National Operational Guidance

Guidance

Hazardous Materials - Health Hazards

NFCC National Fire Chiefs Council

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National Operational Guidance

NFCC National Fire Chiefs Council

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Introduction

This section of guidance examines the hazards encountered by fire and rescue service personnel, other responders and members of the public at hazardous materials incidents. It contains hazard and control measure knowledge relevant to the categories of physical hazards and health hazards as classified by the Globally Harmonised System (GHS) of classification and labelling of chemicals.

Hazard and control measure knowledge relating to generic hazardous materials incidents can be found in National Operational Guidance: Hazardous materials (tier one) and should be used in conjunction with this guidance.

This guidance is supported by supplementary information contained in A foundation for hazardous materials, which may support training or pre-planning.

See National Operational Guidance: Foundation for hazardous materials

Fire and rescue services respond to a wide range of incidents involving hazardous materials that have the potential to cause harm to firefighters, the surrounding community and the environment. Fire and rescue services may be called specifically to deal with emergency spillages or releases, or they may encounter hazardous materials at fires and other emergency incidents.

This guidance primarily deals with accidental hazardous materials incidents. The operational principles are essentially the same for deliberate, malicious or terrorist events. However, terrorist or CBRN(e) events require a more specific response because of:

- Increased security measures
- Increased risks to fire and rescue service personnel
- Complexity of multi-agency working
- Potential for multiple events caused by secondary devices
- Potential for perpetrators to use virulent agents that may be both persistent and difficult to identify
- Potential to change, remove or conceal safety signage and material information
- Potential to select locations that exploit the characteristics of the agent
- Need to exchange information with off-site intelligence and scientific advisers
- Potential for increased public exposure

For these reasons there is guidance in National Operational Guidance Hazardous materials for Initial operational response (IOR) and Special operational response (SOR) to a CBRN(e) incident.

The generic key roles of fire and rescue services at hazardous materials or CBRN(e) incidents are to:

- Save life
- Protect the public and other responders
- Fight and prevent fires involving hazardous materials
- Detect, identify and monitor hazardous materials
- Manage hazardous materials
- Protect the environment
- Mitigate damage from fires or firefighting and rescue
- Ensure the health and safety of fire service responders
- Ensure safety management inside the inner cordon, other than during the initial stages of terrorist incidents
- Provide health and safety management at incidents that involve other emergency responders
- Provide an urban search and rescue capability

This guidance does not give information on the specific hazards and control measures relating to environmental protection. Although these are integral to any hazardous materials response, they are covered separately in National Operational Guidance: Environmental protection.

Relevant knowledge

The term 'hazardous materials' (also referred to as Hazmats or dangerous/hazardous substances or goods) means solids, liquids, or gases that can harm people, other living organisms, property or the environment. They include materials that pose a physical hazard such as:

- Explosives
- Flammables
- Oxidisers
- And those that pose a health hazard such as:
- Corrosives
- Toxic materials
- Biohazards

The term 'hazardous materials' also includes materials with physical conditions or other characteristics that render them hazardous in specific circumstances, such as compressed gases and liquids or hot or cold materials. Non-fire and rescue service organisations and agencies may use more technical and specific definitions because of their own requirements, but the above definition is the most appropriate for fire and rescue services to base their risk assessments and planning assumptions on.

Another clear distinction relating to hazardous material operations is the difference between '*contamination*' and '*exposure*':

Contamination occurs when a substance adheres to or is deposited on people, equipment or the environment, creating a risk of exposure and possible injury or harm. Contamination does not automatically lead to exposure but may do so.

Exposure occurs when a harmful substance enters the body through a route, for example, inhalation, ingestion, absorption or injection, or when the body is irradiated

Due to the technical nature of hazardous materials operations, fire and rescue services must ensure their responders have the appropriate and specific skills, knowledge and understanding to maintain safety. 'FF5 - Protect the environment from the effects of hazardous materials' is the only specific hazardous materials National Occupational Standard (NOS) and is found in the Firefighters' Role Map. Incident commanders require a higher level of knowledge and understanding; this is not specified in the National Occupational Standard (NOS).

To support and manage their hazardous materials response, fire and rescue services may need personnel in specific hazardous materials roles e. These may include hazardous materials adviser (HMA), decontamination director, mass decontamination subject matter adviser or tactical adviser (Tac Ad). The number, type and specification of these roles will vary according to the fire and rescue service's risk profile, risk management plan and equipment/appliances provided.

It should be noted that the term hazardous materials adviser (HMA) is a generic description for any person, with enhanced knowledge of emergency hazardous materials operations, used by a fire and rescue service to provide independent specialist advice to the incident commander. It includes such roles as the hazardous materials officer, hazardous materials and environmental protection officer/adviser (HMEPO/HMEPA), scientific adviser, etc. Their primary functions are to:

- Gather, filter and interpret technical information on hazardous materials for the incident commander
- Assess the risks posed by emergency hazardous materials incidents
- Advise the incident commander on developing a tactical response plan

Foundation material to enable fire and rescue service personnel to develop competence in hazardous materials operations includes:

Fire and rescue service operational guidance - incidents involving hazardous materials, 2012, DCLG, TSO.

Fire service manual – volume 1, fire service technology equipment and media – Physics and chemistry for firefighters, 2001, Home Office, TSO.

The environmental protection handbook for the fire and rescue service, 2013, EA

Initial Operational Response to a CBRN(e) Incident, 2015, Joint Emergency Services Interoperability Programme (JESIP), Home Office.

The dangerous goods emergency action code list 2017, 2017, NCEC, TSO.

The emergency response guidebook 2016 (ERG), 2016, US Department of Transportation

Legislation

A hazardous materials response can be complicated by numerous pieces of legislation and regulation. In the main, legislation and regulation are the responsibility of those who produce, transport, use or store the substances. However, some do relate directly to fire and rescue services. All legislation relevant to fire and rescue services and industry is listed in A foundation for hazardous materials.

It is important for fire and rescue services to have personnel with specialist knowledge about hazardous materials to ensure that legal provisions designed to keep the community and responders safe are recognised, understood and maintained.

Risk management plan

Each fire and rescue authority must develop their strategic direction through their risk management plan. To determine the extent of their hazardous materials capability, strategic managers will consider their statutory duties and the foreseeable risk of hazardous materials emergencies occurring in their area.

Work to identify specific hazardous materials risks and prepare operational plans should be carried out with regard to all stakeholders, including local emergency planning groups and the fire and rescue service's risk management plan.

Personnel who may be exposed to hazardous materials must be provided with suitable and sufficient information, instruction and training on:

- Possible risks to their health
- Precautions that must be taken
- Appropriate use of control measures

Responsibility of fire and rescue services

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

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

Hazard - Exposure to materials with acute health effects

Hazard Knowledge

Substances that cause health effects are commonly referred to as toxic, harmful or poisonous. These terms refer to a substance's ability to cause injury or damage to a human being, an animal or the environment.

Uncontrolled materials that can affect health pose a significant hazard to responders if appropriate controls are not implemented to prevent exposure. In addition to posing risks to health, many of these materials will also present other hazards for the worker or emergency responder. This section deals only with those that relate to the acute health effects of the materials.

Two subcategories differentiate the way in which harm is caused:

- Acute health effects
- Chronic health effects

Acute health effects occur immediately or soon after contact with the hazard. They have a threshold level below which no harm can be observed, although for highly toxic substances this level can be extremely low.

Once symptoms are observable, their severity increases with increased dose, ultimately leading to the death of the organism that was exposed. This is known as the lethal dose. For inhalation hazards, this dose will depend on two key factors; the concentration in air and the time someone is exposed to this concentration.

These are the symbols fire and rescue service personnel are likely to see in relation to acute health hazards and acute toxicity:

Chronic, or long-term, health effects occur as a result of repeated or prolonged exposure to a hazardous material, or where the health effect arises long after the exposure occurs, such as exposure to cancer-causing agents.

The likelihood of chronic health effects increases with prolonged or repeat exposure. However, the severity of the symptoms is the same – for example, a cancer-causing substance can only lead to the development of a cancer or cancer will not develop at all. The likelihood of cancer increases with exposure.

Fire and rescue service personnel are likely to see the following symbols in relation to chronic health hazards. The transport classification and labelling systems do not include classifications for chronic hazards. Therefore, materials that cause chronic effects can only be identified through the Classification, Labelling and Packaging (CLP) labelling. For further information on the categories of toxic materials see A foundation for hazardous materials.

Four routes of exposure can lead to symptoms developing:

- Ingestion
- Contact with skin or eyes (skin absorption)
- Inhalation

- Injection or through cuts

The route through which exposure occurs can also be a significant factor in the speed and type of symptoms displayed. For example, exposure through a cut may mean that some hazardous substances get absorbed into the blood stream more quickly, enabling symptoms to develop rapidly.

Further details can be found in National Operational Guidance: Hazardous materials Control measure - Signs and symptoms of exposure

Substances with acute toxicity need to reach a certain accumulated amount within the body before the onset of symptoms. This is referred to as the dose. Beyond this amount, further exposure will increase the total dose received, causing the severity of symptoms to increase.

The total dose received is a result of both the concentration that an individual is exposed to and the duration of exposure. For example, a short exposure to a high concentration of a substance will lead to the same symptoms as longer exposure to a lower concentration.

The exact symptoms for a given dose are specific to the substance's toxicity but also the susceptibility of the individual exposed. Certain populations are typically more vulnerable to the health effects of hazardous materials, for example, the young and elderly.

A number of data sources provide information for levels of exposure and the expected effects. For further information, see National Operational Guidance: Hazardous materials Control measure – Substance identification, Control measure – Specialist advice: Hazardous materials and A foundation for hazardous materials.

