapse of old workings and therefore the possibility of further movement will need to be considered.

Some non-building or temporary structures can become unstable due to a combination of potential causes that render the environment hazardous to personnel operating within or nearby.

Structures may fail for various reasons, such as:

- Insufficient strength to take the weight or force of a load, or possibly through secondary collapse
- Loads or forces applied to the structure, directly or indirectly, may worsen the instability or progress a collapse; this could include rescue loads and the use of equipment

People may be at risk if they are in the vicinity of an unstable or collapsed structure.

Structural elements: floors, walls, ceilings, ancillary items, fixtures and fittings can partially collapse. Partial collapse can follow on from the collapse of lightweight or decorative features.

If partial collapse is not controlled, it may increase the potential for falling debris and secondary or structural collapse.

Lightweight or fragile structural features may collapse, including non-structural elements; for example roof coverings, false chimneys and glazing.

False chimneys do not form part of the structural fabric of the building, can be a considerable weight and are only supported by roof timbers. If roofing timbers or lightweight trusses fail, they may collapse through the roof. False chimneys are not suitable as an anchor for working at height, as they may not be able to support any additional weight.

Collapse may not be limited to the structure itself, as scaffolding or cranes, for example, may be at risk of damage or collapse.

Moving or cutting structural elements during operational activity can have an impact on the stability of a structure.

The way and speed in which elements of construction distort or fail depend on the type of structure and how construction materials have been used or combined. There may be varying stages or severity of instability or collapse. A structural collapse may occur without warning, giving people little or no time to escape.

In a collapsed structure casualties may be located in voids or spaces or be trapped under debris. The type of structure can provide some indication of the way it has collapsed, and the location of potential voids or spaces.

For more information on construction methods and materials see BRE building supplementary information.

Patterns of collapse

Collapse patterns can be categorised as internal, external or total collapse.

Internal collapse	
Pancake or progressive collapse	Structural failure causes a floor to fall horizontally onto the floor below. The added weight may cause that floor, and subsequent floors, to fail and fall to a lower level, although not always to ground level. Pancake collapse can be mistaken for total collapse.
Lean-to collapse	Where one supporting wall fails, resulting in the roof or floor hinging on the remaining wall creating a triangular void.
V-shape collapse	Usually occurs when the centre support is compromised, and the floor or roof collapses and settles in the shape of a V. Triangular voids may be formed under the V-shape.
A-frame or tent collapse	The floor is no longer supported at the outer edges, but remains supported on internal walls or structures, forming an A-shape.
External collapse	
90° collapse	This is when the wall drops away from the building at a 90 degree angle. Debris will spread as the wall hits the ground.

Curtain fall collapse	Much like a curtain cut loose at the top; walls collapse straight down and create a rubble pile near their base.
Inward or outward collapse	Walls crack horizontally in the middle. The top half usually falls inwards and the lower half outwards.
Total collapse	This is the most severe form of structural failure and occurs when all the floors have collapsed to the ground or basement level and all walls have collapsed onto the floors.

In the event of a partial or structural collapse, the presence of other hazards should be considered, including:

- Fire, heat and smoke
- Damaged utilities
- Heavy dust loads and airborne particulates

Fire, heat and smoke

Fire, heat and smoke are always a hazard to operations, but in unstable or collapsed structures the effect of even a small fire will be amplified. There are many reasons for this, which include:

- Restricted access and egress
- Reduced ability to get firefighting media or ventilation equipment to the scene
- The possibility that fire could weaken the structure further

Incident commanders should consider not committing personnel to the hazard area if there is evidence or a risk of fire. They should also consider withdrawing personnel from the hazard area if a fire is suspected.

For further information refer to:

- Fires and firefighting
- Fires in buildings

Damaged utilities

Gas, electricity and water services may be affected or damaged as a consequence of any structural collapse. This can create the potential for leaking gas, localised flooding or exposed electrical services. Isolating services should be considered in the early stages, along with liaising with the appropriate agencies to provide advice and assistance.

Equal consideration should be given to the possible need to keep certain services functioning to aid in resolving the incident. The list of utilities will depend on the building; a hospital, for example, may have piped steam or oxygen. Unusual services such as these need to be identified in the Site-Specific Risk Information (SSRI) and this should inform the incident commander's decision.

For further information refer to Utilities and fuel.

Heavy dust loads and airborne particulates

Collapsed structure incidents will generate large quantities of dust as a result of the collapse or as a consequence of operations undertaken and the associated equipment used.

Such dust may be inherently carcinogenic or hazardous and have the potential to travel off-site, particularly in some weather conditions. The type and amount of such contaminants will inform the use of appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE). Consideration may also need to be given to people away from the incident, who may be affected by dust plumes.

