Department for Communities & Local Government

CFRA
CHIEF FIRE & RESCUE ADVISER

Fire and Rescue Service

Operational guidance
Incidents involving hazardous materials

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Contents

SECTION 1

Foreword

Major incidents involving hazardous materials in the United Kingdom are rare. Such incidents place significant demands on local fire and rescue services and often require resources and support from other fire and rescue services and emergency responders. However smaller scale incidents involving hazardous materials are more prevalent and these may require a response from any fire and rescue service in England.

The Fire and Rescue Service Operational Guidance – Incidents involving hazardous materials provides robust yet flexible guidance that can be adapted to the nature, scale and requirements of the incident.

The Chief Fire and Rescue Adviser is grateful for the assistance in the development in this guidance from a wide range of sources, including the fire and rescue service and a range of experts from a wide range of industries and other organisations.

It is anticipated that this guidance will promote common principles, practices and procedures that will support the fire and rescue service to resolve incidents involving hazardous materials safely and efficiently.

SECTION 2

Preface

The objective of the *Fire and Rescue Service Operational Guidance – Incidents involving hazardous materials* is to provide a consistency of approach that forms the basis for common operational practices, supporting interoperability between fire and rescue services, other emergency responders, industry experts and other relevant groups. These common principles, practices and procedures are intended to support the development of safe systems of work on the incident ground and to enhance national resilience.

Operational Guidance issued by the Department of Communities and Local Government promotes and develops good practice within the Fire and Rescue Service and is offered as a current industry standard. It is envisaged that this will help establish high standards of efficiency and safety in the interests of employers, employees and the general public.

The Guidance, which is compiled using the best sources of information known at the date of issue, is intended for use by competent persons. The application of the guidance does not remove the need for appropriate technical and managerial judgement in practical situations with due regard to local circumstances, nor does it confer any immunity or exemption from relevant legal requirements, including by-laws.Those investigating compliance with the law may refer to this guidance as illustrating an industry standard.

It is a matter for each individual fire and rescue service whether to adopt and follow this Operational Guidance. The onus of responsibility for application of guidance lies with the user. Department of Communities and Local Government accept no legal liability or responsibility whatsoever, howsoever arising, for the consequences of the use or misuse of the guidance.

Section 3

Introduction

Purpose

3.1 This operational guidance is set out in the form of a procedural and technical framework. Fire and Rescue Services should consider it when developing or reviewing their policy and procedures to safely and efficiently resolve emergency incidents involving hazardous materials, including CBRN(E) materials.[1]

3.2 In everyday language the term hazardous materials, also referred to as dangerous/hazardous substances or goods, means solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They not only include materials that are toxic, radioactive, flammable, explosive, corrosive, oxidizers, asphyxiates, biohazards, pathogen or allergen substances and organisms, but also materials with physical conditions or other characteristics that render them hazardous in specific circumstances, such as compressed gases and liquids, or hot/cold materials.

3.3 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 one for Fire and Rescue Services to base their risk assessments and planning assumptions on.

3.4 A Fire and Rescue Service may respond to a wide range of incidents involving hazardous materials that have the potential to cause harm to firefighters, the community and the environment. They may be called to deal specifically with emergency spillages or releases, or they may encounter hazardous materials at fires and other emergency incidents. The purpose of this guidance is to assist emergency responders to make safe, risk assessed, efficient and proportionate responses whenever hazardous materials are encountered in the operational arena.

Scope

3.5 The scope of this guidance is wide ranging due to the extensive nature of hazardous materials incidents encountered by the Fire and Rescue Service. It is applicable to any event, regardless of scale, from small incidents, such as the careless use of domestic cleaning products, to large scale chemical spillages on the highway and industrial accidents.

3.6 It is focused on the tactical and technical aspects of hazardous materials incidents to assist Fire and Rescue Services with:

- the development and implementation of safe systems of work
- inter-operability at large or cross-border incidents where more than one Fire and Rescue Service is in attendance.

1 CBRN(E) materials terrorism entails the assumption or knowledge, based on intelligence or actual evidence, of actual or threatened dispersal of chemical, biological, radiological or nuclear material (either on their own or in combination with each other or with explosives), with deliberate criminal, malicious or murderous intent, targeted at a given population or economic/symbolic points.

3.7 The guidance covers the time period from the receipt of the emergency call to the closure of the incident by the Fire and Rescue Service Incident Commander. 'Closure' in terms of Fire and Rescue Service involvement may mean the handing over of responsibility to another agency or 'responsible person'.

3.8 In addition to detailed tactical and technical information, this guidance also outlines the key operational and strategic roles, responsibilities and considerations that need to be taken into account to enable the Fire and Rescue Service to plan, train, test and respond effectively to any hazardous materials incident or event.

3.9 This operational guidance has been developed to deal primarily with accidental hazardous materials incidents. However, the operational principles are essentially equally applicable to deliberate, malicious or terrorist events although it is acknowledged that incidents involving chemical,biological,radiological, nuclear and explosive (CBRN(E)) materials events will require a more specific response due to:

- increased security measures
- increased risks to Fire and Rescue Service staff
- complexity of multi-agency working
- potential for secondary devices
- potential for perpetrators to pick virulent agents that are both persistent and difficult to identify
- potential to conceal the identity and/or remove and/or replace signage and material information
- potential to pick locations that exploit the characteristics of the agent
- need to exchange information with off-site intelligence and scientific advisers.

Structure

3.10 This operational guidance is based on nationally accepted good practice. It is written as an enabling guide based around risk-critical operational principles rather than a strict set of rules and procedures. This is done to recognise local differences across the United Kingdom in terms of risk profiles and levels of resources.

3.11 Section 7 contains the bulk of the guidance and it is divided into three parts:

Part A – Pre-planning considerations

Part B – Operational considerations – Generic standard operating procedure

Part C – Technical considerations

Part A: Pre-planning considerations
Provides guidance and information to assist Fire and Rescue Services in the preparation of emergency response plans for hazardous materials incidents and risks.

Part B: Operational considerations – GSOP
Provides guidance to Fire and Rescue Service staff on responding to and resolving typical hazardous materials incidents. It is structured around six emergency response phases common to all operational incidents.

The procedure detailed in this part of the guidance uses the Incident Command System decision making model as its foundation. It is a Generic – Standard Operating Procedure for dealing with hazardous materials incidents that Fire and Rescue Services can adopt or adapt depending on their individual risk assessments and resources.

Each section of the Generic Standard Operating Procedure details extensive lists divided into:

- Possible actions
- Further considerations.

It should be stressed that these are **not mandatory procedures**. They are a 'tool box' of suggestions or 'enabling guide' appropriate to emergency hazardous materials operations.

The Generic – Standard Operating Procedure reflects the hazards and control measures of the national generic risk assessments relevant to hazardous materials incidents.

Part C – Technical considerations
Contains technical and scientific information appropriate to the Fire and Rescue Service functions being performed at hazardous materials incidents. It summarises risk-critical operational guidance and information required by firefighters, commanders and hazardous materials advisers. It also references more detailed guidance that may be of interest to Fire and Rescue Services.

This part only contains technical information with operational implications and is not intended to be a source of scientific theory.

Section 4

Legal framework

Introduction

4.1 This section does not contain detailed legal advice about legislation. It is simply a summary of the most relevant legislation to Fire and Rescue Authorities when considering hazardous materials incidents.

4.2 When considering this legal framework it is essential to recognise that any definitive interpretation of the legal roles and responsibilities imposed by legislation can only be given by a court of law.

4.3 For a full understanding of the responsibilities imposed by the legislation, and by the Fire and Rescue Service National Framework, reference should be made to the relevant legislation or the current National Framework. The range of legislation and guidance that could impact on the operational responsibilities of the Fire and Rescue Authority is extensive and each Authority should seek guidance from their own legal advisors.

Primary Fire and Rescue Service legislation

Fire and Rescue Services Act 2004

4.4 **Section 7 Fires** – places a statutory duty for a Fire and Rescue Authority to plan and provide arrangements for fighting fires and protecting life and property from fires within its area. A Fire and Rescue Authority is required to secure the provision of sufficient personnel, services and equipment to deal with all normal circumstances, as well as adequate training. A Fire and Rescue Authority must also put in place effective arrangements for receiving and responding to calls for help and for obtaining information which it needs to carry out its functions (s7(2)(d)); the latter might include, for example, information about the nature and characteristics of buildings within the authority's area or availability of and access to water supplies.

4.5 **Section 8 Road Traffic Accidents** – places a duty on Fire and Rescue Authorities to make provision for rescuing persons from road traffic accidents and for dealing with the aftermath of such accidents. Historically, the risk of fire was the trigger for attendance at such an incident. While advances in vehicle design have seen the incidence of fire following an accident decrease, calls to assist with the rescue of people from wreckage and protect them from harm from spillage of hazardous substances have increased dramatically. A Fire and Rescue Authority is required, therefore, to secure sufficient resources and training to deal with all normal circumstances. A Fire and Rescue Authority must also put in place effective arrangements for receiving and responding to calls for help and for obtaining information to exercise its functions (for example, knowledge of local road and trunk road network).

4.6 The Secretary of State can also, by order following consultation, direct Fire and Rescue Authorities as to how they should plan, equip for and respond to such emergencies. This may include, for example, directions as to the deployments of

mass decontamination equipment for civil resilience purposes. The intention is to ensure consistency of approach towards emergencies, particularly in response to terrorist incidents.

4.7 Section 9 also allows the order to require an authority to respond to an emergency that has arisen outside its own area if, for example, it has more appropriate equipment and training than the authority in whose area the emergency has occurred.

4.8 The term "emergency" in this Act means an event or situation that causes or is likely to cause:

(a) one or more individuals to die, be seriously injured or become seriously ill, or

(b) serious harm to the environment (including the life and health of plants and animals).

4.9 Sections 11 and 12: Power to respond to other eventualities and other services – replaced section 3(1)(e) of the *Fire Services Act 1947*, and provides Fire and Rescue Authorities with discretion to equip and respond to events beyond its core functions provided for elsewhere in the Act. A Fire and Rescue Authority is free to act where it believes there is a risk to life or the environment.

4.10 Section 44 Powers of fire-fighters etc in an emergency etc

– 44(1) An employee of a fire and rescue authority who is authorised in writing by the authority for the purposes of this section may do anything he reasonably believes to be necessary.