Where a substance is known to display toxic health hazards, this information can be obtained from data sources such as safety data sheets (SDS). However, a number of substances have low intrinsic toxicity but can react to liberate toxic substances, particularly gases. The most common examples are materials that liberate combustion products with toxic effects, such as carbon monoxide.

In such cases where reactions or fire are involved, scientific advice should be sought to assist in identifying the level of hazard posed by the reaction or combustion products formed.

Asbestos

Asbestos-containing materials (ACMs) that are in good condition and left undisturbed cannot cause ill health as fibres will not be released. Handling or touching ACMs that are in good condition will also generally not present a risk. However, when they are disturbed or damaged, fibres are released into the air. Inhaling asbestos fibres is a major hazard to human health. Inhaled fibres can become lodged in the lungs and the body's natural defences are not able to break them down. The principle diseases known to be caused by exposure to asbestos fibres are asbestosis, lung cancer, malignant mesothelioma and asbestos pleural disease.

Control measure - Substance identification: Toxic materials

Control measure knowledge

This control measure should be read in conjunction with National Operational Guidance – Hazardous materials: Substance identification.

Ensuring that personnel immediately recognise the presence or potential presence of substances with toxic health hazards will enable suitable control measures to be implemented to protect responders and the public particularly in the initial stages of an incident.

Materials with the primary hazard of ‘toxic’ (other than toxic gases) will be assigned to UN Hazard Class 6.1. It covers substances that possess a low lethal dose.

Labelling

Materials labelled for transport or use will be displayed with one of the following symbols:

The exclamation mark symbol is used for other hazards in addition to ‘harmful’ (e.g. irritant).

UN Transport Class 2.3 is for toxic gases only, such as ammonia, chlorine or hydrogen chloride.

As well as labelling on containers, other information sources will enable other toxic/harmful hazards to be identified, such as Chemdata, Wiser and the Emergency Response Guidebook.

Information gained from containers or data sources should be compared with other information from the scene (such as signs and symptoms from casualties) to triangulate the information and increase confidence.

Strategic actions

Fire and rescue services should:

- Have procedures and support arrangements with regard to recognising toxic substances and how to protect people from acute health effects

Tactical actions

Incident commanders should:

- Use signs, labels, markings and container types to identify the presence of toxic materials
- Identify the location, physical state (solid, liquid, gas), type, quantity and toxicity of the released material
- Use detection equipment to identify and monitor levels of the toxic materials involved

Control measure - Cordon controls: Toxic materials

Control measure knowledge

This control measure should be read in conjunction with Cordon controls: Hazardous materials.

Once it is clear that toxic/harmful substances are involved, key control measures to protect responders and the public should be considered. An appropriate cordon will initially reduce the risk of exposure or contamination from toxic/harmful substance.

Additionally, for substances that pose an inhalation hazard, protective actions such as evacuation or sheltering-in-place may be necessary to protect people at further distances down-wind of the initial release.

When dealing with vapours, the level of toxicity will have a direct impact on the size of any hazard zone. Although hazardous materials are classified based on their lethal dose or concentration, when deciding on appropriate protective actions other levels have been identified in various data sources, which can assist in making tactical decisions:

- Workplace exposure limits (WEL) – published by the Health and Safety Executive, these determine maximum exposure limits for workers, either based on an eight-hour period known as the 'long term exposure limit' or 15-minute exposure known as the 'short term exposure limit' (STEL)
- Acute emergency guideline levels (AEGLs) – describe the human health effects from once-in-a-lifetime, or rare, exposure to airborne chemicals. AEGLs are used by emergency responders when dealing with chemical spills or other catastrophic exposures and are set through the collaborative effort of public and private sectors worldwide. AEGL values represent threshold levels for the general public. This includes susceptible subpopulations, such as infants, children, the elderly, persons with asthma and those with other illnesses.
- Immediately dangerous to life and health hazard (IDLH) – established by the American National Institute for Occupational Safety and Health (NIOSH) as exposure to airborne substances that are "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment". IDLH are used by respirator manufactures and provide an upper limit for this type of respiratory protective equipment (RPE).

Where it is not possible to contain the spread of a toxic substance, or for areas where a toxic substance remains, protective actions will need to be implemented to prevent harm to people and the environment in that area.

For members of the public, actions will generally be either to evacuate the area or take shelter indoors. To determine where protective actions are necessary, either direct monitoring or a model of dispersal will need to be used. See National Operational Guidance: Hazardous materials.

Anyone who may have been exposed to toxic or harmful substances should be monitored after the incident, in line with specialist advice. Certain toxic materials can produce delayed effects up to 48 hours later and may be exacerbated by physical effort.

Further information and guidance on these hazards and limits is contained in National Operational Guidance: Hazardous materials - Hazards; ' Exposure of responders to hazardous materials' and 'Exposure of the general public to hazardous materials'.

Strategic actions

Fire and rescue services should:

- Have procedures and support arrangements with regard to recognising toxic substances and how to protect people from acute health effects
- Assess the foreseeable storage, use and transportation of toxic substances within their response area and provide their responders with suitable and sufficient personal protective equipment (PPE)
- Provide processes and systems to enable emergency responders to identify toxic substances

Tactical actions

Incident commanders should:

- Establish exclusion zones, inner and outer cordons based on level of risk from toxic material
- Extend the initial cordon downwind for airborne toxic materials
- Consider additional post-incident monitoring of responders who may have been exposed to toxic/harmful material as effects may be delayed

Control measure - Containment: Toxic materials

Control measure knowledge

Managing a release of a substance with toxic health hazards will be primarily determined by their physical form. The overall objective is to disrupt the spread and prevent access to areas where the concentration is high enough to cause harm. The physical form as well as quantity are key factors that determine where harmful concentrations will spread. The physical form will then dictate vulnerable routes of entry, for example, inhalation risk from gases and vapours. In circumstances where it is not possible to prevent spread, dispersal to low concentrations should be considered. This option must be weighed against the wider impact on public health and the environment.

Where there is a continuous release, a key priority will be to prevent further material from escaping, minimising the size of the release and therefore the size and duration of any hazard zone.

Solids

Key properties that will affect the way solids behave, and therefore their spread, include

- Size of particles
- Melting point
- Water reactivity and miscibility

Liquids

Key properties that affect the way liquids behave, and therefore spread, include:

- Vapour pressure (vapours may be given off in dangerous quantities)
- Water reactivity and miscibility
- Relative density
- Vapours

Key properties that affect the way vapours behave, and therefore spread, include:

- Vapour density
- Level of toxicity
- Solubility in water

To make a full assessment of substances and their properties, suitable equipment and advice may be required. For crews who operate in this area, key control measures are to prevent toxic substances from getting into the body, therefore appropriate personal protective equipment (PPE), respiratory protective equipment (RPE) and decontamination should be assessed.

See National Operational Guidance: Hazardous materials

Strategic actions

Fire and rescue services should:

- Consider their local risks and provide procedures and support arrangements for gas and vapour monitoring including equipment purchase, mobilising, use and maintenance

- Provide suitable containment equipment to prevent the spread of hazardous materials

Tactical actions

Incident commanders should:

- Attempt to contain the spill or release of any toxic substances as close to the source as possible

- Determine the potential spread of toxic substances

- Protect emergency responders' routes of entry based on the physical form of the toxic substance

- Consider options to contain or disperse the spread of toxic materials in consultation with HMA

- Consider options to contain or disperse the spread of toxic materials in consultation with a hazardous materials adviser (HMA)

- Consider reducing vaporisation or gassing-off by covering or reducing the surface area of spills

- Consider reducing vaporisation or gassing-off by absorbing spills with inert materials

- Consider reducing vaporisation or gassing-off by reducing the temperature of bulk containers

- Consider the potential reaction between the toxic material and containment material / water

- Consider the potential reaction between the toxic material and containment material/water, in some cases producing heat and/or flammable/toxic gas

- Prevent accidental mixing of different toxic materials as this can lead to reactions which may give off large amounts of heat and or gas

- Consider using water spray or curtains to contain and control toxic vapours and gases

Control measure - Safe method of work: Asbestos

Control measure knowledge

Asbestos can be found in any industrial or residential building built or refurbished before the year 2000. It was used in many of the common materials used in the building trade.

The presence of asbestos-containing material at an incident does not automatically mean that it will present a hazard. The following three step hazard identification process will assist the Incident Commander's initial risk assessment:

- Step 1 – are asbestos-containing materials present?
- Step 2 – can asbestos fibres be released or disturbed?
- Step 3 – do responders have to enter the hazard zone?

Once it has been established that asbestos is involved at an incident, fire and rescue services must comply with a method of work that has been agreed with the Health and Safety Executive (HSE). This is to enable fire and rescue services to comply with an exemption to work with asbestos without providing 14 days notice to the HSE. The work method is set out in A foundation for hazardous materials.