For more information on specific substances such as asbestos and silica refer to Hazardous materials - Health hazards.

A partial or structural collapse may create other physical hazards such as:

- Unstable or fragile surfaces
- Exposed structural members
- Sharp edges
- Unsafe cabling or wiring, including hanging cables

Control measure - Cordon controls: Unstable structures

This control measure should be read in conjunction with Incident command: Cordon controls

CONTROL MEASURE KNOWLEDGE

The hazard area for an unstable structure that may undergo partial or structural collapse needs to take into account:

- Construction materials
- The height and type of the structure
- Severe weather conditions, such as flooding, heavy snow or high winds
- The potential for damage to surrounding structures and infrastructure

In the UK, a portal or rigid frame construction is designed for inward collapse – in a fully developed fire a basic single storey structure may be expected to collapse within 30 minutes. Portal frame structures are generally designed so that they collapse within their own footprint.

Cordons may need to consider the potential collapse of scaffolding and tower cranes. On a construction site they could collapse outside the existing hoarding or site boundary. For further information refer to the hazard: Scaffolding.

Glass (glazing) or other flat panels falling from height may travel (plane) significant distances from a structure, particularly in windy conditions.

Specialist advice may be required from local authority building control teams, structural engineers or urban search and rescue (USAR) tactical advisers.

Cordons may also need to take into account the impact of current or predicted weather conditions on unstable and collapsed structures. Incident commanders should consider accessing Met Office systems such as Hazard Manager when establishing appropriate cordons.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
17635	Make arrangements with appropriate agencies to establish specialist advice for cordons at unstable or collapsed structures	Revised
17636	~~Ensure personnel are aware of the specialist advice available~~	Archive

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Evaluate and monitor the potential footprint of collapse and debris
No change	Consider seeking specialist advice when defining the hazard area for a potential collapse
New	Consider the impact of current or predicted weather conditions on the structure when establishing cordons

Control measure - Assess and monitor structural stability

CONTROL MEASURE KNOWLEDGE

An appropriate understanding of structure design and construction materials is required to assess and monitor an unstable or collapsed structure. This will include identifying:

- Age, design and condition of the structure
- Structural materials and construction methods

All aspects of the structure, the actions taken, and the efforts made to distribute applied loads should be considered. An assessment of the unstable or collapsed structure should be made to determine the hazard area and, because of risks such as secondary collapse or falling debris, it should be monitored while personnel are working within the hazard area.

An unstable or collapsed structure should be assessed at the earliest opportunity. Although the initial assessment can be carried out by first responders, it may be necessary to seek specialist advice.

Specialist advice and monitoring may be available from local authority building control teams, structural engineers or urban search and rescue (USAR) tactical advisers.

Signs of collapse may include:

- Cracks in walls
- Sagging floors or floors deflecting from wall
- Displaced columns
- Dropping arches
- Bulging walls
- Buckling columns or beams
- Unusual noises coming from the structure

The minimum number of personnel should be committed to the hazard area, especially if assessment or monitoring indicates the potential for further collapse. Emergency procedures should also be in place, which can be initiated if required.

If safe routes are identified they should be marked, and exposed elements or other hazards should be marked or clear.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
17640	Establish arrangements with appropriate agencies to provide structural advice, assessment, and monitoring	No change
17641	Ensure personnel are aware of local or national arrangements and the specialist advice available	No change

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Identify the age, design and condition of the structure
No change	Identify the type of structural materials and construction methods
No change	Assess and continuously monitor the structure for signs of collapse
No change	Ensure that competent personnel assess and monitor the suitability of the structure for working in the hazard area

No change	Consider the stability of surrounding structures and the wider area before and during operational activity
No change	Ensure that minimum number of personnel work in the hazard area
No change	Have emergency procedures in place for unstable or collapsed structures
No change	Consider appointing an external safety officer to monitor structural stability
No change	Consider requesting structural advice, assessment and monitoring from appropriate agencies

Control measure - Use of geological monitoring equipment

CONTROL MEASURE KNOWLEDGE

Urban search and rescue (USAR) tactical advisers (TacAds) will have some knowledge of the equipment available for monitoring ground movement, such as geological monitoring, but access to this type of highly specialist equipment will be limited. Some external specialists, such as mine rescue, will have access to or knowledge of geological monitoring equipment. It may be appropriate to consider using this type of equipment and service, especially in the case of protracted incidents, but it will take time to source and implement.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
13543	Identify contacts who may be able to provide geological monitoring at incidents involving collapsed structures	Revised

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Consider requesting geological monitoring equipment in consultation with urban search and rescue (USAR) tactical advisers or other specialists

Appendix A: Content for Industry guidance

Hazard - Non-ionising radiation

HAZARD KNOWLEDGE

Non-ionising radiation does not cause changes to the molecular structure of living tissue, as opposed to ionising radiation, such as gamma and X-rays, that does have this effect.