(a) if he reasonably believes a fire to have broken out or to be about to break out, for the purpose of extinguishing or preventing the fire or protecting life or property;

(b) if he reasonably believes a road traffic accident to have occurred, for the purpose of rescuing people or protecting them from serious harm;

(c) if he reasonably believes an emergency of another kind to have occurred, for the purpose of discharging any function conferred on the fire and rescue authority in relation to the emergency;

(d) for the purpose of preventing or limiting damage to property resulting from action taken as mentioned in paragraph (a), (b) or (c).

– 44(2) In particular, an employee of a fire and rescue authority who is authorised as mentioned in subsection (1) may under that subsection:

(a) enter premises or a place, by force if necessary, without the consent of the owner or occupier of the premises or place;

(b) move or break into a vehicle without the consent of its owner;

(c) close a highway;

(d) stop and regulate traffic;

(e) restrict the access of persons to premises or a place.

– 44(3) A person commits an offence if without reasonable excuse he obstructs or interferes with an employee of a fire and rescue authority taking action authorised under this section.

– 44(4) A person guilty of an offence under subsection (3) is liable on summary conviction to a fine not exceeding level 3 on the standard scale.

4.11 Section 58 defines the meaning of "emergency". It means an event or situation that causes or is likely to cause:

(a) one or more individuals to die, be seriously injured or become seriously ill, or

(b) serious harm to the environment (including the life and health of plants and animals).

4.12 Further information can be found at:

www.opsi.gov.uk/acts/acts2004/en/ukpgaen_20040021_en_1.htm

The Fire and Rescue Services (Emergencies) (England) Order 2007

4.13 The Order gives Fire and Rescue Authorities mandatory functions in connection with key types of emergencies: chemical, biological, radiological or nuclear emergences ('CBRN emergencies') and emergencies requiring the freeing of people from collapsed structures or non-road transport wreckages (urban search and rescue, or 'USAR emergencies').

4.14 It makes it mandatory for Fire and Rescue Authorities to:

(a) make provision for decontaminating people following the release of CBRN(E) substances;

(b) make provision for freeing people from collapsed structures and non-road transport wreckages;

(c) use, on request from an affected Fire and Rescue Authority, specialist CBRN(E) or USAR resources outside their own areas to an extent reasonable for dealing with the CBRN(E) or USAR emergency.

4.15 Giving Fire and Rescue Authorities mandatory functions by order sends a clear signal that making provision for dealing with CBRN(E) and USAR emergencies is a core activity in the same way as it already is for firefighting and road traffic accidents. This further improves national resilience to such disruptive incidents.

4.16 Further information can be found at:

http://www.opsi.gov.uk/si/si2007/uksi_20070735_en_1

Civil Contingencies Act 2004

4.17 Previous legislation relating to civil protection at the local level (the Civil Defence Act 1948 and its Northern Ireland counterpart, the Civil Defence Act (Northern Ireland) 1950) related solely to civil defence. "Civil defence" was defined as measures, other than actual combat, for affording defence against a hostile attack by a foreign power. The focus on civil defence reflected the concerns which were current when the legislation was enacted. The previous legislation also relates to local authorities, police authorities and certain fire authorities only.

4.18 This Act repeals in their entirety the Civil Defence Act 1948 and the *Civil Defence Act (Northern Ireland) 1950.* Part 1 of the Act creates a new concept of an 'emergency'. This term is broadly defined. It includes events which would have engaged the existing civil defence legislation (war or attack by a foreign power). It also includes terrorism which poses a threat of serious damage to the security of the United Kingdom and events which threaten serious damage to human welfare in a place in the United Kingdom or to the environment of a place in the United Kingdom.

4.19 The Act imposes a series of duties on local bodies in England and Wales, Scotland and Northern Ireland (to be known as "Category 1 responders"). These duties include the duty to assess the risk of an emergency occurring and to maintain plans for the purposes of responding to an emergency. The Fire and Rescue Service is a Category 1 responder, the range of Category 1 responders is broader than the range of local bodies which were subject to the previous legislation. It includes certain bodies with functions which relate to health, the Environment Agency and the Secretary of State, in so far as his functions relate to responding to maritime and coastal emergencies.

4.20 More detailed information is contained in Section 7 Part A, Pre-planning considerations and at:

www.opsi.gov.uk/acts/acts2004/en/ukpgaen_20040036_en_1

Water Resources Act 1991

4.21 In England and Wales, The Water Resources Act applies to surface, ground and coastal waters (up to three miles).

4.22 Sections 85-89 of the Act which used to cover offences relating to polluting controlled waters have been repealed and replaced by the Environmental Permitting Regulations.

4.23 The Environment Agency's cost recovery powers are still primarily covered by the Water Resources Act.

The Environmental Permitting (England and Wales) Regulations 2010

4.24 Regulation 12 – Requirement for environmental permit:

(1) A person must not, except under and to the extent authorised by an environmental permit:

(a) operate a regulated facility; or

(b) cause or knowingly permit a water discharge activity or groundwater activity.

4.25 Regulation 38 – Offences:

(1) It is an offence for a person to:

(a) contravene regulation 12(1); or

(b) knowingly cause or knowingly permit the contravention of regulation 12(1)(a).

(2) It is an offence for a person to fail to comply with or to contravene an environmental permit condition.

(3) It is an offence for a person to fail to comply with the requirements of an enforcement notice or of a prohibition notice, suspension notice, landfill closure notice or mining waste facility closure notice.

4.26 Regulation 40 – Defences

(1) **It is a defence** for a person charged with an offence under regulation 38(1), (2) or (3) to prove that the acts alleged to constitute the contravention were done **in an emergency** in order to avoid danger to human health in a case where:

(a) the person took all such steps as were reasonably practicable in the circumstances for minimising pollution; and

(b) particulars of the acts were furnished to the regulator as soon as reasonably practicable after they were done.

4.27 NOTE: Regulations 38 and 40 are of particular interest to the Fire and Rescue Service as they are potentially issues that could arise, for example, at a fire where contaminated firefighting water run-off enters a water system. In theory the enforcing authority could prosecute the Fire and Rescue Service for causing or knowingly permitting a water discharge activity or groundwater activity without a permit. In such circumstances the Fire and Rescue Service defence would need to ensure that, during the emergency, it took all reasonable steps to minimise the pollution and that the Environment Agency was informed when the discharge occurred.

4.28 Further information can be found at:

http://www.opsi.gov.uk/si/si2010/draft/ukdsi_9780111491423_en_1

Environmental Protection Act 1990

4.29 The Act deals with a number of environmental issues that may affect Fire and Rescue Authority operations.

4.30 **Part 1** – Integrated Pollution Control. This part of the act provides a system whereby a license or authorisation is required if a prescribed process is being carried out.

4.31 **Part 2** – Waste on Land. This part of the act introduced a new system of covering the management and disposal of waste. Under Section 33 of the Act, it is an offence to dispose of, treat or store controlled waste without a waste management license. Part 2 also places a duty of care on anyone who produces, imports, keeps, carries, disposes of or acts as a broker of controlled waste.

4.32 **Part 3** – Statutory Nuisance. This part of the Act defines the following statutory nuisances:

- smoke emitting from premises
- fumes or gases emitted from domestic premises
- noise emitted from premises
- noise that is prejudicial to health and is emitted from or caused by a vehicle
- machinery or equipment in a street
- any dust, steam, smell or other effluvia arising on industrial, trade or business premises
- any other matter declared by any enactment to be a statutory nuisance.

4.33 Further information can be found at:

http://www.opsi.gov.uk/acts/acts1990/Ukpga_19900043_en_1.htm

The Environmental Damage (Prevention and Remediation) Regulations 2009

4.34 The *Environmental Damage (Prevention and Remediation) Regulations 2009* came into force on 1st March 2009 in England and on 6 May 2009 in Wales and implement the Environmental Liability Directive 2004/35/EC. The regulations ensure that the polluter pays for the most serious types of environmental damage, supplementing any existing legislation, such as the *Water Resources Act 1991*.

4.35 The regulations apply only to 'environmental damage' which is defined as follows:

(i) protected species or natural habitats, or a site of special scientific interest (SSSI) This is also referred to as 'biodiversity damage'. At a SSSI, the damage must be such that it has an adverse effect on the integrity of the site. Outside SSSIs, the damage must be such that it has a significant adverse effect on the conservation status of the protected species or natural habitat.

(ii) surface water or groundwater damage to a waterbody that is sufficient to lower its status under the Water Framework Directive (whether or not the waterbody is re-classified). This refers to serious

damage only, not short term effects, or effects that are limited in geographical extent land.

(iii) Contamination of land by substances, preparations, organisms or micro-organisms that results in a significant risk of adverse effects on human health.

4.36 **NOTE:** Releases to air that cause deterioration in air quality are not covered by the regulations unless damage to water, land or biodiversity occurs. For example a deposition of airborne pollutants that contaminate land, so that the land itself presents a significant risk of adverse effects on human health would be covered.

4.37 The regulations apply to operators of all economic activities, whether public or private and whether carried out for profit or not. This includes Fire and Rescue Services and other public bodies.

4.38 If environmental damage is caused by an activity listed in Schedule 2 of the regulations, the operator is liable under the regulations regardless of whether they have been at fault or negligent. This is known as "strict liability", although some defences do apply (see below). Schedule 2 activities relevant to the Fire and Rescue Service include discharges of pollutants into surface or groundwater that require authorisation and the use/release into the environment of dangerous substances.

4.39 If biodiversity damage is caused by any activity, operators are also liable if they have caused the damage intentionally or negligently.

EXEMPTIONS

4.40 The regulations are not retrospective and do not apply to damage before the regulations came into force. There are other exemptions which include:

- acts of terrorism
- damage caused by an exceptional natural phenomenon if the operator took all reasonable precautions to prevent it
- activities which have the sole purpose of protecting against natural disasters and activities which have the main purpose of serving national defence or international security.

4.41 **NOTE:** The regulations contain no 'emergency' defence for the protection of life and health, as there is in under Regulation 40 of the *Environmental Permitting Regulations 2010*. However we would hope that Fire and Rescue Service training, equipment, policies and procedures already in place and recognised in our partnership will go a good way towards ensuring that the Fire and Rescue Service have taken all practicable steps to prevent damage (see below).

4.42 To comply with the regulations the Fire and Rescue Service must:

(i) Take all practicable steps to prevent environmental damage occurring as a result of their activities – The Fire and Rescue Service must take all practicable steps to prevent damage where

there is an imminent threat of damage occurring from their activities (Regulation 13) or where some damage has already occurred and there is a threat of further damage (Regulation 14)

(ii) Notify all relevant details to the enforcing authority – Regulations 10 and 11 specify different enforcing authorities, according to the type of activity and damage. Operators must report threats of damage or actual damage to the authority that appears to be the appropriate one.