Strategic actions

Fire and rescue services should:

- Comply with the Control of Asbestos Regulations 2012/Control of Asbestos (Northern Ireland) Regulations 2012

- Provide arrangements for medical surveillance of personnel following incidents involving asbestos (by an appointed doctor), where appropriate

- Ensure operational policy reflects all aspects of the agreed method of work

- Provide procedures and support arrangements for identifying asbestos-containing materials

Tactical actions

Incident commanders should:

- Comply with the conditions detailed in the Exemption Certificate from CAR 12 Asbestos Licensing and Notification Requirements
- Ensure a suitable method of work has been agreed with the Health and Safety Executive (HSE) prior to attending incidents involving asbestos-containing materials (for example, the method statement proposed in CFOA circular 2014-03)
- Identify the presence of asbestos-containing materials and assess the level of risk (High or Lower Hazard)
- Avoid disturbing or releasing asbestos materials wherever possible
- Avoid committing responders into areas that may lead to contamination with asbestos if possible
- Follow the three-step asbestos hazard identification process
- If entering the hazard area follow HSE agreed method of working with asbestos-containing materials
- Identify the presence of asbestos containing materials and assess the level of risk (High or Low Hazard)

Hazard - Release or spill of corrosive material

Hazard Knowledge

Corrosive materials cause visible destruction of, or irreversible alterations to, living tissue by chemical action at the point of contact. Corrosive materials include acids, bases, alkalis and salts. The pH scale ranges from 0 to 14, with strong acids having low pH values and strong bases or alkaline materials having high pH values. A neutral substance would have a value of 7.

Acids are compounds that form hydrogen ions in water. These compounds have a pH of less than 7, and acidic aqueous solutions which will turn litmus or pH paper red. Materials with a pH of less than 3 are considered strong acids. Inorganic acids such as nitric, sulphuric, hydrochloric and hydrofluoric acid can cause severe tissue burns to the skin and permanent eye damage. Many acids react and corrode various metals to produce hydrogen gas, but whether a particular reaction will occur or not depends on the particular acid and metal concerned and also on the conditions. The hydrogen produced is lighter than air and likely to produce flammable/explosive atmospheres in confined spaces. Acids will produce carbon dioxide from a carbonate (e.g. sodium carbonate or 'soda ash'). Acids are neutralised by bases (or alkalis) to give only salts and water. Note that this could potentially be a violent reaction.

Bases (or alkalis) are compounds that will react with acids to but can also be corrosive. These compounds have a pH of more than 7, and alkaline solutions will turn litmus or pH paper blue. Materials with a pH greater than 11 are considered a strong base. Bases (or alkalis) such as sodium hydroxide and potassium hydroxide are corrosive because they break down fatty acids in skin tissue and penetrate deeply.

Acids generally cause greater surface-tissue damage and bases (or alkalis) produce deeper, slower healing burns. Inhaled corrosive gases and vapours can cause acute swelling of the upper respiratory tract and chemically-induced pulmonary oedema. Highly water-soluble materials, such as anhydrous ammonia, will affect the upper respiratory tract and since they are very soluble, they will attack skin readily, especially in sweated or wet areas. Less water-soluble materials, such as hydrogen sulphide and phosgene, will affect the lower respiratory tract. Lower respiratory tract injuries can lead to chemically-induced pulmonary oedema and may be delayed for up to 48 hours after the exposure.

Control measure - Substance identification: Corrosive materials

Control measure knowledge

This control measure should be read in conjunction with National Operational Guidance – Hazardous materials: Substance identification.

Corrosive materials can be identified in a number of ways:

- UN GHS/CLP label
- UN hazard warning diamond
- Safety data sheet (SDS) as a UN Class 8 corrosive material
- Name (e.g. sulphuric acid, caustic potash)
- Testing with litmus or pH paper/equipment

The corrosive nature of a material can be established practically by testing the solution with either litmus paper or pH paper. This is most easily done if the unknown material is in a liquid state but damp paper can be used on gases and solids although the results should be used with caution.

The following symbols are likely to be seen in relation to corrosive hazards, For further information on the categories and labelling of corrosive materials see A foundation for hazardous materials.

Materials with the primary hazard of being 'corrosive' will be assigned to GHS/UN hazard class 8. It covers substances that attack tissue on contact, or damage other materials, by chemical action and may also cause other hazards such as corrosive vapours or toxic gases.

Most corrosives encountered are either acids, bases (or alkalis) or salts but a number of other hazardous materials may be corrosive as a secondary or tertiary hazard.

The effects of corrosive materials may take some time to become evident; this should be considered when looking for signs of corrosion. Strong alkalis and some acids have a latent period before a feeling of burning on the skin is experienced, by this time the damage is already done. Any corrosive materials should be washed off immediately after contact using copious amounts of water.

Strategic actions

Fire and rescue services should:

- Have procedures to enable responders to safely recognise and protect people from corrosive materials

Tactical actions

Incident commanders should:

- Use signs, labels, markings and container types to identify the presence of corrosive materials
- Use detection equipment to identify and monitor any corrosive materials involved
- Identify the location, physical state (solid, liquid, gas), type, quantity and corrosivity of the released material
- Contact and liaise with corrosive product specialists
- Consider testing a small sample of the corrosive material with pH paper to help assess its hazards
- Assess the risk of fire or flammable/explosive atmospheres from the potential production of hydrogen gas through reaction of corrosive materials with metals. See Physical hazards – Flammable vapours: Unignited.

Control measure - Cordon controls: Corrosive materials

Control measure knowledge

This control measure should be read in conjunction with Cordon controls: Hazardous materials.

People can be protected from releases of corrosive materials by effective and proportionate:

- Cordons
- Respiratory protective equipment (RPE)
- Chemical protective clothing (CPC)

Further information and guidance on these is contained in National Operational Guidance: Hazardous materials – Exposure of responders to hazardous materials and Exposure of the general public to hazardous materials.

Strategic actions

Fire and rescue services should:

- Review the foreseeable storage, use and transportation of corrosives within their response area and provide their responders with suitable and sufficient personal protective equipment (PPE)

- Have information available to crews on the incident ground regarding identifying corrosive substances, appropriate levels of personal protective equipment (PPE) and correct interventions

Tactical actions

Incident commanders should:

- Establish exclusion zones, inner and outer cordons based on level of risk from corrosive material

- Implement a suitable initial cordon based on quantity, location and physical state

- Ensure suitable contamination assessment/decontamination arrangements are in place for corrosive materials prior to committing crews

- Ensure personnel to be committed into the hazard area do not come into contact with corrosive liquids, gases or vapours, without wearing appropriate respiratory protective equipment (RPE) and personal protective equipment (PPE), and avoid any unnecessary contact

- Consider the potential for delayed visual effects of corrosive materials and that strong alkalis may damage the skin without causing any initial pain

Control measure - Containment: Corrosive materials

Control measure knowledge

There are four principal ways of dealing with spills/releases of corrosives:

- Contain for recovery – ideally by a specialist waste disposal company or the owner of the material
- Contain and absorb in some inert material – for example, earth, vermiculite or dry sand, prior to appropriate disposal
- Contain and 'neutralise' – for example, with soda ash; this method does not work with alkali spills (see Control measure – Neutralise corrosive releases)
- Dilute and disperse using copious quantities of water – this method is the last resort, and consultation with the environment agencies and the owner/operator must take place (see Control measure – Dilute corrosive releases)

In practice, any treatment of a spill of corrosive materials may require elements of all these tactics. The spill may be contained and recovered, residues may be absorbed and, if possible, neutralised before the last traces are diluted and dispersed. The key consideration when attempting to contain corrosive materials is the effect and/or reaction of the container's material with the corrosive.

Corrosive substances can react with many materials, such as cloth, paper and several metals. The decomposition often producing heat and gases, and in some cases extremely flammable hydrogen gas. Therefore, contact with other materials should be avoided where possible. Mixing different corrosive materials can result in violent reactions and may produce large volumes of gas.

Further guidance on containment methods and tactics can be found in The environmental protection handbook for the fire and rescue service and National Operational Guidance: Hazardous materials: Hazard – 'Uncontrolled release and/or spill of a hazardous material'.

Strategic actions

Fire and rescue services should:

- Review the foreseeable storage, use and transportation of corrosives within their response area and make provision for suitable and sufficient containment equipment
- Consider arrangements with specialist waste disposal organisations who can contain and dispose of released corrosives on behalf of the owner/transporter
- Have procedures in place to enable responders to safely contain a release of corrosive materials
- Ensure that responding personnel understand containment options for corrosive substances

Tactical actions

Incident commanders should:

- Attempt to contain the spill or release of any corrosive substance as close to the source as possible
- Stop or reduce the corrosive leak/release at, or as close as possible to, the source by plugging/ patching defective containers or valving down, decanting containment systems or damming drains.
- Consider reducing vaporisation or gassing-off by covering or reducing the surface area of spills or absorbing spills with inert materials
- Reduce the temperature of bulk containers, etc.
- Consider the potential reaction between the corrosive material and containment material, which in some cases will produce heat and/or flammable/toxic gas
- Prevent accidental mixing of different corrosive materials as this can lead to violent reactions

which may give off large amounts of gas, some of which may be toxic and/or corrosive.

- Consider containing/controlling corrosive vapours and gases in the open using water sprays and 'curtains', taking the need for containing water run-off into account, where appropriate

Control measure - Treatment: Corrosive materials

Control measure knowledge

This control measure should be read in conjunction with National Operational Guidance: Environmental Protection - Treatment

Neutralisation is a chemical method of making a spill less corrosive by applying a second material that will chemically react with the original to form a less harmful substance. The most common example is applying a base or alkali to an acid spill to form a neutral ‘salt’.

Firefighters should not assume that the salt produced by neutralisation is safe. These salts, while no longer presenting a corrosive hazard, can have other hazards (for example, they may be toxic or explosive).

The major advantage of neutralisation is the significant reduction of harmful vapours being given off. In some cases, the corrosive material can be rendered harmless and disposed of at much lower cost and effort. However, during the initial phases of combining an acid and a base, a tremendous amount of energy may be generated along with toxic and flammable vapours.

When a decision has been made to neutralise a spill, consideration should be given to the type of neutralising agent that will be used. Certain neutralising agents produce less heat when reacting and some materials are more environmentally friendly than others; the key concern is biodegradability. Environment agencies should be consulted prior to any neutralisation tactics being implemented.