However, non-ionising radiation can increase core body temperature, causing thermal damage to exposed sensitive body tissue, such as the skin and eyes and localised limb heating. Its effects also focus on areas where there is a high water content and low blood flow, such as in the muscles and testes.

Non-ionising radiation is the term used to describe the part of the electromagnetic spectrum covering two main regions: optical radiation and electromagnetic fields (EMFs).

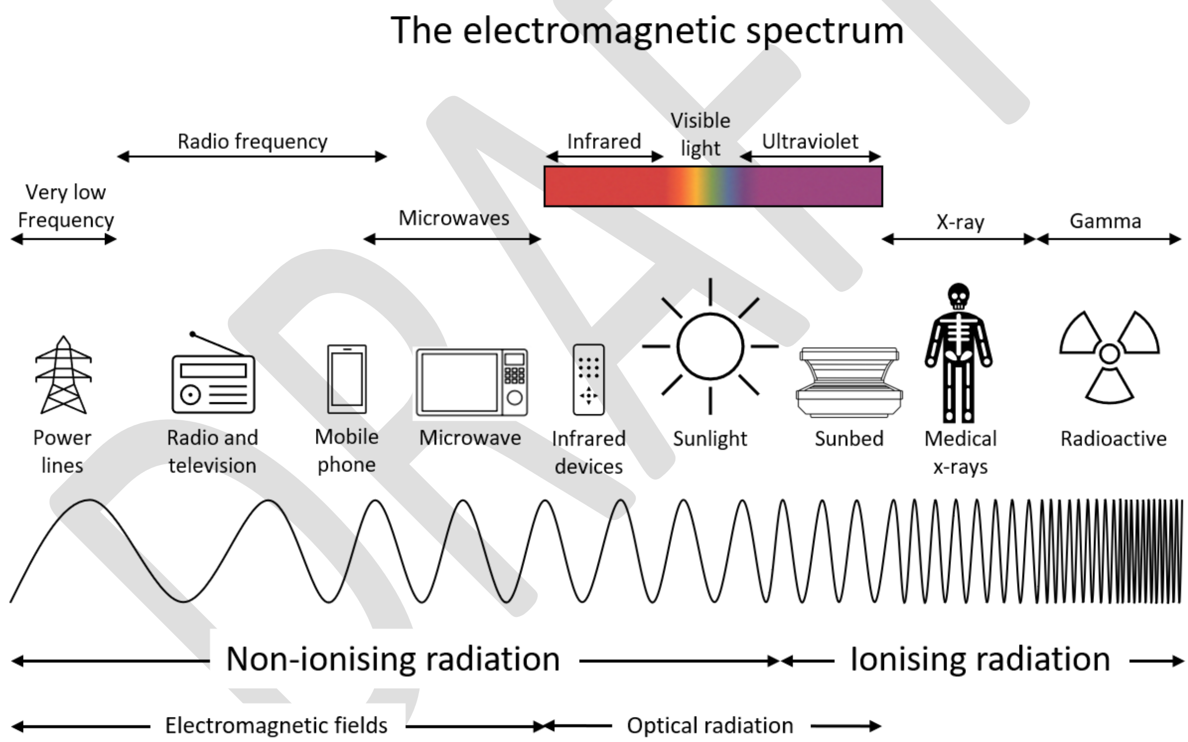

Figure: Diagram showing the electromagnetic spectrum

Optical radiation

Optical radiation covers ultraviolet radiation, visible light and infrared radiation. While these occur naturally through sunlight, there is also artificial optical radiation which is manufactured for a variety of purposes that include:

- Germicidal sterilisation
- Sunbeds
- Ink curing

- Photocopying
- Heating

While the above list is from manufactured sources, artificial optical radiation can be produced during processes such as welding. The Control of Artificial Optical Radiation at Work Regulations and The Control of Artificial Optical Radiation at Work Regulations (Northern Ireland) are in place to protect workers from the risks to health from hazardous sources of artificial optical radiation.

For most people the main source of exposure to ultraviolet radiation is sunlight. Artificial exposure occurs for specific groups such as:

- People who use and work in tanning facilities
- People who receive ultraviolet radiation medical treatment
- People who work with some industrial applications

Low exposure to ultraviolet radiation does not usually cause health-related issues. However, if personnel are exposed to ultraviolet radiation in the ionising radiation spectrum, this has the potential to cause damage to eyes, burns and various types of skin cancer.