4.43 Failure to comply with the above duties is an offence. The Environment Agency will expect Fire and Rescue Services to take action to mitigate the impact of any of their activities that may cause or contribute to environmental damage. This is little different to the current requirements placed upon Fire and Rescue Services by the *Environmental Permitting Regulation 2010*. Such action could include blocking drains and/or modifying firefighting activities, providing it does not compromise public safety. The Environment Agency will also expect Fire and Rescue Service to notify them of threats of damage or actual damage where the Environment is the enforcing authority. Current notification procedures set out in the *Fire and Rescue Manual – Environmental Protection.*

(iii) Remediate, where environmental damage has been caused.

4.44 If the activities of the Fire and Rescue Service cause environmental damage and the regulations apply (ie if the activity is listed in Schedule 2 or if there is biodiversity damage that has been caused intentionally or negligently) the enforcing authority has a duty to serve a notification of liability. If this happens, the Fire and Rescue Service would be invited to submit proposals for the remediation of the damage. The enforcing authority would consider any proposals, consult members of the public if relevant, and would then serve a remediation notice, detailing the measures that Fire and Rescue Service would have to take within a specified time scale. It is important to note that:

- For water and biodiversity damage, the regulations set high thresholds and therefore remediation under the regulations will only be required in the most serious cases. Thresholds for land damage are lower however so incidents of land contamination may be covered
- If environmental damage does occur, it is possible that Fire and Rescue Service may themselves be liable on the basis that their own activity caused the damage. However, depending on the circumstances, the cause may be viewed as the activity of the site/vehicle owner whose property caught fire. Enforcing authorities may serve the notification of liability on any person they consider to be legally liable
- Although the enforcing body has a duty to serve a liability notice, it also has the power to withdraw the notice if it is satisfied that the notice should not have been served, or an appeal is likely to succeed.

4.45 **NOTE:** There are no defences to the duty to prevent environmental damage. There are some defences to a notification of liability to remediate damage.

These include:

- compliance with one of the permits or consents listed in Schedule 3 of the regulations (for example, permits under the *Environmental Permitting Regulations*, water discharge consents, groundwater authorisations)
- damage caused by a third party where the operator took all appropriate safety measures
- damage resulting from compliance with an instruction from a public authority (except where it relates to an emission or incident caused by the operator's own activities).

4.46 The Environment Agency is responsible for:

- all types of environmental damage (water, biodiversity and land) from activities we authorise under the *Environmental Permitting Regulations 2007* (EPR)
- all water damage
- biodiversity damage in inland waters
- biodiversity damage in the sea caused by activities we authorise.

4.47 Local authorities are mainly responsible for land damage.

4.48 Further information can be found at:

http://www.legislation.gov.uk/uksi/2009/153/contents/made

Health and Safety

4.49 *Health and Safety at Work Act 1974:* requires employers have to take reasonable steps to ensure the health, safety and welfare of their employees at work.

4.50 *Management of Health and Safety at Work Regulations 1999:* require employers to carry out risk assessments, make arrangements to implement necessary measures, appoint competent people and arrange for appropriate information and training.

4.51 *Personal Protective Equipment at Work Regulations 1992:* require employers to provide appropriate protective clothing and equipment for their employees.

4.52 *Provision and Use of Work Equipment Regulations 1998:* require that equipment provided for use at work, including machinery, is safe.

4.53 *Control of Substances Hazardous to Health Regulations 2002 (COSHH):* require employers to assess the risks from hazardous substances and take appropriate precautions.

4.54 Further information can be found at:

http://www.hse.gov.uk/legislation/index.htm

Planning

4.55 *Notification and marking of sites regulations 1990 (NAMOS)* – More detailed information is contained in Section 7 Part A, Pre-planning considerations.

4.56 *Notification of Installations Handling Hazardous Substances Regulations 1982 (NIHHS)* – More detailed information is contained in Section 7 Part A, Pre-planning considerations.

4.57 *The Control of Major Accident Hazards Regulations 1999 (as amended) (COMAH)* – More detailed information is contained in Section 7 Part A, Pre-planning considerations.

Radiation

4.58 *Ionising Radiation Regulations* 1999 (IRR99) – apply to a large range of workplaces where radioactive substances and electrical equipment emitting ionising radiation are used. They also apply to work with natural radiation, including work in which people are exposed to naturally occurring radon gas and its decay products. Any employer who undertakes work with ionising radiation must comply with IRR99. It requires employers to keep exposure to ionising radiations as low as reasonably practicable. Exposures must not exceed specified dose limits. Restriction of exposure should be achieved first by means of engineering control and design features. Where this is not reasonably practicable employers should introduce safe systems of work and only rely on the provision of personal protective equipment as a last resort. Further information can be found in Section 7 Part C-10, Radioactive materials and at:

http://www.hse.gov.uk/radiation/ionising/legalbase.htm

4.59 *Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)* – REPPIR establishes a framework of emergency preparedness measures to ensure that members of the public are properly informed and prepared, in advance, about what to do in the unlikely event of a radiation emergency occurring, and provided with information if a radiation emergency actually occurs. A 'radiation emergency' is an event that is likely to result in a member of the public receiving an effective dose of 5 mSv during the year immediately following the emergency.

4.60 REPPIR do not replace existing nuclear site licence conditions but operators of licensed sites who comply with those conditions will satisfy equivalent provisions in REPPIR. REPPIR place legal duties on:

(a) operators of premises where work with ionising radiation is carried out eg licensed nuclear sites, hospitals, universities, ports, airports, factories,

(b) people who transport radioactive substances through a public place (but not those using standard forms of transport such as road, rail, inland waterway, sea, air, or through a pipeline),

(c) all local authorities, not just those who have REPPIR operators within their boundaries, and

(d) the employers of people who intervene in a radiation emergency, such as the Fire and Rescue Services.

4.61 Further information can be found in Section 7 Part C-10, Radioactive materials, and at:

http://www.hse.gov.uk/radiation/ionising/reppir.htm

Control of Asbestos Regulations

4.62 The Regulations include requirements on:

- managing asbestos in non-domestic premises
- prevention or reduction of the spread of asbestos
- identification of the presence of asbestos
- assessment of work which exposes employees to asbestos
- prevention or reduction of exposure to asbestos
- plans for working with asbestos
- information, instruction and training
- use and maintenance of control measures etc
- provision and cleaning of protective clothing
- air monitoring
- health records and medical surveillance
- licensing and notification of work with asbestos.

4.63 Further information can be found in Section 7 Part C-13, Asbestos containing materials and at:

http://www.hse.gov.uk/asbestos/

Other legislation and regulation

4.64 Other legislation and regulatory guidance relevant to the Fire and Rescue Service for dealing with hazardous materials incidents is contained in:

- *ADR (European Agreement Concerning the International Carriage of Dangerous Goods by Road)*

- *RID (Regulations Concerning the International Carriage of Dangerous Goods by Rail)*
- *ADN 2007 (European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways)*
- *Dangerous Goods Regulations 2008 - International Air Transport Association (IATA)*
- *International Maritime Dangerous Goods (IMDG) Code*
- *The Chemical (Hazard Information and Packaging for Supply) Regulations*
- *Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)*
- *The Water Industry Act 1999 – Applies to sewerage systems in England and Wales*
- *The Groundwater Regulations 1998 – Applies to groundwater and the associated land or soil*
- *The Hazardous Waste Regulations 1996 (as amended)*
- *Fire and Rescue Service National Framework 2008-11 (DCLG)*
- *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 SI 2009 No 1348 (known as CDG 2009)*
- *The Chemicals (Hazard Information and Packaging for Supply) Regulations 2008*
- *The Air Navigation Order 2005*
- *The Air Navigation (Dangerous Goods) (Amended) Regulations 2006*
- *Radioactive Material (Road Transport) (Great Britain) Regulations (RAMRoad)*
- *Packaging Labelling and Carriage of Radioactive Materials by Rail Regulations*
- *Manufacture and Storage of Explosives Regulations 2005 (MSER).*

Section 5

Strategic role of operational guidance

Strategic perspective

5.1 Fire and Rescue Authorities and strategic managers within the Fire and Rescue Service are responsible for ensuring their organisation and staff operate safely when dealing with incidents involving hazardous materials. Their legal duties and responsibilities are contained in Section 4 of this guidance.

5.2 Fire and Rescue Services should continually assess the risk, in terms of the foreseeable likelihood and severity, of incidents involving Hazardous materials occurring within their areas. This assessment should form part of their integrated risk management plan. The findings will help them ensure they have appropriate organisation, policy and procedures in place for dealing with these types of incidents.

5.3 The following principles may assist Strategic Managers when determining the level of acceptable service and whether they are meeting their duty of care:

- operations must be legal and within the requirements of regulations
- actions and decisions should be consistent with voluntary consensus standards, and nationally recommended practices and procedures
- actions and decisions to control a problem should have a technical foundation and be based on an appropriate risk assessment
- actions and decisions must be ethical.

At the incident

5.4 'Response' can be defined as the actions taken to deal with the immediate effects of an emergency. It encompasses the resources and effort to deal not only with the direct effects of the emergency itself (eg fighting fires, rescuing individuals, mitigating the effects of hazardous materials) but also the indirect effects (eg disruption, media interest). The duration of the response phase will be proportionate to the scale and complexity of the incident.

5.5 The generic key roles of the Fire and Rescue Services at hazardous materials incidents are:

- save life and carry out rescues
- fight and prevent fires
- manage hazardous materials and protect the environment
- mitigate the effects of the incident
- ensure the health and safety of Fire Service staff, other category 1 & 2 responders and the public
- safety management within the inner cordon.

5.6 When responding to incidents involving hazardous materials the Fire and Rescue Service has strategic multi-agency responsibilities. These are additional, and in the main complimentary, to the specific fire and rescue functions that the Fire and Rescue Service performs at the scene. The strategic objective is to co-ordinate effective multi-agency activity in order to:

- preserve and protect lives
- mitigate and minimise the impact of an incident
- inform the public and maintain public confidence
- prevent, deter and detect crime
- assist an early return to normality (or as near to it as can be reasonably achieved).

5.7 Other important common strategic objectives flowing from these responsibilities are to:

- participate in judicial, public, technical or other inquiries
- evaluate the response and identify lessons to be learnt
- participate in the restoration and recovery phases of a major incident.