Strategic actions

Fire and rescue services should:

- Consider appropriate arrangements for the provision and use of suitable and sufficient corrosive materials neutralising agents

Tactical actions

Incident commanders should:

- Attempt to neutralise any release or spill of corrosive materials based on specialist advice
- Contact and liaise with product specialists to find out if the 'salt' of the corrosive substance from neutralisation will retain or develop further hazards
- Consult environment agencies before carrying out any neutralisation
- Control and confine the spill to prevent run-off after application of the neutralising agent
- Ensure there is sufficient neutralising agent on-scene to complete the process
- Apply the neutralising agent from the outermost edge inward, thereby protecting responders

Control measure - Dilution: Corrosive materials

Control measure knowledge

This control measure should be read in conjunction with National Operational Guidance: Environmental Protection - Dilution

Dilution is a chemical method by which a water-soluble corrosive solution release is made larger but less corrosive by adding large volumes of water. This should be regarded as a last resort if no other method can be used. Specialist advice should be taken to ensure the corrosive can be safely and effectively diluted. Consultation with environment agencies and site operators must take place prior to any dilution.

These important criteria must be considered before dilution:

- Concentration
- pH
- Water reactivity
- Potential to generate heat and/or toxic vapours on contact with water
- Potential to form any kind of solid or precipitate
- Water solubility

As a general rule, dilution should only be attempted on liquid and solid corrosives, and only when all other reasonable methods of mitigation and removal have proven unacceptable.

In emergency situations, water sprays or 'curtains' may be used for controlling the spread of corrosive vapours to populated areas. This tactic will lead to a degree of 'scrubbing' of the vapour or gas cloud if the corrosive is water soluble. This means that the water run-off may itself become corrosive. This side effect may cause environmental damage unless it is controlled.

Dilution can be effective for small corrosive spills of up to one litre but environment agencies, water authorities and landowners should be consulted if the products of dilution are to be dispersed on-site.

The major disadvantage to dilution is that it is not well understood by emergency responders. It is not a straight, linear, one-to-one process. It is important to recognise that dilution is actually a logarithmic process (on a one-to-ten scale). The viability of the tactic will depend on the resulting pH that can be achieved.

Table 1: The resulting pH when diluting a one-litre spill of acid with increasing amounts of water

One-litre spill of acid with pH of 0	
Water needed to dilute it 1 pH level	**Resulting pH**
10 litres	1
100 litres	2
1000 litres	3
10,000 litres	4
100,000 litres	5

One-litre spill of acid with pH of 0	
Water needed to dilute it 1 pH level	**Resulting pH**
1000,000 litres	6
10,000,000 litres	7 neutral

However, partial dilution to reduce the level of corrosivity and therefore reduce the hazard may be a suitable tactic in certain situations following specialist advice.

See National Operational Guidance: Environmental protection

Strategic actions

Fire and rescue services should:

- Have procedures in place to enable responders to safely dilute corrosive materials
- Ensure that responders understand the potential risks associated with dilution

Tactical actions

Incident commanders should:

- Consider dilution and dispersal of corrosive materials as a last resort following consultation with relevant environmental agency
- Confirm the suitability of the corrosive materials for dilution, in terms of physical and chemical properties
- Consider using water sprays and 'curtains' to reduce and control corrosive vapours when they are threatening populated areas (but be aware that the run-off will be corrosive)

Hazard - Biological agents not involved in fire

Hazard Knowledge

A biological agent is any microorganism, cell culture or human endoparasite, including any that have been genetically modified, that can cause infection, allergy, toxicity or otherwise pose a hazard to human health. Biohazards arise from exposure to a range of pathogenic organisms. Acute or chronic infectious diseases may be caused by bacteria, viruses, protozoa, prions or fungi. The pathogen can enter the body via skin contact, puncture wounds, cuts, inhalation of aerosols or dusts and also by ingestion of contaminated food or drink. These pathogens are found almost everywhere in varying forms; they are a biohazard when the numbers exceed what is regarded as an 'infective dose'.

Pathogenic organisms

Most biological agents arise from single-celled organisms of various types, which are collectively referred to as 'pathogenic organisms'. These can be grouped into four different classes:

- Bacteria (e.g. Escherichia coli/E. coli, tuberculosis/TB, salmonella, legionella)
- Viruses (e.g. hepatitis B, hepatitis C, HIV)
- Protozoa (e.g. toxoplasmosis, ringworm, malaria)
- Fungi and spores (e.g. aspergillosis).
- Prions: Transmissible spongiform encephalopathies (TSEs) (Creutzfeldt-Jakob disease CJD)

Included within the above list, there is a serious health risk to firefighters from the transmission of infectious diseases through direct or indirect contact with animals (zoonoses) that are alive or dead and with animal waste. Examples of zoonoses are Lyme disease and salmonella. Contact between pregnant firefighters and animals carrying chlamydia abortus toxoplasmosis or listeriosis can also result in miscarriage or damage to the unborn child.

Categorisation of microorganisms

The Advisory Committee on Dangerous Pathogens issue an Approved List of Biological Agents that is updated regularly. It classifies biological agents in four categories. The hazard Group classification is for wild-type or naturally occurring pathogens made under CoSHH whilst the Class indicates that the organism has been genetically modified:

- Hazard group/class 1 – unlikely to cause disease
- Hazard group/class 2 – can cause disease, may be a hazard to employees, is unlikely to spread to the community and there is usually an effective prophylaxis or treatment available; examples include measles and mumps
- Hazard group/class 3 – can cause severe human disease, may be a hazard to employees, may spread to the community but there is usually an effective prophylaxis or treatment available; examples include hepatitis B and tuberculosis
- Hazard group/class 4 – causes severe human disease, is a serious hazard to employees, is likely to spread to the community and there is usually no effective prophylaxis or treatment available; examples include haemorrhagic fevers (Ebola and Lassa)

Hazards

Additional hazards are associated with facilities that undertake biological agent research and development. Hazards may include:

- High security levels, including electronic locking mechanisms, that prevent unauthorised access
- Premises containing hazard group 3 and 4 agents are required to maintain negative pressure (up to –100Pa) to prevent biological agents being released outside the building
- Uninterruptible power supplies to laboratory equipment and building facilities
- Laboratories may be regularly disinfected; this generally takes the form of gaseous formaldehyde fumigation over a 36-hour period
- Premises may house various types of animals, used for research purposes
- Gases may be present, including nitrogen, hydrogen, helium and oxygen; these may present a cryogenic hazard
- Chemicals may be used, including acids, bases, alcohols, volatile agents and toxic or carcinogenic organic compounds, such as benzene
- Various radiation sources may be used for tracer experiments
- Liquid nitrogen for cryogenic storage

Labelling

For transport operations biological materials will show the symbol shown below:

Under the classification, labelling and packaging (CLP) regulations (the European Union version of the globally harmonised system (GHS)), biological materials are generally not placed on the market. However, materials that may have an effect on the public carry the following symbol.

This symbol also covers risks such as germ cell mutagenicity, carcinogenicity, reproductive toxicity and specific target organ toxicity.

On-site controls

Using, researching and handling biological agents are strictly regulated activities. Many of the regulations require controls and actions that will assist a fire and rescue service at an incident. Sites must provide a written contingency plan for dealing with laboratory accidents; the plan will provide operational procedures for:

- Biological agent risk assessment
- Managing and decontaminating workplace and personnel

- Emergency medical treatment for exposed and injured persons
- Clinical surveillance and management of exposed persons

The Dangerous Pathogen Regulations 2002 requires a safety officer/adviser be appointed. The duties of the safety officer/adviser will be to assist the employer.

Employers are required to;

- Carry out risk assessments on the work being undertaken
- Notify local authority fire services in advance, as part of the emergency plan, of substances to be handled that may be a hazard to fire officers in the course of their duties
- Have appropriate decontamination procedures in place
- Have arrangements for disposing of infectious waste.
- Provide expert advice where necessary

The Control of Substances Hazardous to Health (COSHH) and the Genetically Modified Organisms Regulations require the Health and Safety Executive (HSE) to be notified of the intention to use, store or transport certain hazard groups. Sites handling HG 3 and 4 organisms must have staff on call in case of an emergency – it will be essential to liaise with them during any incident.

Control measure - Substance identification: Biological agents

Control measure knowledge

This control measure should be read in conjunction with Hazardous materials: Substance identification.

Biological agents can be found almost everywhere, however, general hygiene is sufficient to deal with the majority of situations (See Control measure - Decontamination for biological agents). At any location where there is foul or dirty water, waste materials, body fluids and human or animal waste, it should be considered that a biological agent may also be present. Establishments that have biological agents will be marked with the appropriate signage and will incorporate additional control measures such as security, access restrictions, ventilation systems and specialist/technical staff.

Biological agents may be encountered in a wide range of situations:

- Hospitals, e.g. isolation wards, post mortem areas, medical schools
- Veterinary practices, quarantine kennels, abattoirs
- Laboratories and research establishments
- Farms, zoos, wildlife parks
- Sewers, sewage treatment plants and flood water
- Post offices and mail delivery couriers
- Funeral parlours/embalmers

Biological agents can also be encountered in transit. Transport categories are defined as:

- Category A – an infectious substance transported in a form that can cause permanent disability, life-threatening or fatal disease to humans or animals if they are exposed to it
- Category B – an infectious substance that does not meet the criteria for inclusion in Category A

For all substances a 'triple packaging system' is used. This includes:

- A primary, watertight and leak-proof receptacle surrounded by sufficient absorbent material to absorb any spills caused by breakage
- Secondary, watertight and leak proof packaging, again containing sufficient absorbent material to absorb any spills
- Outer packaging that protects the secondary packaging from physical damage

The outer wrapping of any package should bear the international warning signs with a warning that the package should be neither opened nor touched. On the outer packaging there should be an indication of the nature of the contents, together with the name and address of both the consignor and consignee. These details should also be included on the package itself.