For more information refer to:

- Industry: Lasers
- Health and safety executive: Optical radiation

Electromagnetic fields

An electromagnetic field (EMF) is produced whenever a piece of electrical or electronic equipment is used. Electrical power supplies and appliances are the most common sources of low frequency EMFs.

Mobile telephone, television and radio masts, along with radars and microwave ovens, produce high frequency (also referred to as radiofrequency) EMFs.

There is no evidence to conclude that exposure to low level EMFs is harmful to health. However, the main effect of high frequency EMFs is the heating of body tissues; even short-term exposure to very high levels of EMFs can be harmful to health. For further information refer to the Health and Safety Executive (HSE) information on Electromagnetic fields.

EMFs may interfere with:

- The operation of medical implants, such as heart pacemakers or insulin pumps
- Fire and rescue service communications including radios, mobile phones and telemetry systems
- Remotely operated equipment, such as aerial platforms operated by wireless controls or drones

For more information refer to:

- Supplementary information - Mobile phone base stations
- Supplementary information - Radar
- Hazard – Electricity
- Health and Safety Executive (HSE) publication, A guide to the Control of Electromagnetic Fields at Work Regulations; this includes details about equipment with high frequency electromagnetic fields (EMFs)

First responders may need to gain access and work near non-ionising sources of radiation, such as radio frequency (RF) antennas that may be potentially hazardous to health. The antennas may be located on freestanding masts, buildings or street furniture.

Control measure - Adherence to local restrictions and signage for non-ionising radiation hazards

CONTROL MEASURE KNOWLEDGE

Information regarding electromagnetic fields (EMFs) should be gathered from:

- Risk information
- The responsible person
- Warning signs and notices

Warning signs should be observed and confirmed by the responsible person.

Most sites or structures that have non-ionising radiation hazards will have signage detailing the type of hazard, safe distances, emergency contact numbers and the site identification number. It may be possible to work safely near the source if all local restrictions are followed.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
16717	Ensure that information about non-ionising radiation is included in SSRI	Revised
	Identify and maintain contact details of specialist advisers for non-ionising radiation	New

TACTICAL ACTIONS

Fire control personnel should:

Revised, new, archive or no change	Tactical action

New	Contact non-ionising radiation specialist advisers when sources of non-ionising radiation have been identified

Incident commanders should:

Revised, new, archive or no change	Tactical action
Revised	Observe and adhere to any warnings and local restrictions when working near to sources of non-ionising radiation
Revised	Consider avoiding the area affected by high frequency electromagnetic fields (EMFs)
Revised	Ensure that all personnel are made aware of the presence of non-ionising radiation

Control measure - Manage risk from non-ionising radiation

CONTROL MEASURE KNOWLEDGE

It may be necessary to isolate the non-ionising radiation source so that responders can work safely. The information on the signage will normally need to be obtained to contact the responsible person to request and confirm isolation of the source.

If possible, the source of the non-ionising radiation should be avoided. If the source of the non-ionising radiation has not been isolated it may be necessary to establish an exclusion zone.

The effects of non-ionising radiation depend on the:

- Distance from the source
- Time exposed
- Power level

If there is no other choice but to be exposed to non-ionising radiation, the distance from the source should be as far away as possible and the time exposed should be kept to a minimum.

STRATEGIC ACTIONS

Fire and rescue services should:

Reference No. if applicable	Strategic action	Revised, new, archive or no change
16718	Inform personnel about the hazard of exposure non-ionising radiation, especially if they have medical implants that may be affected	Revised
	Consider completing an electromagnetic fields exposure assessment for operational personnel	New
	Regularly maintain contact details for isolation purposes of known sites that have sources of non-ionising radiation	New

TACTICAL ACTIONS

Incident commanders should:

Revised, new, archive or no change	Tactical action
No change	Establish and control appropriate cordons to keep personnel away from sources of non-ionising radiation
Revised	Identify the responsible body and isolate the power to the source before commencing operations
No change	Ensure personnel entering the hazard area do not have any medical implants that may be affected by electromagnetic fields (EMFs)
No change	Consider the impact of electromagnetic fields (EMFs) on fire and rescue service equipment and communications
Revised	Liaise with the responsible person for information about electrical or electronic equipment that generates high frequency EMFs and its isolation procedures
No change	Consider isolating the source of electromagnetic fields (EMFs)
New	Relay all signage contact information to the fire control room to confirm isolation of non-ionising equipment

Appendix B: Content for Industry supplementary information

Mobile phone base stations

While many sites are controlled and maintained by a single operator, there are sites around the UK that have multiple operators therefore there will be multiple operators' information.