Values

5.8 The Fire and Rescue Service expresses its values and vision of leadership in the form of a simple model. The model has been named Aspire and is fully described in the *Fire and Rescue Manual (volume 2 Operations) – Incident Command*. It has at its heart, the core values of the service; which are:

- diversity
- our people
- improvement
- service to the community.

5.9 These values are intrinsic to everything Fire and Rescue Services strive to achieve at an operational incident, where they routinely serve all communities equally and professionally, with the safety and well being of their crews at the forefront of their procedures and reflecting on how well they performed in order to be better next time. It is important that core values are recognised and promoted by all strategic managers and fire and rescue authority members.

5.10 This guidance has been drafted to ensure that equality and diversity issues are considered and developed and has undergone full equality impact assessment in line with priority one of the Equality and Diversity Strategy.

Operational guidance review protocols

5.11 This operational guidance will be reviewed for its currency and accuracy three years from date of publication. The Operational Guidance Programme Board will be responsible for commissioning the review and any decision for revision or amendment.

5.12 The Operational Guidance Programme Board may decide that a full or partial review is required within this period.

Section 6

Generic Risk Assessment

Introduction

6.1 Owing to the size and nature of the Fire and Rescue Service and the wide range of activities in which it becomes involved, there is the potential for the risk assessment process to become a time consuming activity. To minimise this and avoid having inconsistencies of approach and outcome, DCLG have produced a series of generic risk assessments.[2] These risk assessments have been produced as a tool to assist Fire and Rescue Services in drawing up their own assessments to meet the requirements of the *Management of Health and Safety at Work Regulations, 1999.*

6.2 There are a number of generic risk assessments that Fire and Rescue Services should consider when developing their policy and procedures for dealing with emergency hazardous materials incidents. They have been used as the foundations of the information and guidance contained in this operational guidance.

6.3 Generic risk assessments relevant to hazardous materials incidents:

- 1.1 Emergency response and arrival at the scene (Section 3 – Arriving and getting to work)
- 5.2 Acetylene
- 5.3 Chemical
- 5.4 Biological
- 5.5 Radiation
- 5.7 Explosives
- 5.9 Asbestos.

6.4 Fire and Rescue Services should use these generic risk assessments as part of their own risk assessment strategy not as an alternative or substitute for it. They are designed to help Fire and Rescue Services assess their specific risks, and should be considered as part of the Services' normal planning process. It is suggested that competent assessors:

- check the validity of the information contained in the generic risk assessment against their Fire and Rescue Service's current practices and identify any additional or alternative hazards, risks and control measures
- evaluate the severity and likelihood of hazards causing harm, and the effectiveness of current controls, for example, operational procedures, training and personal protective equipment etc, by using the Service's methodology
- consider other regulatory requirements
- identify additional measures which will be needed to reduce the risk, so far as is reasonably practicable

2 Generic risk assessments are available from TSO Bookshops: www.tsoshop.co.uk/GRA

- put those additional measures and arrangements in place.

6.5 Generic risk assessments provide a guide to the type of information, arrangements and training that should be given to the Incident Commander, firefighters and any other staff likely to be affected.

6.6 Full guidance on the generic risk assessments is contained in Occupational health, safety and welfare: *Guidance for fire services: Generic Risk Assessments, Introduction.*

Section 7

Fire and Rescue Service Operations

Part A

Pre-planning considerations

Introduction

7A.1 Major catastrophes occurring in the UK and overseas have helped shape the legislative framework for emergency preparedness. Events such as the terrorist attacks of 11 September 2001 in the United States of America, the bombing of the London transport system in July 2005 and lessons learned from other major hazardous materials accidents have brought about a change in our thinking in terms of the perceived threat and the associated planning regimes needed to support our resilience capability and preparedness for incidents of a new dimension or previously unseen scale.

7A.2 The change in our frame of reference for emergency preparedness has been underpinned by an amendment to the existing EC Seveso II Directive (96/82/EC) and by the introduction of the principles of long term resilience capability into the *Fire and Rescue Service National Framework* document and the introduction of emergency planning legislation to cover civil contingencies.

7A.3 Pre-planning for operational incidents is a safety-critical part of Fire and Rescue Service work. Services must ensure they have suitable and sufficient emergency response plans in place to cover the following hazardous materials risks within their authority's area:

- buildings and/or establishments subject to the *Control of Major Accident Hazard Regulations* (COMAH)
- buildings and/or establishments known to manufacture, store or use significant quantities of hazardous materials but not subject to COMAH regulations
- buildings or establishments known to have asbestos containing materials
- leaking and/or heated cylinders
- road transportation accidents, spillages or releases of hazardous materials
- rail transportation accidents, spillages or releases of hazardous materials
- waterborne transportation accidents, spillages or releases of hazardous materials
- air transportation accidents, spillages or releases of hazardous materials
- military accidents, spillages or releases of hazardous materials
- deliberate, criminal, malicious or terrorist events resulting in the release of hazardous materials.

7A.4 The extent of pre-planning that individual Fire and Rescue Services carry out is dependent on the likelihood and severity of foreseeable hazardous materials and/or CBRN/CBRN(E)[3] emergencies within their areas. The starting point for pre-planning should be the generic risk assessment process and guidance.

7A.5 Part A of this operational guidance sets out the United Kingdom's legislative framework covering the key principles of hazardous materials emergency preparedness:

- Gathering and use of risk information
- *Notification and Marking of Sites Regulations 1990* (NAMOS)
- *Notification of Installations Handling Hazardous Substances Regulations 1982* (NIHHS)
- *The Control of Major Accident Hazards Regulations 1999 (as amended)* (COMAH)
- *The Civil Contingencies Act 2004* (CCA).

Gathering and use of risk information

7A.6 The *Fire and Rescue Services Act 2004*, states that a Fire and Rescue Authority must make provision for the purpose of:

(a) extinguishing fires in its area, and

(b) protecting life and property in the event of fires in its area.

7A.7 Section 7(2)d of the Act places a responsibility on the Fire and Rescue Authority to make arrangements for obtaining information needed for that purpose. Sections 8(2)d, and 9(3)d place a similar responsibility on the Authority in respect of road accidents and other emergencies.

7A.8 In support of the above legislative responsibilities, The *Fire and Rescue Service National Framework* document places a requirement on all Fire and Rescue Authorities to have in place effective arrangements for gathering risk information and making it readily available to operational crews. These arrangements should include an effective audit and review system to ensure that the information is current and in the required format.

7A.9 Identifying and managing risk is at the heart of the role and responsibility of the Fire and Rescue Service and must be considered within a holistic approach to integrated risk management, whether that be through the pre-planning and management of emergencies, fire safety, crime and disorder initiatives, training or undertaking other day-to-day activities.

3 CBRN/CBRN(E) (chemical, biological, radiological and nuclear/chemical, biological, radiological, nuclear and explosive) terrorism entails the assumption or knowledge, based on intelligence or actual evidence, of actual or threatened dispersal of chemical, biological, radiological or nuclear material (either on their own or in combination with each other or with explosives), with deliberate criminal, malicious or murderous intent, targeted at a given population or economic or symbolic points.

7A.10 The importance of multi-agency pre-planning in respect of significant known or foreseeable hazardous materials risks cannot be stressed highly enough. Local resilience forums, set up under the *Civil Contingencies Act 2004*, are comprised of the key stakeholders in the local community. They should hold details of all significant risks within their area in the form of a community risk register.

7A.11 The gathering and use of 'risk information' forms part of the Fire and Rescue Operational Assessment Toolkit. The toolkit uses briefing sheets to support each key line of enquiry and assists the assessment team in focusing on key areas for assessment.

7A.12 Each Fire and Rescue Service should assess the hazards and risks in its area relating to hazardous materials and site-specific plans should be considered for locations where these are significant. This assessment should include other Fire and Rescue Service areas where 'cross border' arrangements make this appropriate. Such contingency plans should include:

- levels of response
- relevant standard operating procedures
- tactical considerations including rendezvous points, appliance marshalling areas and access points.

7A.13 Information should also be gathered and used to review safe systems of work, from sources both within and outside the Fire and Rescue Service, including:

- fire safety audits
- incident de-briefs
- health and safety events
- local authorities
- local resilience forums.

7A.14 Involving others in pre-planning is also an effective way to build good working relations with partner agencies and other interested parties, such as site owners. Fire and Rescue Services should ensure systems are in place to record and regularly review risk information and to ensure that new risks are identified and recorded as soon as practicable.

7A.15 Fire and Rescue Services must ensure that the information gathered is treated as confidential, unless disclosure is is required for legal reasons.

7A.16 Fire and Rescue Services should consider the benefits of using consistent systems and formats to record information from all sources. Consideration should also be given to when access will be provided to information to support operational decision-making. Information needs and the capacity of Fire and

Rescue Service staff to assimilate information will vary in proportion to the nature and size of the incident and what stage the operational response has reached. Arrangements need to be flexible and may be based on more than one system.

7A.17 It is essential that all plans and relevant supporting information are available to emergency responders. Information retrieval systems should be easy and quick to operate, and should have some back-up facility were the main system to fail or become unavailable

7A.18 Specific pre-planning for hazardous materials incidents includes the requirement for a written policy which outlines:

- how the Fire and Rescue Service will deal with hazardous materials incidents by using good practice for reducing the risk of contamination based on the principals of hierarchical control
- how the Fire and Rescue Service is going to train their staff to raise awareness, reduce the risk of exposure and to protect themselves, the public and the environment
- effective Fire and Rescue Service decontamination procedures.

Notification and marking of sites regulations 1990 (NAMOS)

7A.19 NAMOS regulations came into force on 1 September 1990 and are designed to complement the *Notification of Installations Handling Hazardous Substances Regulations 1982* (NIHHS) (as amended).

7A.20 Under the regulations, if there is present on site a total of 25 tonnes or more of dangerous substances at any time, the site controller must notify in writing the Fire and Rescue Authority and the enforcing authority. For the purpose of the regulations, 'dangerous substances' means any substance that falls within the definition of current edition of the *Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations*.

7A.21 7A.21 The enforcing authority for these regulations is the Fire and Rescue Authority except that:

- under Regulation 4 Notification, the enforcing authority will be either the Health and Safety Executive or the local authority
- under Regulation 5 Access Marking, 6 Location Marking and 7 Signs to be Kept Clean, etc, the enforcing authority will be the local Fire and Rescue Authority with the exception of:
  - local authority, fire, police premises
  - crown property (except Health and Safety Executive)
  - United Kingdom Atomic Energy Authority property

- armed forces (UK or visiting).

7A.22 In these cases the Health and Safety Executive will be the enforcing authority.