For transportation, infectious substances will be assigned to UN 2814, UN 2900 or UN 3373. Vehicles used for the transportation of Category A biological substances will display the orange placard and relevant warning diamond.

Postal delivery

Group 3 and 4 materials must not be sent through the postal system. Special arrangements apply to their transportation, nationally and internationally.

Diagnostic samples and Group 2 materials may be transported either by post or an authorised courier provided they comply with the packaging requirements and bear the international warning signs together with the names and addresses of the sender and recipient.

Organisations that regularly send such materials through the post should have procedures in place for contacting competent personnel in the event of an accident.

Location and meaning of signs

Establishments will display the international biohazard sign within the building. However, the use of this sign varies considerably. Other black and white signs may relate to animals (e.g. 'Do Not Remove', 'May be Removed in Cages' etc.).

Where biological agents are present within a building there should always be a warning symbol at the entrances to laboratories and refrigeration units for agents of hazard Groups 2, 3 and 4, but they may not be found externally

Biological agents are often transported on the road and sometimes in private vehicles. In these cases, a safety officer familiar with the hazard will be on call to deal with any incidents.

Location and meaning of signs

Many establishments will display the international biohazard sign. However, the use of this sign varies considerably. Other, black and white, signs may relate to animals (e.g. 'do not remove', 'may be removed in cages').

If there are biological agents in a building there should always be a warning symbol at the entrances to laboratories and refrigeration units for agents of hazard groups 2, 3 and 4, but the signs may not be found on the outside of the building itself.

Strategic actions

Fire and rescue services should:

- Ensure there are means of recording known locations with biological agents
- Provide the means for accessing specialist advice specific to biological agents
- Provide systems for recognising and interpreting biological agent signage

Tactical actions

Incident commanders should:

- Use signs, labels, markings and container types to identify the presence of biological agents

- Identify the location, physical state (solid, liquid, gas), type and quantity of any released biological agents

- Use detection equipment to identify and monitor levels of any biological agents involved

- Recognise areas where biological agents may be present – such as sewers or refuse sites

- Obtain biological specialist advice from hazardous materials advisors (HMAs), scientific advisers, on-site specialists or other appropriate sources

Control measure - Hazard identification within a controlled site or uncontrolled location

Control measure knowledge

This control measure should be read in conjunction with Scene survey: Hazardous materials.

Premises that contain and use biological agents for the purpose of research are also known to contain a number of additional hazards; these areas are covered by other areas of National Operational Guidance, such as:

- Radioactive materials
- Compressed gas cylinders
- Bulk solvents/flammable liquids
- Cryogenics
- Magnetic resonance imaging (MRI) scanners

However, some hazards are either specific to biological research establishments or present risks that are specific to biological research, such as:

- Hazard Group/Class 1 – 4 biological agents
- Infected people/animals

Where these hazards are present, certain alternate actions may be necessary to resolve an operational incident.

If a biological agent is stored or used, then the site should be a controlled site. Uncontrolled areas are described as areas where biological agents maybe encountered but are not being stored or used. Such incidents could include road traffic collisions (RTCs) where bodily fluids are encountered, or foul water areas where either animal or human excrement may be found. Simple steps can be employed to protect against these risks, such as using impervious personal protective equipment (PPE) barriers (eye protection, nitrile gloves, etc.). Medical precautionary measures can also be considered, such as immunisation. Simple general hygiene steps, such as hand washing with warm water and soap, and laundering contaminated clothing may be sufficient.

Animals within the facility should not normally be rescued, as they may potentially be infected with biological agents. However, the incident commander should consider all information when making a risk-based analysis. Information such as the unique nature of work being undertaken and the potential of total loss without the ability to repeat the work should be considered. Fire and rescue service personnel should liaise with a hazardous materials adviser (HMA) or on-site specialist.

Strategic actions

Fire and rescue services should:

- Ensure there are means of recording known locations with biological agents
- Provide the means for accessing specialist advice specific to biological agents
- Provide systems for recognising and interpreting biological agent signage

Tactical actions

Incident commanders should:

- Determine the hazards and nature of the release of biological agents and the containment area in which the release has occurred
- Identify all hazardous material hazards in addition to biological agents
- Consider the environment of the incident, the potential biological agent exposure and the precautionary steps required – seek advice from a hazardous materials adviser (HMA) if required

Control measure - Containment: Biological agents

Control measure knowledge

Premises that contain or work with biological agents will be equipped to control the use of the agents, protect those who work with them and prevent unauthorised access to controlled areas. Some premises use a control room to manage and access information from the safety systems in operation – these rooms are normally staffed by security personnel and may also be the location of the fire alarm panel.

Controlled areas are likely to involve secure access doors – depending on the hazard group of the biological agent, the number and type of door will vary but the most secure facilities will have several high-security doors with 'air-lock' arrangements for containing the biological agent. Between these air-lock doors there are likely to be facilities for washing and changing clothes. Air-lock doors will open automatically and will have inflatable seals that form the air-tight door seal. Controlled areas will also have air-filtration systems to prevent biological agents being released from the areas. The air-filtration systems will include negative air-pressure systems that ensures the air will flow into the controlled area rather than out of the controlled area, should a leak occur.

Strategic actions

Fire and rescue services should:

- Identify and maintain records of premises that use and contain biological agents and ensure these sites are visited as part of familiarisation visits, in accordance with relevant fire and rescue legislation

- Make appropriate arrangements with biological sites for emergency responders to access control rooms in an emergency

- Make arrangements for obtaining specialist advice on biological agents, including out of hours contact details

Tactical actions

Incident commanders should:

- Attempt to contain the spill or release of any biological agent as close to the source as possible
- Make contact with biological agent specialist staff to determine the controls that can be operated – and the effect of operating controls
- Identify the safety systems for biological agents that can be operated by fire and rescue service personnel, along with the measures that must remain in operation and those that can/should be shut down
- Identify safe areas, accessibility and relevant levels of personal protective equipment (PPE) required at the biological agent scene

Control measure - Personal protective equipment (PPE): Biological agents

Control measure knowledge

This control measure should be read in conjunction with Personal protective equipment (PPE): Hazardous materials.

Biological agents may enter the body via any of the known routes (see National Operational Guidance: Hazardous materials – section on routes of entry in Tier 1 guidance). Any personal protective equipment (PPE) that can prevent entry will provide sufficient protection. In the absence of specialist advice, PPE should provide respiratory protection and an impervious layer that can be decontaminated (see Control measure – Decontamination for biological agents) or disposed of, as a minimum.

Strategic actions

Fire and rescue services should:

- Provide appropriate levels of respiratory protective equipment (RPE) that gives respiratory protection, such as breathing apparatus (BA) or a powered respirator protective suit

- Provide appropriate levels of respiratory protective equipment (RPE) that gives respiratory protection, such as breathing apparatus (BA) or a powered respirator protective suit

Tactical actions

Incident commanders should:

- Ensure that all personnel wear the level of PPE identified by service risk assessments, procedures and training for biological agents

- Ensure all crews don PPE appropriate to the hazard if it is determined that an entry to the risk area is required (for example, to perform life saving actions)

Control measure - Firefighter decontamination: Biological agents

Control measure knowledge

This control measure should be read in conjunction with Hazardous materials - Firefighter decontamination.

For generic information on decontamination, See National Operational Guidance: Hazardous materials Hazards – Contaminated members of the public and Contaminated responders.

Although materials that may contain biological agents – such as sewage or bodily fluids – can be seen, biological agents themselves are invisible to the naked eye. Decontamination may be as simple as washing with soap and warm water (using non-alcohol based cleaners on the incident ground). However, as the level of biological agent increases (such as hazard Group/Class 3 and 4 materials), the importance of decontamination will also increase, which will be more likely to require procedures that will kill the biological agent.

However, as biological agents are invisible to the naked eye, determining the effectiveness of decontamination system may become so difficult as to be deemed not cost-effective and, as such, disposable personal protective equipment (PPE) becomes a significant consideration. The only effective way to determine if decontamination has been successful (for high hazard group materials) would be to test swab the entire surface of the PPE and attempt to grow cultures from the swabs; this is not a practical solution. For PPE that has been contaminated with sewage and/or bodily fluids, etc. normal PPE laundry processes will be sufficient to clean the total surface area; combined with instructing personnel to shower with soap and water, this will be the most effective way to complete decontamination. For impervious PPE options (liquid-tight or gas-tight suits) introducing a suitably-based decontamination additive would be necessary as this is the most recognised method of killing biological agents. However, some biological agents will be resistant to decontamination and a significant 'contact time' will also be required.

It should also be noted that whilst a chlorine-based disinfectant is suitable for most applications there are organisms where it is not effective, tuberculosis being an example.

A 'contact time' is the amount of time the biological agent needs to be in contact with the suitably-based additive to kill the agent. The time may vary, and can range up to 20 minutes depending on the agent involved. This becomes difficult for decontamination, as it entails keeping the personal protective equipment (PPE) wet with the additive for the recommended duration; when the wearer is waiting for extraction this becomes a significant issue. Advice from subject matter experts should be sought, to determine how long a contact time is required. It may be necessary to carry out a controlled removal from the PPE with expert advice. This could include dousing the PPE with a chlorine additive, removing the PPE, and then leaving it to soak for the required 'contact time'; Confirmation that the decontamination process has been successful will still be required.