Antenna exclusion zones

Compliance limit distances (also known as exclusion zones) around base station antennas, bounds the area where the exposure may exceed the International Commission on Non-Ionizing Radiation Protection (ICNIRP) limitations while the transmitter is at its maximum power setting. What is pictorially demonstrated below is a 5G signal at maximum power and is unlikely to be an on-site scenario.

The dimensions given below are for Occupational Exclusion. They are very conservative, working on the maximum projected capability of current equipment plus a 20% margin above ICNIRP guidelines.

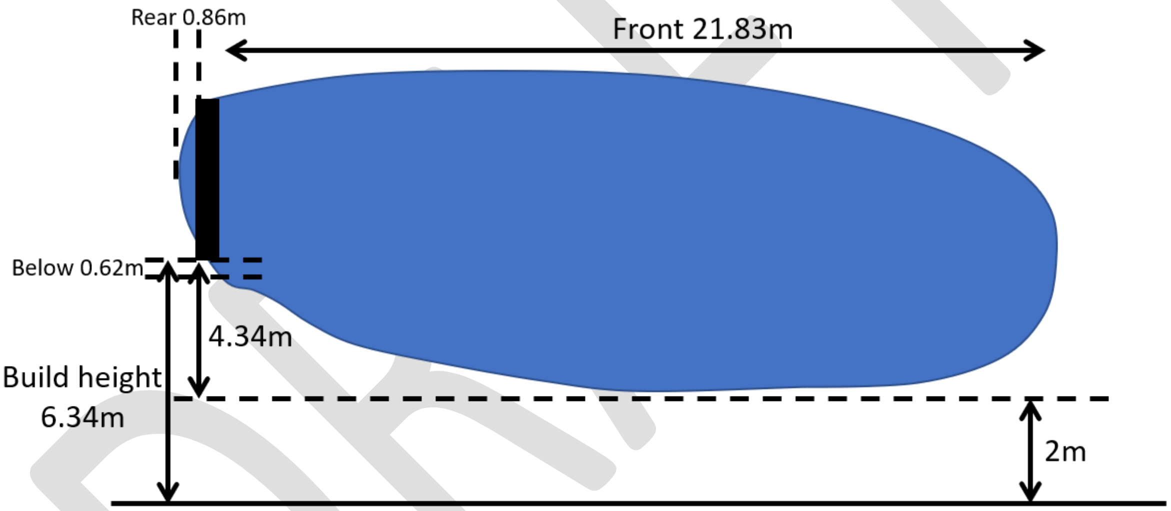

Figure: Pictogram showing the elevation view of a 5G signal at maximum power

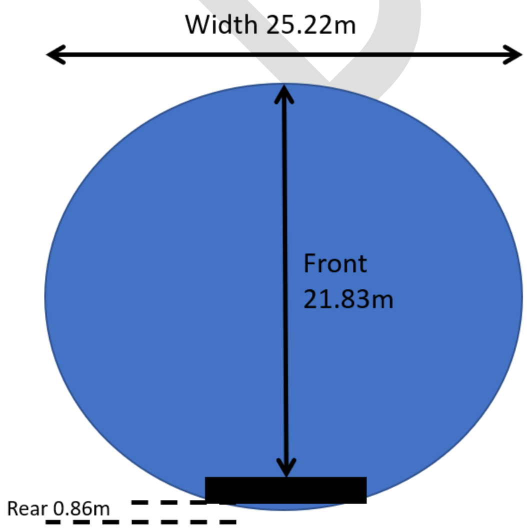

Figure: Pictogram showing the plan view of a 5G signal at maximum power

As displayed in both pictograms, the areas where there is less likely of exposure to EMFs is by approaching from the rear, below and sides.

Site signage

Warning signs should be observed and the strength of the source should be confirmed by the responsible person.

Site-entry signs have been designed using standard safety pictograms, words and colours. They are designed to inform visitors of:

- Site ID
- Site location
- What form or type of hazard exists on site, which they could be exposed to
- What actions they need to take to avoid or minimize such exposure
- Who operates the equipment that is producing the hazard
- How to contact the site operators

Figure: Site entry sign for a mobile phone base station

Antenna warning signs are placed at the boundary of a non-compliance area. They are designed to give a clear warning of the hazard and details of the owner of the equipment.

Figure: Warning sign for a mobile phone base station

As the majority of people would be unable to recognise an antenna and where the point of maximum exposure is likely to be, antenna **warning signs** are placed on the antenna itself.

Figure: Antenna warning sign for a mobile phone base station