Particulars to be notified

7A.23 The following particulars should be notified:

- name and address of person making the notification
- full postal address of the site
- a general description of the nature of the business carried on or intended to be carried on at the site
- a list of the classifications of any dangerous substances which are, or are liable to be, present
- the date on which it is anticipated that a total quantity of 25 tonnes or more of dangerous substances will be present, or, if they are already present, a statement to that effect.

Changes to be notified

7A.24 The following changes should be notified:

- the cessation of the presence of dangerous substances at the site, other than a temporary cessation
- the reduction of the total quantity of dangerous substances present at the site to below 25 tonnes, other than a temporary reduction
- any change in the list of classifications notified to the authorities.

7A.25 Although the person in control of a site does not have to notify the total quantities on site, they will be required to assess total quantities to know whether they are required to notify under the regulations. They should therefore take into account any quantities present in:

- vehicles or vessels used for storage purposes – tanks, containers, drums – after unloading
- vehicles used for on-site transportation
- materials used for cleaning, etc
- process, manufacture, storage.

Access marking

7A.26 If there are more than 25 tonnes of dangerous substances on site at any one time, the person in control of the site should ensure that safety signs are displayed sufficiently clearly to give adequate warning of them to firefighters in an emergency. The safety sign for access marking is shown below.

Safety sign for access

Figure 1 *Access sign*

7A.27 Signs should be placed in conspicuous positions close to site entrances that could reasonably be expected to be used by firefighters. They may be free-standing or fixed to fences, railings, faces of buildings, etc.

Location marking

7A.28 At a site storing a total of 25 tonnes or more of dangerous substances, an inspector may give directions to the person in control of the site to display safety signs at specified locations. These directions will only be given where the inspector is satisfied on reasonable grounds that:

- twenty-five tonnes or more of dangerous substance are, or are liable to be, present
- the display of signs is necessary to warn firefighters in an emergency of the presence of dangerous substances at these locations
- the safety signs shall be warning signs as defined by paragraph 3.2 of part II of schedule 1 to the *Health and Safety (Safety Signs and Signals) Regulations 1996* (see Figure 2)
- the sign shall bear the hazard warning symbol and hazard warning text
- where two or more substances with different classifications are stored at the same site then the access marking sign bearing the exclamation mark should be displayed with the text 'Dangerous Substance'
- signs do not have to be displayed at the site when dangerous substances are not present
- reference to 'The Site' means at or in the vicinity of the site location.

Location signs

Figure 2 *Location signs*

7A.29 The person in control of the site shall, as far as is reasonably practicable, ensure that any safety signs displayed at the site (to provide access and location marking) are kept clean and free from obstruction.

7A.30 These regulations shall not apply to nor bear relation to:

- dangerous substances buried or deposited in the ground as waste
- radioactive substances (only hazard)
- substances, which, under the Classification and Labelling of Explosives Regulations 1983, are classified as Class 1 goods within the meaning of:
  - *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment regulations*
  - *The International Maritime Dangerous Goods Code; or*
  - *The Technical instructions for the Safe Transport of Dangerous Goods by Air.*
- aerosol dispensers unless labelled in accordance with the *Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations.*

7A.31 Notification shall not apply to:

- sites that are notifiable to the executive under the *Notification of Installations Handling Hazardous Substances Regulation 1982* (NIHHS)
- Control of Major Accident Hazards sites
- licensed sites under the *Petroleum Consolidation Act 1928* (as amended)

- sites within the area of a harbour authority if Regulation 27 of the *Dangerous Substances in Harbour Regulation 1987 (as amended)* applies
- sites that have a disposal licence in force under the *Control of Pollution Act 1974 (as amended)*
- nuclear sites licensed under the *Nuclear Installations Act 1969* (as amended).

7A.32 **NOTE:** Access and location marking regulations shall not apply to petroleum filling stations.

7A.33 The Health and Safety Executive has the power to grant general or special exemptions and to impose conditions and time limits on them. Before granting any exemption, the Executive would have to consider the circumstances of the case and consult any bodies likely to be affected.

Notification of Installations Handling Hazardous Substances Regulations 1982 (NIHHS)

7A.34 These regulations came into force on 1 January 1983 and were introduced to identify sites that handled certain quantities of hazardous materials not covered by the *Control of Major Accident Hazards Regulations (COMAH).*

7A.35 The definition of 'site' means:

- the whole area of land under control of a person and includes a jetty, pier or similar structure, whether floating or not; or
- any structure, floating or otherwise, which is within the inland waters of Great Britain and is controlled by a person.

7A.36 Before any activity commences at a site deemed to be covered by these regulations, the occupier must notify the Health and Safety Executive at least three months before operations begin. In the case of ammonium nitrate this has been set in the 2002 amendment regulations at four weeks.

7A.37 Information to be supplied:

- name and full postal address of the site
- name and address of person making the application
- the area of the site and any site within 500 metres
- the date the activity commences
- a general description of the activities carried out
- name and address of the planning authority covering the site address
- name and quantity of each hazardous substance to be stored on site.

7A.38 To determine the exact quantity of a hazardous material held on a site the following must be taken into account:

- quantity held in any pipeline which is within 500 metres of, and connected to, the site
- quantity held in any other site within 500 metres of the original site
- any vessel, vehicle or aircraft used for storage at, or within 500 metres of, the site.

7A.39 The only exceptions are waste sites licensed under Section 5 of the *Control of Pollution Act 1974 (as amended)*. Should the quantity of any hazardous material stored be either increased to an amount three or more times of the original declaration, or reduced by any amount or cease to be used altogether, the Health and Safety Executive must be informed.

7A.40 The regulations contain schedules that list the hazardous substances and quantities that require notification to the Health and Safety Executive.

The Control of Major Accident Hazards Regulations 1999 (as amended) (COMAH)

7A.41 The *Control of Major Accident Hazard Regulations* (COMAH) implemented the *Seveso II Directive (96/82/EC)* in Great Britain, except for land-use planning requirements which are to be implemented by changes to planning legislation. They replace the *Control of Industrial Major Accident Hazards Regulations 1984* (CIMAH) which implemented the original *Seveso Directive (82/501/EEC)*. They came into force on 1st April 1999 and are amended by the *Control of Major Accident Hazards (Amendment) Regulations 2005.*

7A.42 Their purpose is to prevent major accidents involving dangerous substances and limit the consequences to people and the environment of any which do occur. COMAH applies mainly to the chemical industry, but also to some storage activities, explosives and nuclear sites, and other industries where threshold quantities of dangerous substances identified in the Regulations are kept or used.

7A.43 A key feature of the COMAH Regulations is that they will be enforced by a competent authority comprising the Health and Safety Executive and the Environment Agency in England and Wales, and the Health and Safety Executive and the Scottish Environment Protection Agency in Scotland. Operators will generally receive a single response from the competent authority on all matters to do with COMAH.

7A.44 The mechanism for determining whether COMAH applies has been simplified. Basically, an establishment having any substance specified in Schedule 1 present above the qualifying quantity is subject to the Regulations. There are two

thresholds, known as lower-tier and top-tier. Further details can be found in the guidance to Schedule 1 which lists 39 substances by name in Part 2 and 10 generic categories in Part 3.

7A.45 Even if there are no threshold quantities of substances present at an establishment, it may still be subject to the Regulations if specified dangerous substances could be produced in threshold quantities as a result of loss of control of an industrial chemical process.

7A.46 The Major Accident Control Regulations for the Ministry of Defence are intended to discharge the requirement from the Secretary of State for Defence to have in place arrangements which are at least as good as those required by statute where the Secretary of State holds an exemption, with respect to COMAH.

7A.47 More information on the Regulations and how to comply with them can be found on the Health and Safety Executive's website: **www.hse.gov.uk/comah/index.htm**.

Lower-tier duties

7A.48 If the lower-tier threshold is equalled or exceeded, operators must notify the competent authority. Notification should be to the local Health and Safety Executive office which will pass the details to the relevant Environment Agency office.

7A.49 Operators of all establishments subject to the Regulations must notify certain basic details to the competent authority. The key points which have to be included in the notification are given below but full details are given in Schedule 3 to the Regulations:

- name and address of operator
- address of establishment
- name or position of person in charge
- details of dangerous substances on site (a breakdown is required for petroleum products)
- site activities
- environmental details.

SITE OPERATORS MUST MAKE ALL MEASURES NECESSARY TO PREVENT MAJOR ACCIDENTS AND LIMIT THEIR CONSEQUENCES TO PEOPLE AND THE ENVIRONMENT

7A.50 This is the general duty on all operators and underpins all the regulations. It is a high standard and applies to all establishments within scope. By requiring measures both for prevention and mitigation there is a recognition that all risks cannot be completely eliminated. This in turn implies that proportionality must remain a key element in the enforcement policy of the Health and Safety

Executive and the Environment Agency. Thus, the phrase 'all measures necessary' will be interpreted to include this principle and a judgment will be made about the measures in place. Where hazards are high then high standards will be required to ensure risks are acceptably low, in line with the Health and Safety Executive's and Environment Agency's policy that enforcement should be proportionate. Prevention should be based on the principle of reducing risk to a level as low as is reasonably practicable for human risks and using the best available technology not entailing excessive cost for environmental risks. The ideal should always be, wherever possible, to avoid a hazard altogether.

SITE OPERATORS MUST PREPARE A MAJOR ACCIDENT PREVENTION POLICY

7A.51 Regulation 5 requires lower-tier operators to prepare a document setting out their policy for preventing major accidents, this is known as a major accident prevention policy or MAPP.

7A.52 The MAPP will usually be a short and simple document setting down what is to be achieved but it should also include a summary and further references to the safety management system that will be used to put the policy into action. The detail will be contained in other documentation relating to the establishment eg plant operating procedures, training records, job descriptions, audit reports, to which the MAPP can refer.

7A.53 The MAPP also has to address issues relating to the safety management system. The details are given in Schedule 2 of the Regulations but the key areas are:

- organisation and personnel
- identification and evaluation of major hazards
- operational control
- planning for emergencies
- monitoring, audit and review.

Top-tier duties

7A.54 If any top-tier threshold is equalled or exceeded, the operator must also comply with regulations 7 to 14.

SITE OPERATORS MUST PREPARE A SAFETY REPORT

7A.55 A safety report is a document that provides information to demonstrate to the competent authority that all measures necessary for the prevention and mitigation of major accidents have been taken.