For biological agents such as hazard Group/Class 3 and 4, where contamination has occurred it may be better to use disposable personal protective equipment (PPE). Decontamination will then consist of either a safe undress or a wet decontamination with a chlorine-based or other additive followed by a safe undress; the PPE should then be sent for disposal via incineration.

Strategic actions

Fire and rescue services should:

- Provide equipment for decontamination against biological agents

- Make arrangement for responders to access decontamination additives at the incident
- Introduce decontamination additives for biological agents that provide a free-chlorine-based option

Tactical actions

Incident commanders should:

- Consider firefighter decontamination arrangements for biological agents prior to committing personnel to the hot zone

Hazard - Biological agents involved in fire

Hazard Knowledge

Most biological agents do not survive well in high temperature situations; in fact, one method of cleansing equipment that has been used with biological agents is treatment in an autoclave. An autoclave subjects the items inside it to temperatures of approximately 120C and pressures of in excess of normal atmospheric pressure (2.2 bar). In fire situations, it is more than likely that a biological agent subjected to the fire will have been destroyed.

In the absence of any life risk, because the biological agent is likely to be destroyed in the fire, a ‘controlled burn’ is often considered rather than an offensive attack on the fire. The decision to employ a controlled burn should not be undertaken without seeking expert advice; advice from the hazardous materials adviser (HMA) may be particularly important and they may in turn seek specialist advice from experts in the industry. Advice from these experts will determine if the agents involved in the fire will have been destroyed.

Chemical protective clothing (CPC) is not suitable for firefighting activities. Therefore, it may be necessary to adopt defensive firefighting tactics if biological agents are involved.

The hazards and risks associated with making an offensive attack on a fire involving biological agents are varied but include:

- Biological agents may be released from the incident by either the smoke plume or run-off

- Animals used for research, which are potentially infected, may be released
- There may be difficult access, high security doors and entrance systems or air-lock door systems
- There may be ventilation systems
- There may be radiation sources
- Bulk solvents/flammable materials may be present
- Cryogenic materials may be present

It may be difficult to determine a release – limited detection, identification and monitoring (DIM) equipment

Some establishments will be involved in the process of research on animals. These animals, if infected, may present a significant risk of infection and also a risk of spreading the infection if they were to be released from the confinement of the facility. In these circumstances, the normal protocol is to not release any animals from this type of establishment. However, the research being carried out may be unique and the loss of these animals may significantly affect developments in medical research. It is generally understood that no attempt is made to release or rescue animals, but on-site specialists should be consulted early in the incident to establish the importance of these animals. Therefore, the hazardous materials adviser (HMA) should discuss these issues with on-site specialists to advise the incident commander on the tactics to be employed, such as the areas to focus on.

Control measure - Life saving actions: Biological agents

Control measure knowledge

This control measure should be read in conjunction with Hazardous materials - Life saving actions.

Biological research establishments are not the only locations where biological agents may be encountered. In addition to research, there are also locations that treat members of the public infected by biological agents; this needs to be considered when assessing life risk*.

Some hospitals and medical facilities have isolation wards where infected members of the public are kept away from uninfected people. This may mean that access is restricted, secure and will require specialist assistance. It may also mean that infected members of the public must be kept isolated when removed from the incident and this should also be considered by the incident commander. Maintaining any isolation conditions will be the responsibility of the health agencies, but fire and rescue service personnel may need to support this in the initial stages of an incident.

*The term 'life risk' is generally accepted by fire and rescue services to refer to human life – however, at biological research establishments there may also be high animal life risks.

Strategic actions

Fire and rescue services should:

- Make appropriate arrangements with persons responsible for any premises that carry out biological research, treatment of members of the public infected by biological agents or animal research

- Provide a system of recording the use of biological agents and ensure that this information is made available to operational personnel for access at operational incidents

Tactical actions

Incident commanders should:

- Assess the existence of life risk at biological incidents

- Commit crews to perform life-saving operations – in appropriate chemical protective clothing (CPC) if away from the fire risk or full structural firefighting personal protective equipment (PPE) and breathing apparatus (BA) if in fire situation

- Liaise with medical personnel and on-site advisers to establish an appropriate location for an isolation area away from uninfected people

- Consider appropriate methods for animal protection, rescue and/or recovery

Control measure - Appropriate intervention: Biological agents involved in fire

Control measure knowledge

This control measure should be read in conjunction with Appropriate speed and weight of intervention.

When deciding how to tackle a fire in a biological research establishment, the decision needs to be based on the biological agents present and the best method to ensure these agents do not leave the confines of the building.

Most biological agents will be killed by high temperatures – many die at temperatures exceeding 60C – and the temperatures in a fire may exceed this temperature. Allowing the fire to continue within the enclosed area will subject these agents to the fire and destroy them. However, if attempts are made to extinguish the fire, then the biological agents may not have reached the temperatures necessary to kill them before firefighting water is applied. This would mean the 'live agent' may contaminate the run-off water from applied firefighting media or the smoke plume, effectively spreading the biological agent.

Premises which work with materials such as hazard Group/Class 3 and 4 agents use high-security containment systems, comprising filtration systems and air-lock door systems. These areas are often intentionally not connected to the sprinkler system, so that any fire will consume everything in the area, including the agent, and then burn out due to oxygen starvation. The filtration and containment systems are designed to 'run to destruction' and will not shut down in fire situations.

It should be recognised that the biohazard symbol (shown below) is regularly used by many industries and the risk the symbol is referring to at the site in question should be established as early as possible. For example, soiled laundry from a hospital may display this symbol, meaning a controlled burn would not be an appropriate tactic, but a HG/Class 4 pathogen may also carry the same symbol and a controlled burn could be an appropriate tactic.

Biohazard symbol

Strategic actions

Fire and rescue services should:

- Ensure premises where biological agents are located are visited regularly and that the fire engineering is observed and recorded
- Liaise with responsible persons where biological risks exist and establish operational tactical plans including control burn options, fixed installations and location of risks on site
- Ensure emergency planning information for biological agents is recorded and available for the incident commander attending any incident

Tactical actions

Incident commanders should:

- Ensure early and regular contact is maintained with on-site specialists who have knowledge of both the biological agent risks on site and the filtration/containment systems in operation
- Consider a controlled burn where there is no life risk, as an option for minimising the risks posed by biological agents
- Make themselves aware of any fire engineering systems to control biological agents within the building, including those facilities to support a controlled burn
- Use minimal water to attack a fire involving biological agents
- Consider appropriate intervention to deal with fire involving biological agents, as chemical protective clothing (CPC) cannot be worn in fire situations

Control measure - Controlled burning: Biological agents

Control measure knowledge

This control measure should be read in conjunction with Controlled burning

Hazard group/class 3 and 4 materials are tightly controlled because they can spread through the population. Controls include systems that will capture any potential release before it is able to escape the confines of the building.

In the event of a fire these systems may be compromised and the biological agent could escape if not destroyed by the fire. The two most likely routes for the material to escape would be in the smoke plume and the firefighting water run-off.

Employing controlled burn tactics should be sufficient to kill the agents before they are released but this will need to be confirmed with specialist advice.

See National Operational Guidance: Fires and firefighting.

Strategic actions

Fire and rescue services should:

- Develop procedures for controlled burns at incidents involving biological agents
- Provide equipment for controlling fire-water run-off that has become contaminated with biological agents, e.g. equipment supplied by environment agencies
- Establish links with other agencies who will need to be informed if biological agents are released either via a smoke plume or fire-water run-off (environment and/or public health agencies)

Tactical actions

Incident commanders should:

- Deploy appropriate pollution control equipment to contain any firefighting run-off that may have become contaminated with biological agents

- Notify relevant agencies if biological agents are believed to have been released in smoke or run-off

- Keep firefighting personnel away from biological agents when not in suitable personal protective equipment (PPE) or respiratory protective equipment (RPE), including away from contaminated, equipment, clothing, firefighting run-off and smoke plumes.

Hazard - Radioactive contamination

Hazard Knowledge

Two basic hazards arise when dealing with radioactive materials:

- Irradiation, which is covered in Hazard – Exposure to radiation
- Contamination by a radioactive material, which is associated with unsealed sources. This can cause harm through external or internal contamination, i.e. the subject is exposed to radiation while the material is present on skin or clothing or the source is ingested or inhaled into the body causing both contamination and irradiation.

Contamination arises as a result of an unsealed source (e.g. a radioactive powder, liquid or gas) being dispersed into the local environment and therefore having the potential to find a pathway either onto the surface of the skin or into the human body, usually via inhalation or ingestion. Radioactive materials inside the body are many times more hazardous than the equivalent amount of radioactivity outside the body and as a result they are mainly a problem related to internal exposure rather than external exposure.

See Foundation for hazardous materials for further information on radioactive sources.

Control measure - Substance identification: Radioactive materials

Control measure knowledge

Radioactive materials can be identified in a number of ways:

- UN hazard warning diamond
- Site registration information and risk-based inspections

Materials with the hazard radioactive will be assigned to UN hazard class 7.

Strategic actions

Fire and rescue services should:

- Ensure there are means of recording known locations with radioactive materials
- Provide the means for accessing specialist advice specific to radioactive materials
- Provide systems for recognising and interpreting radioactive materials signage

Tactical actions

Incident commanders should:

- Use signs, labels, markings and container types to identify the presence of radioactive materials

- Identify the location, physical state (solid, liquid, gas), type and quantity of the released radioactive material

- Use detection equipment to identify and monitor levels of the radioactive materials involved

- Obtain specialist advice from hazardous materials advisors (HMAs), scientific advisers, on-site specialists or other appropriate sources, for example, the National Arrangements for Incidents involving Radioactivity (NAIR) or Radsafe

Control measure - Cordon controls: Radioactive materials

Control measure knowledge

Following initial assessment of the contaminated area, an appropriate hazard zone will need to be established to ensure the public and emergency responders do not inadvertently enter the risk area.