7A.56 The safety report must include:

- a policy on how to prevent and mitigate major accidents
- a management system for implementing that policy

- an effective method for identifying any major accidents that might occur
- measures (such as safe plant and safe operating procedures) to prevent and mitigate major accidents
- information on the safety precautions built into the plant and equipment when it was designed and constructed
- details of measures (such as fire-fighting, relief systems and filters) to limit the consequences of any major accident that might occur; and
- information about the emergency plan for the site, which is also used by the local authority in drawing up an off-site emergency plan.

7A.57 Safety reports will be available to the public via the competent authority registers, subject to safeguards for national security, commercial and personal confidentiality.

SITE OPERATORS MUST UPDATE THE SAFETY REPORT AFTER SIGNIFICANT CHANGES OR NEW KNOWLEDGE ABOUT SAFETY MATTERS OR EVERY FIVE YEARS

7A.58 The safety report needs to be kept up to date. If there are any modifications to the plant or the way it is operated or if new facts or information become available, the safety report must be reviewed and, if necessary, revised at the time. It must be reviewed after five years even if there have not been any changes. The operator must notify the competent authority of any revision, and also if the five-year review does not lead to a revision.

SITE OPERATORS MUST PREPARE AND TEST AN ON-SITE EMERGENCY PLAN

7A.59 Top-tier operators must prepare an emergency plan to deal with the on-site consequences of a major accident.

SITE OPERATORS MUST SUPPLY INFORMATION TO LOCAL AUTHORITIES FOR OFF-SITE EMERGENCY PLANNING PURPOSES

7A.60 Local authorities (this means the Fire and Rescue Service in London and other metropolitan areas) play a key role by preparing, reviewing, revising and testing off-site emergency plans for dealing with the off-site consequences of major accidents at top-tier sites. In order to fulfil this role they need information from operators. Operators will need to hold discussions with their local authorities to determine their exact needs.

SITE OPERATORS MUST PROVIDE CERTAIN INFORMATION TO THE PUBLIC ABOUT THEIR ACTIVITIES

7A.61 People who could be affected by an accident at a COMAH establishment must be given information without having to request it. Also safety reports must be made available to the public via public registers.

7A.62 Operators planning to build new top-tier establishments must submit information in advance of construction and wait for the competent authority's response before starting to build safety-critical parts of the establishment. This is to ensure that safety is considered fully at the design stage.

7A.63 The COMAH regulations specifically require operators to consult their employees or employees' representatives about the preparation of the on-site emergency plan. Consultation with those doing the work is crucial in raising awareness of the importance of health and safety and environmental protection. It can make a significant contribution to creating and maintaining a safe and healthy working environment and an effective health and safety culture. In turn, this can benefit the business, making it more efficient by reducing the number of accidents and the number of work-related ill-health incidents.

7A.64 Upon receipt of the safety report the competent authority should inform employee representatives and provide the name of the assessment manager. If the competent authority finds serious deficiencies in the safety report, it will copy to employee representatives any correspondence it has with operators in respect of this. Similarly, the competent authority will copy the letter informing the operator of its conclusions of the assessment of the safety report, to employee representatives.

7A.65 The Environment Agency has been pro-active in working alongside the European Commission's activities related to the implementation of the Seveso II Directive. This work reflects the following arrangements introduced by the *Seveso II Directive and the Amending Directive (2003/105/EC)*:

- The Directive 2003/105/EC introduces more explicit requirements on the environment. One of the generic categories of substances is 'dangerous for the environment' – designed to bring establishments which pose an environmental threat within scope. Also, clean-up and restoration of the environment is a new objective of emergency plans
- The environment now has a higher public profile to be sure that high levels of protection are achieved for the environment as well as for people
- The Environment Agency was created in 1996 and it brings together, in single regulatory authority, a wide range of responsibilities for, and expertise on, all aspects of environmental protection. This, and the move towards integrated pollution control, makes it easier to co-ordinate environmental inputs to the regulation of major hazards
- There has been a trend within industry, and particularly the chemicals sector, to integrate health, safety and environment policies and practices and adopt a more holistic approach to hazard identification and risk control.

7A.66 There is other environmental legislation which, to some extent, overlaps with Seveso II. In particular, the *Directive on Integrated Pollution Prevention and Control* (IPPC, Directive 96/61/EC) establishes a permitting process by the competent authority which covers, amongst many other things, accidental pollution.

7A.67 The Health and Safety Executive and the Environment Agency will work together as the competent authority for the COMAH regime. In considering how this should be done, the objective was to achieve high levels of protection from major accidents for both people and the environment. The arrangements will ensure that:

- appropriate expertise on health and safety and the environment is brought to bear on the regulation of major hazards
- the activities of Health and Safety Executive and the Environment Agency, in relation to duties under the Regulations, are co-ordinated, consistent, transparent, targeted and proportionate
- the possibility of conflicting requirements being placed on operators is eliminated; and
- the Health and Safety Executive and the Environment Agency will collaborate on issues of joint interest, so avoiding duplicating activity for themselves and for operators.

7A.68 The working arrangements are set out in a memorandum of understanding, copies of which are available on request from the competent authority.

7A.69 There are many aspects of an operator's activities which do not relate exclusively to protection of either people or the environment. Co-ordinating the operational implementation of COMAH by the Health and Safety Executive and the Environment Agency is, therefore, crucial. For key regulatory activities which require action by the competent authority, such as:

- assessing safety reports
- applying derogation procedures; and
- designating domino effects establishments, the operator will make a submission or application and receive a single response agreed between the Health and Safety Executive and the Environment Agency.

7A.70 The Health and Safety Executive and the Environment Agency will discuss and exchange inspection programmes for establishments subject to COMAH. Inspections relating to COMAH will be coordinated to avoid duplication of effort.

The Civil Contingencies Act 2004 (CCA)

7A.71 The *Civil Contingencies Act 2004* delivers a single framework for civil protection in the United Kingdom capable of meeting the challenges of the twenty-first century.

7A.72 The Act is separated into two parts:

- **Part 1**: local arrangements for civil protection, establishing a statutory framework of roles and responsibilities for local responders.
- **Part 2**: emergency powers, establishing a modern framework for the use of special legislative measures that might be necessary to deal with the effects of the most serious emergencies.

7A.73 The definition of emergency in the Act covers the consequences of emergencies. It defines an emergency as:

- an event or situation which threatens serious damage to human welfare
- an event or situation which threatens serious damage to the environment
- war, or terrorism, which threatens serious damage to security.

7A.74 For Part 1 of the Act the definition sets out the range of possible incidents for which local responders must prepare when fulfilling their civil protection duties.

7A.75 For Part 2 it sets out the situations in which it may be possible to use emergency powers if the appropriate safeguards are met.

7A.76 This does not mean that the definition of 'emergency' is the same in both parts. In Part 1, the threat must pose a threat of serious damage to human welfare or the environment of a 'place' in the United Kingdom. This reflects the fact that Part 1 is designed to deal with preparations by local responders for localised emergencies.

7A.77 In Part 2, the threat must pose a threat of serious damage to human welfare or the environment of one of the English regions, or one of the other constituent parts of the UK (Scotland, Wales or Northern Ireland). This higher threshold reflects the fact that Part 2 is designed for use in very serious emergencies which affect a larger geographical area.

Part 1: Local arrangements for civil protection

7A.78 The purpose of Part 1 of the Act is to establish a new statutory framework for civil protection at the local level. Local responders are the building block of resilience in the UK, and the Act will enhance existing arrangements by:

- establishing a clear set of roles and responsibilities for local responders
- giving greater structure and consistency to local civil protection activity; and
- establishing a sound basis for performance management at a local level.

7A.79 The Act divides local responders into two categories depending on the extent of their involvement in civil protection work, and places a proportionate set of duties on each.

7A.80 Category 1 responders are those organisations at the core of emergency response (eg emergency services, local authorities). Category 1 responders are subject to the full set of civil protection duties. They are required to:

- assess the risk of emergencies occurring and use this to inform contingency planning
- put in place emergency plans
- put in place business continuity management arrangements
- put in place arrangements to make information available to the public about civil protection matters and maintain arrangements to warn, inform and advise the public in the event of an emergency
- share information with other local responders to enhance co-ordination
- co-operate with other local responders to enhance co-ordination and efficiency; and
- provide advice and assistance to businesses and voluntary organisations about business continuity management (local authorities only).

7A.81 The definition of emergency in the Act defines the sorts of events or situations that Category 1 responders should be preparing for.

7A.82 Part 2 of the Act additionally establishes a threshold that events or situations would need to meet to constitute an emergency, and thus to trigger the duties in Part 1 of the Act. This provides that Category 1 responders' duties under the Act only apply to events or situations which require the use of assets beyond the scope of normal operations and require a special deployment.

7A.83 Category 2 organisations (eg the Health and Safety Executive, transport and utility companies) are 'co-operating bodies' who, while less likely to be involved in the heart of planning work, will be heavily involved in incidents that affect their sector. Category 2 responders have a lesser set of duties – co-operating and sharing relevant information with other Category 1 and 2 responders. The detail of what this means in practical terms is contained in the *Contingency Planning Regulations 2005* and statutory guidance on emergency preparedness that can be found at:

http://www.cabinetoffice.gov.uk/ukresilience

7A.84 Category 1 and 2 responders are also required to come together to form 'local resilience forums' (based on police force areas outside London) which will help co-ordination and co-operation between responders at the local level.

Part 2: Emergency powers

7A.85 In the UK emergency powers allow the making of special temporary legislation to deal with the most serious of emergencies. They are not a means for instigating martial law, for undermining Parliament, banning political parties or anything else

of that nature. An essential point to note is that emergency powers legislation is a mechanism for dealing with only the most serious of emergencies that require an urgent response, an instrument of last resort. The previous emergency powers legislation (the *Emergency Powers Act 1920*) was used twelve times in its eighty-four year history, the last time being in 1974. In the years since, a considerable amount of sector specific emergency legislation has been introduced. This reduced the need to resort to emergency powers, in part because of recognition that emergency powers legislation was inadequate. Nevertheless, there is still a need for a latent capacity to rapidly make new temporary statutory provision where this is the most effective way of enabling the resolution of an emergency situation.

Part B

Operational considerations – Generic Standard Operating Procedure

Background

7B.1 **Part B Operational considerations** provides good practice advice to assist Fire and Rescue Services to carry out emergency operations at incidents involving hazardous materials. It is structured around the:

- response phases of an emergency incident, common to all Fire and Rescue Service operations
- operational key principles, the critical 'must do's' or 'should do's' for the Fire and Rescue Service to ensure firefighter safety and inter-operability.

7B.2 This operational guidance follows a chronological timeline through a typical hazardous materials incident and builds into a generic standard operating procedure (G-SOP) comprising:

- Actions
- Considerations.

7B.3 The G-SOP is intentionally generic in nature because it is intended as a series of check-lists of considerations, rather than a set of rules that must be strictly adhered to.

7B.4 This approach has been taken to recognise local differences across the Fire and Rescue Service in terms of risk profiles and levels of resources. Services with limited capability for research and development may choose to adopt the procedures with few amendments. Whilst larger organisations with greater resources and a more complex risk profile may simply use them as foundation stones to ensure inter-operability at cross border or large scale incidents. However, it must be stressed that both approaches should be supported by full local risk assessments.

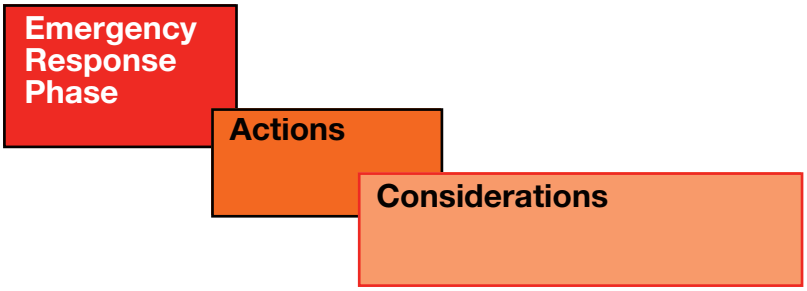
7B.5 The G-SOP has been formulated by bringing together existing 'good practice' from Fire and Rescue Services throughout the United Kingdom. This 'good practice' has been heavily influenced over the years by the hazardous materials training courses provided by the Fire Service College in Moreton-in-Marsh, and the Scottish Fire Services College, Gullane. International operational guidance has also been considered, particularly that used in the United States of America, Canada and Mexico (eg *National Fire Protection Association's standard 472 for Professional Competence of Responders to Hazardous Materials Incidents, Hazardous Waste Operations and Emergency Response regulations* etc).

7B.6 The G-SOP also reflects the hazards and control measures detailed within the relevant Fire and Rescue Service generic risk assessments.

7B.7 It is deliberately written concisely and in an easy to navigate, colour coded format so that it can be used as a quick reference guide for operational staff, an aide memoir containing the most critical information is contained in Section 8, Appendix A. Where further more detailed explanations or technical information is needed it will be found in Part C, Technical considerations.

7B.8 Each phase of operations is broken down into more detailed hazardous materials – specific guidance grouped together under 'actions'. These are not meant to be compulsory steps at every incident, but rather a check-list that should be considered by staff, particularly those with command responsibilities.

7B.9 'Actions' are subdivided into 'Considerations'. Again, these form a toolbox of good practice options rather than mandatory procedures.

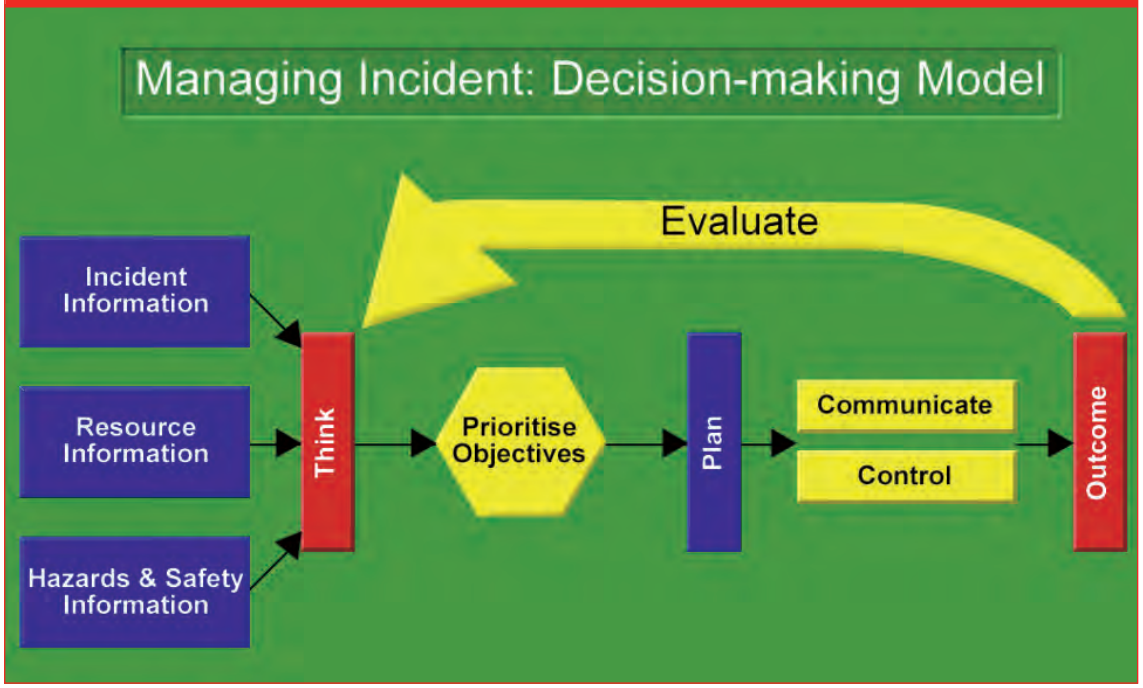


Command and control at hazardous materials incidents

7B.10 Guidance on command and control at incidents is contained within the *Fire and Rescue Manual, Volume 2 Fire Service Operations, Incident Command*. The incident command system described in the manual should be used at all hazardous material incidents.

7B.11 The processes associated with the command and control of serious operational incidents are complex and detailed. A great deal of work has been done to assist Incident Commanders, and others charged with operational responsibilities, to understand the cognitive and emotional processes that occur at such times. However, such processes are not a tool. In the search for a device to practically assist commanders in the discharge of their responsibilities, experienced officers have reported the value they have derived from the *Decision Making Model* developed by the London Fire Brigade. This is a cyclical process control model which may assist commanders in achieving their operational objectives at hazardous materials incidents. The full explanatory note can be found in Appendix 4, of the *Fire and Rescue Manual, Volume 2, Fire Service Operations, Incident Command.*

Figure 1: Decision making model developed by the London Fire Brigade



7B.12 The Fire and Rescue Service Incident Commander has the responsibility for controlling the Service's resources and operations at the scene. They must ensure that the operational risk philosophy is implemented at the scene.

Operational key principle

Operational risk philosophy:

- The benefits of proceeding with a task must be weighed carefully against the risks
- It is important to think before you act, rather than, act before you think.

7B.13 All Fire and Rescue Service staff attending hazardous materials incidents must strictly adhere to the 'line of command' principle within the incident command system.

Operational key principle

Line of command principle:

- All commanders must know who they are responsible for
- All staff must know who they report to
- All staff must know what their operational brief is.

The incident command system relies upon a single unified command line. With the exception of urgent safety related issues staff should not take control of operations outside their assigned responsibility and should ensure all information and instruction is passed via the relevant command line officers.

This will enhance scene safety by ensuring that staff and crews do not, under any circumstances, 'self-deploy' to hazardous areas at hazardous materials incidents.

Fire and Rescue Service hazardous materials responders – Key levels

7B.14 The three key levels of Fire and Rescue Service hazardous materials responder are:

Firefighter

As defined in the Emergency Fire Service Rolemaps. The skills, knowledge and understanding referred to in the generic standard operating procedure (G-SOP) relate to a 'competent' firefighter.

Commander

Generic term for all 'Operational' (Bronze) and 'Tactical' (Silver) Fire and Rescue Service command roles designated within the incident command system. 'Strategic' (Gold) command issues are not detailed within the G-SOP as it is an on-site operational and tactical guide.

Hazardous Materials Adviser

Generic term for any person, with enhanced knowledge of hazardous materials operations, used by a Fire and Rescue Service to provide specialist advice to the Incident Commander at emergency incidents involving hazardous materials. This level of responder includes such roles as the Hazardous Materials Officer, Hazardous Material and Environmental Protection Officer, Scientific Adviser, Chemical, Biological, Radiological, Nuclear and Explosive Subject Matter Advisor 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 the development of a hazardous materials tactical response plan

NOTE: At an incident where National Resilience DIM (detection, identification and monitoring) teams are deployed the Hazardous Materials Adviser will act as the link from the DIM team to the Incident Commander. It should also be noted that at a CBRN(E) event, a CBRN(E) Subject Matter Advisor, when mobilised, will be responsible for advising the Incident Commander on the development of the tactical response plan.

Generic standard operating procedure (G-SOP) – Overview

Operational key principle

Operations risk management

On-site Fire and Rescue Service emergency operations should always be based on structured, standardised and risk assessed safe systems of work. These are commonly known as standard operating procedures. All good standard operating procedures allow flexibility, within defined boundaries, so that competent staff can use professional judgement to choose the most appropriate procedures and tactics when faced with unique, or rapidly developing, emergency situations. This controlled but dynamic management of risk must always have firefighter safety at its core, whilst acknowledging that a professional, highly trained emergency service will be exposed to some controlled risk to achieve the community's expectations. Any residual risk at emergency incidents must be kept as low as reasonably practicable.

7B.15 The critical success factors in the first hour of a hazardous materials incident will typically be the ability of responders to:

- identify hazards in order to effectively carry out a risk assessment, possibly under considerable pressure and with limited and/or incomplete information
- recognise that the incident involves hazardous materials, especially if they have not been mobilised specifically to a hazardous materials incident

NOTE:
Responders should also be aware that what may appear to be a hazardous materials incident initially, maybe a CBRN(E) event

- gain control of the incident ground, identify the problem and separate responders and the public from it
- establish command and control
- stabilise the situation.

7B.16 The G-SOP described in the following paragraphs details the operational and tactical functions to be evaluated and possibly implemented at incidents involving hazardous materials to achieve these success factors and then go on to resolve the incident in the most safe, effective and efficient manner.

7B.17 This G-SOP should be viewed as a flexible guide and not a set of rigid rules. Individual Fire and Rescue Services should decide what works best for them in terms of the level of detail their organisation requires. They should then design training and development programmes that incorporate their specific equipment, risks and resources.