Members of the public should be informed of the most appropriate means to avoid the risk of contamination. This may include a safe route away from the radioactive contaminant or instructions to shelter-in-place.

The best method to protect emergency responders against contamination is for them to wear personal protective equipment (PPE) and respiratory protective equipment (RPE) while taking measures to avoid direct contact with radiation source.

Strategic actions

Fire and rescue services should:

- Provide procedures and support arrangements regarding the hazards that may be encountered and actions to take to prevent radioactive source contamination of public and emergency responders

- Provide appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE) to control personal contamination from radioactive sources

- Provide equipment to detect, identify and monitor the presence of radioactive contamination

Tactical actions

Incident commanders should:

- Establish exclusion zones, inner and outer cordons based on level of risk from the radioactive material
- Consider evacuation routes or shelter-in-place tactics for members of the public
- Ensure crews required to enter the hazard area wear appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE)
- Withdraw all other personnel from the hazard area
- Withdraw public and emergency responders to a safe position immediately on discovering a potential source of radiation.
- Set up a monitoring and decontamination zone before committing crews

Control measure - Warn, inform and advise people

Control measure knowledge

Under the Civil Contingencies Act, Category 1 responders are required to put arrangements in place to make information available to the public about civil protection matters and to maintain arrangements to warn, inform and advise the public in the event of an emergency.

In some situations, information provided to the public may have to be restricted, especially if its release could cause panic and potentially result in further harm to people.

Information communicated to, or withheld from, people can influence their behaviour. Communicating with people, particularly those in groups or crowds, is essential to maintain order and manage behaviour.

In emergencies, the key communications objective will be to deliver accurate, clear and timely warnings, information and advice to people, so they feel confident, safe and well-informed.

Warnings, information and advice should:

- Be specific and clear
- Be timely and accurate
- Come from a credible source and be verifiable
- Convey the nature and extent of the danger

Warnings, information and advice can be delivered in many ways including:

- Face-to-face
- Visiting premises – residential and commercial
- Media and social media announcements
- Public announcements in areas such as public buildings, shopping centres, sports venues and transport networks

Strategic actions

Fire and rescue services should:

- Develop guidance and support arrangements to effectively communicate with people during emergency incidents
- Develop arrangements with partner agencies for the delivery of warnings, information and advice during emergency
- Develop guidance and support arrangements for the effective use of media services

Tactical actions

Incident commanders should:

- Use the most effective methods for communicating with people who are either directly or indirectly involved in the incident
- Consider the use of media, social media and other methods to communicate with people
- Establish a media liaison point and brief a nominated media liaison officer

Control measure - Evacuation and shelter

Control measure knowledge

'Evacuation' is the immediate and urgent movement of people away from a threatened or existing hazard. The response of people to emergencies can vary from inaction to panic; a key factor in maintaining control and order when conducting evacuation is communication.

The need to evacuate or shelter people could be due to:

- An act of terrorism
- The actual or threatened release of hazardous substances

- Fire
- An unstable or collapsed structure
- The risk of explosion
- Severe weather, including widespread flooding
- Environmental contamination
- Transport incidents

When producing Site-Specific Risk Information (SSRI) and developing incident plans, the evacuation or shelter of large numbers of people should be considered. Planning should be carried out with statutory resilience forums who may be able to mobilise resources to assist during the emergency phase of an incident.

Personnel at the incident and in the fire control room should develop a joint understanding of risk when determining if there is a need for evacuation, shelter in place or 'stay put'. To achieve this effectively, robust communications should be established and maintained throughout the incident. For further information refer to Incident command - Effective communications.

The decision to evacuate, and the size of the area to be evacuated, should be based on a joint understanding of risk which is agreed by the Strategic Co-ordinating Group (SCG). As a decision to evacuate is likely to affect multiple agencies, they should all be consulted if possible. If this is not possible, all agencies involved should be informed as quickly as possible.

The police are normally the lead agency for evacuation, and are likely to make a decision to evacuate in consultation with the local authorities. However, the police can only recommend evacuation and have no power to force responsible adults to leave their homes, with the exception of evacuation of the inner cordon for a terrorist incident.

In any decision about whether or not to evacuate, the overriding priority should be the safety of the public and emergency responders. It is possible that evacuating people to the open may put them at greater risk; buildings may provide protection against some types of risks and the public may be safer seeking shelter in a suitable building.

Unless they are provided with specific instructions, people are likely to follow the most obvious or familiar egress route; this could result in a stampede, evacuating towards the hazard, or result in people being trampled.

Evacuation time comprises the time taken for individuals to move towards an exit, plus the time taken before movement is initiated – the time taken to recognise there is a danger and to decide on the most appropriate course of action. Communication and sharing of information should aim to enhance the effectiveness of evacuation. For further information refer to Operations - Warn, inform and advise people.

For further information, refer to the Cabinet Office publication, Understanding Crowd Behaviours:

[Supporting Evidence](#)

Once implemented the evacuation plan should be regularly reviewed, to take into account:

- The development of the incident
- Changes in weather conditions
- Information gathered from emergency responders and the public
- The effectiveness or impact of the evacuation

Fires in buildings

Taller or larger buildings are likely to have scalable evacuation plans, with some people remaining in relatively safe areas of the building during firefighting operations.

To prevent access, egress and escape routes becoming compromised, compartmentation and suitable routes for firefighting teams should be identified and secured at the earliest opportunity. Building signage should not be relied on for suitable access and egress routes.

Access and egress routes should be suitably and sufficiently protected by:

- Using personnel with appropriate firefighting media
- Making use of the building's fixed installations
- Maintaining the structure and integrity of fire-protected areas

The primary objective of an evacuation strategy is to ensure that in the event of a fire, the people in the building can reach a place of ultimate safety outside the building. The evacuation procedures are an essential part of the overall fire strategy. There are two basic categories of evacuation procedure:

Total evacuation

Total evacuation of people to a place of ultimate safety, by either simultaneous or phased procedures:

- Simultaneous evacuation
  - The default approach, where it is unreasonable to expect people to remain in the building for a prolonged time when there is a fire
- Phased evacuation
  - A common approach adopted in high-rise premises where the storeys are separated by fire resisting construction, or in certain atrium buildings
  - The first people to be evacuated are all those on the storey most immediately affected by the fire, and those on other storeys with impaired ability to evacuate, unless their personal emergency evacuation plan (PEEP) has determined otherwise

    - The remaining storeys are then evacuated, usually two storeys at a time, at phased intervals

Progressive evacuation

Progressive evacuation of people, initially to a place of relative safety within the building where they can remain or, if necessary, complete the evacuation to ultimate safety as part of a managed system. There are two categories of progressive evacuation:

- Progressive horizontal evacuation
    - The process of evacuating people into an adjoining fire compartment on the same level, from which they can later evacuate to a place of ultimate safety
- Zoned evacuation
    - A common approach adopted in large retail developments, where an operational loss could be created by evacuating a large building for a relatively small fire
    - A zoned evacuation is achieved by moving people away from the affected zone to an adjacent zone; for example, in a shopping centre where people would be moved to the adjacent smoke control zone while the fire-affected zone was brought under control

Evacuation or escape strategies

Evacuation or escape strategies will vary; the responsible person should be able to provide information about them. Some buildings have a policy to simultaneously evacuate when hearing an alarm, others maintain a 'stay put' or 'defend in place' policy and some adopt a vertical phased approach.

The 'stay put' policy, as detailed in the Home Office's Fire safety in purpose-built blocks of flats may be considered appropriate, based on the levels of fire resistance for compartment walls and floors. The use of evacuation or escape strategies that are based on 'stay put' or 'defend in place' policies should be kept under review throughout the incident.

When determining the evacuation strategy the following factors should be considered and reviewed to maintain the safety of people:

- That there is a clear passageway to all evacuation routes
- The risks to people exiting along firefighting access routes
- Exposure to potential hazards
- Whether any people require assistance to evacuate
- If the evacuation routes are clearly marked, and are as short and direct as possible
- Whether there are enough exits and routes available for all people to evacuate
- If emergency doors open easily in the direction of evacuation
- Whether there is emergency lighting provided where needed
- If training has taken place about using the evacuation routes

- Whether a safe assembly point has been designated and communicated

Evacuation of medical facilities

Medical facilities are likely to contain patients, visitors and staff. These people will have varying levels of familiarity with their surroundings and the evacuation procedures. It is also likely that some people will be impaired by physical or mental disabilities.

Fire and rescue service personnel may be able to provide assistance to evacuate non-ambulant patients.

Medical facilities may have more than one evacuation strategy. This may include simultaneous evacuation, where people immediately go to a designated assembly point, 'horizontal phased' or 'vertical phased' evacuation.

Methods of horizontal phased evacuation are particularly useful when dealing with seriously ill or infirm people, who may require life support equipment, medical gases or strict environmental conditions for their well-being.

Hazardous materials

The aim should be to reduce the impact of a hazardous material on members of the public not originally involved in the incident, but who could potentially become involved as the material moves from the incident. This may be achieved by implementing an evacuation or shelter in place plan.

An assessment about which course of action is correct for protecting the public should be made by a hazardous materials adviser (HMA), and provided to the incident commander. For further information about the information that will influence this assessment refer to:

- Hazardous materials - Assess impact of release or spill

- Hazardous materials – Safe and controlled approach: Hazardous materials

For information regarding contaminated casualties, refer to Hazardous materials - Controlled evacuation of contaminated casualties.

Strategic actions

Fire and rescue services should:

- Liaise and consult with developers, owners, occupiers and responsible persons of buildings, to provide expert safety advice and to develop tactical guidance and support arrangements for the associated hazards and actions to take to confirm the occupier's evacuation policy or strategy

- Ensure that personnel have access to pre-determined evacuation plans for buildings or locations that have them

- Develop and test emergency plans and support arrangements for evacuating large numbers of affected people, in conjunction with statutory resilience forums and partner agencies
- Participate in pre-planning and exercises for evacuating medical facilities
- Provide on-scene mapping facilities to enable risk areas to be identified and actions to be planned and documented
- Consider liaising with partner agencies who have air monitoring capabilities, public communication responsibilities and specialist knowledge on issues relating to public health

Tactical actions

Incident commanders should:

- Determine whether people should be advised to evacuate, shelter in place or 'stay put'

- Establish communication arrangements to allow information to be gathered from and passed to fire control rooms

- Identify the most appropriate evacuation plan and record rationale for decision

- Establish the availability of pre-arranged evacuation strategies and policies

- When evacuation is necessary, identify the number of people affected and develop a plan
- Consider people who need assistance to evacuate, for example, disabilities or medical needs
- Establish a safe evacuation point and consider safe egress routes and refuge points or areas

- Assess the suitability of the location for people to shelter in place

- Review the use and effectiveness of evacuation, shelter in place or 'stay put' plans throughout the incident, to ensure they remain valid
- Consider the impact of the incident on the local community and consider a shelter in place strategy
- Ascertain the likely impact of people on emergency responders
- Make contact with the relevant authorities for advice on evacuation arrangements and progress

Control measure - Containment: Radioactive materials

Control measure knowledge

An unsealed source is a dust, powder or liquid. When released within a building the source can be contained within the confines of the structure. When released outside, weather conditions can significantly affect the dispersal of the material.

The hierarchy of pollution control can be used as framework to identify the most appropriate intervention. Methods for containing unsealed radioactive materials may include:

- Closing or returning to the container
- Switching off ventilation inside a building
- Closing doors and windows
- Covering spillages when they occur outside
- Using booms for containing liquid contaminants

For further information regarding the prevention of environmental contamination see National Operational Guidance: Environmental Protection

Strategic actions

Fire and rescue services should:

- Provide procedures and support arrangements regarding the hazards that may be encountered and actions to take to prevent unsealed radioactive sources being dispersed into the environment

- Provide containment equipment to prevent the dispersal of radioactive materials

Tactical actions

Incident commanders should:

- Attempt to contain the release of any radioactive materials as close to the source as possible

- Gain specialist advice regarding the mitigation of a release of radiation sources

- Consider deploying environmental protection equipment to prevent contamination from entering a water course

- Monitor elevated background radiation down-wind of the incident

- Liaise with specialist agencies to arrange for all radioactive contaminants to be managed on scene

Control measure - Firefighter decontamination: Radioactive materials

Control measure knowledge

Once any contamination with a radiation source has been identified using appropriate instrumentation, decontamination procedures should be implemented. Decontamination for radioactive materials is usually a ‘dry’ or ‘safe’ undress process. Using large amounts of water, such as in showers, is discouraged as this will lead to the spread of contamination. Wet decontamination should only be used where emergency responders have been inadvertently contaminated; this should be restricted to using wet flannels and wipes wherever possible.

Whenever emergency responders have been contaminated with radioactive materials, medical attention should be sought at the earliest opportunity.

Strategic actions

Fire and rescue services should:

- Provide procedures and support arrangements regarding the hazards that may be encountered and actions to take to decontaminate emergency responders from radioactive contamination

- Provide equipment to allow contamination monitoring and the decontamination of responders who have become contaminated by radioactive materials

- Provide means for occupational health monitoring for responders who may have become contaminated

Tactical actions

Incident commanders should:

- Ensure an appropriate decontamination process is set up before committing responders into the radiation hazard area

- Monitor for contamination of radioactive material before and after decontamination to determine the effectiveness of the process

- Consider a safe undress/dry decontamination from chemical protection clothing (CPC) or firefighting personal protective equipment (PPE) where radioactive materials are involved

- Where necessary, consider further decontamination with soapy water and flannels if skin has become contaminated – all contaminated waste must be contained

- Seek medical attention for any emergency responder who may have been exposed to radioactive material

Hazard - Exposure to radiation

Hazard Knowledge

Radiation is the general term given to the process by which energy is transmitted away from an energy source. The term can be applied equally to heat, light, microwave, radio or atomic sources of energy. This guidance is only concerned with the radiation arising from atomic sources, as only these along with electrically generated x-rays have the property of causing ionisation when they interact with other substances; they are referred to as ‘ionising radiations’.

Two basic hazards which arise when dealing with radioactive materials:

- Irradiation, which is generally, but not exclusively, associated with sealed sources; this can cause harm through an external exposure (the source is located outside the body and possibly some distance away).
- Contamination, which is covered in the Hazard – Radioactive contamination

In all cases of exposure to ionising radiation, the principle of ‘as low as reasonable practicable’ (ALARP) applies. This means that, even though there is a legal maximum permitted absorbed dose, all exposures must be minimised.

The principle of time/distance/shielding should be used to protect against the harmful effects of penetrating radiation.

- Time – the shorter the duration of the exposure, the smaller the accumulated dose
- Distance – the greater the distance from the source of radiation, the lower the dose rate (the ‘inverse square’ law applies - doubling the distance reduces the dose rate to one quarter)
- Shielding – in general, the higher the density and greater the thickness of the shielding, the better the protection.

To manage the dose received when in an area of elevated radiation levels, a survey meter should be used to continuously assess the dose rate being received.

At any site where radionuclides are stored and used, a risk assessment will have been undertaken to determine potential dose rates and working times. A hazardous materials adviser (HMA) can make use of this information at an incident, to ensure the principles of radiation protection are implemented. However, radiation monitoring equipment should always be used as a key risk control measure in radiation protection procedures.

Control measure - Substance identification: Radioactive materials

Control measure knowledge

Radioactive materials can be identified in a number of ways:

- UN hazard warning diamond
- Site registration information and risk-based inspections

Materials with the hazard radioactive will be assigned to UN hazard class 7.

Strategic actions

Fire and rescue services should:

- Ensure there are means of recording known locations with radioactive materials

- Provide the means for accessing specialist advice specific to radioactive materials

- Provide systems for recognising and interpreting radioactive materials signage

Tactical actions

Incident commanders should:

- Use signs, labels, markings and container types to identify the presence of radioactive materials

- Identify the location, physical state (solid, liquid, gas), type and quantity of the released radioactive material

- Use detection equipment to identify and monitor levels of the radioactive materials involved

- Obtain specialist advice from hazardous materials advisors (HMAs), scientific advisers, on-site specialists or other appropriate sources, for example, the National Arrangements for Incidents involving Radioactivity (NAIR) or Radsafe

Control measure - Manage the radiation dose received by firefighters

Control measure knowledge

The radiation dose received by firefighters should be kept as low as reasonable practicable (known as ALARP). Exposure is reduced by managing these factors:

- Time
- Distance
- Shielding

Fire and rescue services may or may not be required to intervene; in any case, a hazard/exclusion zone should be established. Any members of the public or personnel should be immediately withdrawn until specialist advice is available. The perimeter should be set where the background reading is consistent with the normal background reading for that location or where recommended by site-/incident-specific specialist advice.

Should no intervention be required, the cordon should be managed appropriately until such time as the scene can be handed over to the appropriate authority.

If an intervention is deemed necessary, anyone entering the hazard zone must be equipped with a personal dosimeter and each team should be equipped with a dose rate survey meter. To ensure exposure is minimised, the incident commander should:

- Consider the location and type of the source (i.e. unsealed or sealed). An inventory and local rules should be available where radionuclides are held legally.
- Consider the potential of damage to the source(s)
  - Does any packaging or shielding appear to have been damaged?
- Make use of any transport index that may be available, whilst deploying monitoring equipment (The transport index is the maximum dose rate in micro Sieverts per hour divided by 10 when measured at one metre from the surface of the packaging)
- Keep crews committed to the hazard zone to a minimum
- Ensure each crew has one crew member dedicated to constantly monitoring the detection equipment – where the task can be performed by one crew member the minimum crew can remain at two
- Ensure the person deploying the survey meter is competent in using fire and rescue service radiation monitoring equipment

Strategic actions

Fire and rescue services should:

- Provide procedures and support arrangements regarding the hazards that may be encountered and actions to take when managing radiation doses at operational incidents
- Provide procedures and training for incidents declared as radiation emergencies, including authorisation for using informed volunteers
- Provide equipment to actively measure the dose rate from any potential radiation source. See A foundation for hazardous materials for further information on radiation instrumentation
- Ensure the dose limits and all other regulations are adhered to in all operational guidance
- Consider adopting a dose constraint below the legal dose limits
- Make arrangements with relevant organisations to ensure specialist advice is available from

the scene of an incident. For further information on sources of specialist advice see A foundation for hazardous materials.

Tactical actions

Incident commanders should:

- Keep exposure to ionising radiation ‘as low as reasonably practicable’ (ALARP) in all cases
- Employ the principles of time, distance and shielding
- Where it is necessary to commit personnel to the hazard area, keep the number of personnel to a minimum
- Establish, record, communicate and continually monitor the level of background radiation
- Ascertain if the packaging or shielding for the radiation source has been damaged
- Determine whether or not the fire and rescue service are required to enter the radiation hazard zone
- Monitor radiation dose rates periodically and keep individual accumulated dose records of everyone who has entered the risk area