7B.18 **Assumptions behind the G-SOP:**

- All staff attending the incident are competent to do so, or are properly supervised
- Predetermined attendances are suitable and sufficient for the safe operation of the G-SOP
- The G-SOP consists of 'actions' and 'considerations', not all actions must be followed at every incident, but they should be considered
- Emergency response phases are generic and do not equate to strict time-lines. In particular Phases 3 (Planning), 4 (Implementing) and 5 (Evaluating) should be cyclical at complex incidents. Evaluation should be a continual process when circumstances or risks are changing. This is shown in the Emergency Incident Phase Cycle diagram
- Actions and considerations are not necessarily sequential, or indeed mandatory
- Actions will often occur simultaneously or in a different order to the G-SOP depending on the incident dynamics
- G-SOP should be used as an 'enabling guide' or 'toolbox' of possible approaches rather than a prescriptive list of 'should-do's'
- The Incident Commander will decide which actions and considerations are appropriate for the incident and also their priority
- Local risk assessment by the Fire and Rescue Service as the 'employer' is still required
- G-SOP covers all of the control measures raised in the relevant national generic risk assessments.

7B.19 The G-SOP offers several benefits as it:

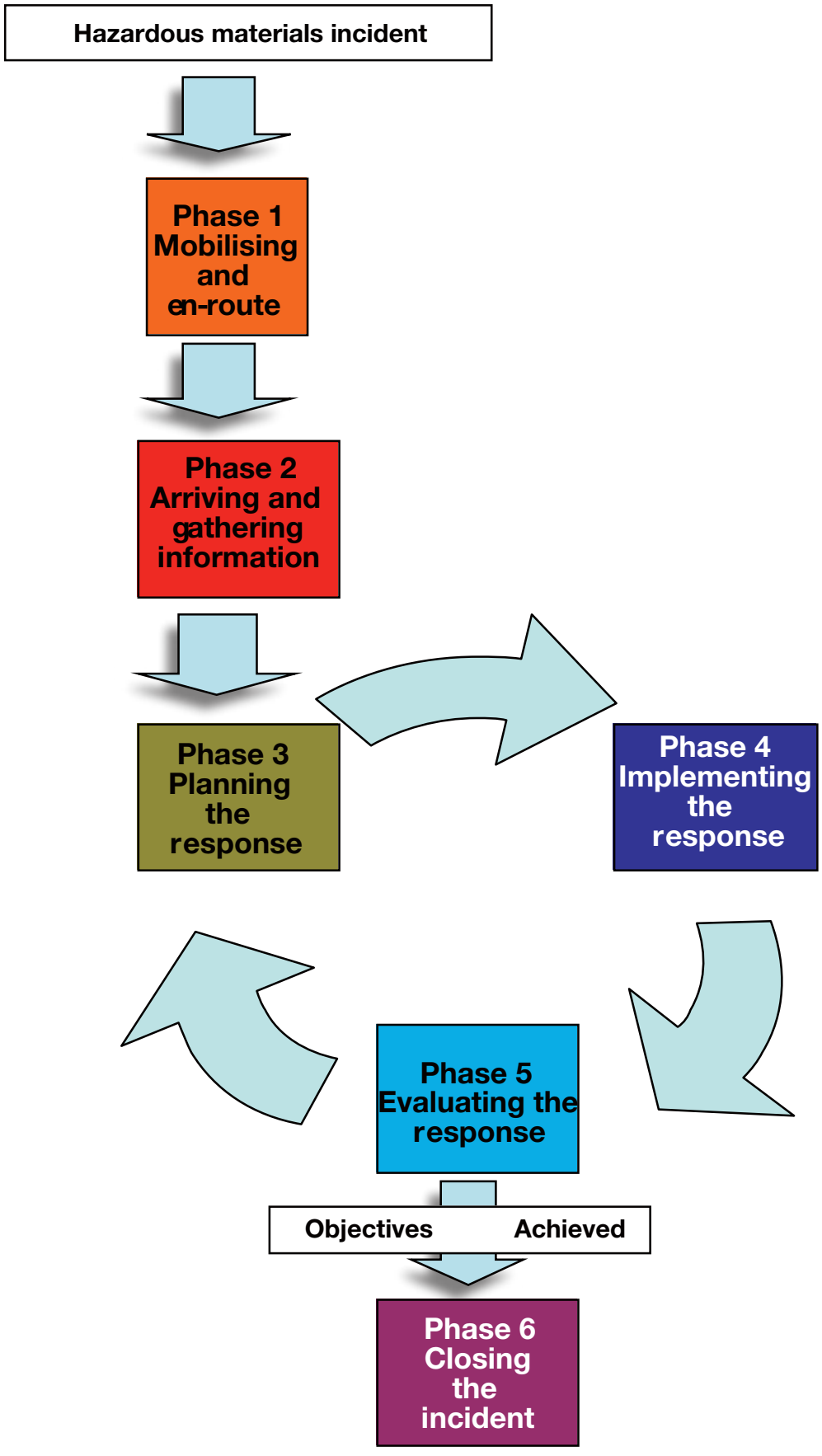
- recognises that the majority of hazardous materials incidents are minor in nature and generally involve limited quantities of harmful substances
- provides a flexible management system that expands as the scope and magnitude of the incident grows
- provides a consistent management structure, regardless of the classes of hazardous materials involved.

7B.20 It should be regarded as the minimum safe level of operational procedure to maintain the safety of staff and ensure inter-operability in critical areas of emergency operations. Where risk-critical issues exist, operational key principles have been developed and highlighted. These are distinguished in the text by red text boxes. Fire and Rescue Services are advised to consider such guidance as the 'highest priority' guidance.

7B.21 There are six basic response phases that should be considered at all emergency incidents:

1	*Mobilising and en-route*
2	*Arriving and gathering information*
3	*Planning the response*
4	*Implementing the response*
5	*Evaluating the response*
6	*Closing the incident*

Emergency incident phase cycle



Summary of phases and actions

Phase 1 Mobilising and en-route	
1.1	Assess the level, scale and type of incident
1.2	Mobilise appropriate resources to the incident, marshalling areas or predetermined rendezvous points
1.3	Access incident specific information en-route
1.4	Notify relevant agencies
Phase 2 Arriving and gathering information	• **Incident information** • **Resource information** • **Hazard and safety information**
2.1	Approach the incident safely and estimate the potential hazard zone
2.2	Recognise hazards and risks from a safe location and implement an initial cordon
2.3	Liaise with persons on and off-site
2.4	Consider the immediate life risk (**NOTE:** Immediate life risk = immediate human life saving rescues; immediate evacuation to prevent serious injury; prevention of catastrophic escalation likely to endanger life)
2.5	Identify the problem and the likely impact
2.6	Estimate the resource requirements (**NOTE:** make-up if necessary)
2.7	Implement the incident command system
Phase 3 Planning the response	• **Think** • **Prioritise objectives** • **Plan**
3.1	Identify the objectives
3.2	Develop a response plan with specialist advisers and other agencies
3.3	Identify the level and type of personal protective equipment required
3.4	Identify effective decontamination procedures

Phase 4 Implementing the response		• **Communicate** • **Control**
4.1	Review and monitor cordons to control access at the scene	
4.2	Communicate and control the response plan	
4.3	Establish and operate decontamination	
4.4	Implement deliberate reconnaissance to gather further information	
4.5	Implement effective firefighting, containment and pollution control techniques	
4.6	Work with people and agencies that may provide additional advice and assistance	
Phase 5 Evaluating the Response		• **Evaluate the outcome**
5.1	Evaluate the effectiveness of the response	
5.2	Adjust the response plan if necessary	
Phase 6 Closing the incident		
6.1	Close down Fire and Rescue Service operations	
6.2	Hand-over control of the incident site	
6.3	Facilitate incident debriefs	
6.4	Anticipate post incident considerations	

7B.22 It is sometimes useful to see the emergency incident response phases in the context of the typical stages of an incident referred to in the incident command system and the Fire Service guide – 'Dynamic management of risk at operational incidents', this is shown below.

Stages of an incident (Dynamic management of risk)	Incident command system decision making model links	Generic – Standard Operating Procedure Response Phases
		1 Mobilising and en-route
Initial Stage	• Incident information • Resource information • Hazard and safety information	2 Arriving and gathering information
Development Stage	• Think • Prioritise objectives • Plan	3 Planning the response
	• Communicate • Control	4 Implementing the response
	• Evaluate the outcome	5 Evaluating the response
Closing Stage		6 Closing the incident

7B.23 The operational and tactical guidance contained in this document has been developed to deal primarily with accidental hazardous materials incidents. However, the guidance is essentially equally applicable to deliberate, malicious or terrorist events. This said, it must be stressed that terrorist or CBRN(E) events do require a more specific response due to:

- increased security measures
- increased risks to Fire and Rescue Service staff
- complexity of multi-agency working
- potential for secondary devices
- potential for perpetrators to pick virulent agents that are both persistent and difficult to identify
- potential to conceal the identity and/or remove and/or replace signage and material information
- potential to pick locations that exploit the characteristics of the agent
- need to exchange information with off site intelligence and scientific advisers.

7B.24 Section 7 Part C-17 provides a brief overview of CBRN(E) considerations and signposts the guidance produced by the National Resilience Assurance Team.

Phase 1: Mobilising and en-route

Emergency incident response phases

Phase 1	**Mobilising and en-route**
Phase 2	**Arriving and gathering information**
Phase 3	**Planning the response**
Phase 4	**Implementing the response**
Phase 5	**Evaluating the response**
Phase 6	**Closing the incident**

Summary of actions and considerations whilst mobilising and en-route to a hazardous materials incident

DEFINITION:

The activation and continuous process of deployment and management of staff and resources including emergency call handling, turning-out and travelling to the emergency.

Phase 1: Mobilising and en-route summary	
1.1	**Assess the level, scale and type of incident**
a)	Gather information from caller
b)	Match incident details to site-specific pre-determined attendances, operational plans, multi-agency plans etc
c)	Implement 'major incident' plan, if necessary.
1.2	**Mobilise appropriate resources to the incident, marshalling areas or predetermined rendezvous points**
a)	Consider use of pre-planned marshalling sites or rendezvous points for significant known hazardous materials risks/sites
b)	Utilise Firemet and supply information to responders
c)	Consider mobilising to up-wind rendezvous points for significant incidents
d)	Mobilise resources according to incident type, scale and location
e)	Mobilise enhanced resources for 'major incidents'
f)	Mobilise enhanced resources to known CBRN(E) events.

1.3	Access Incident specific information en-route
a)	Responders should request information on, and begin to think about, the likely hazards and control measures when mobilised to known substances and hazardous materials sites
b)	Access site specific risk inspection information
c)	Request and use weather information (eg FireMet)
d)	Assess and review marshalling/rendezvous point arrangements.
1.4	**Notify relevant agencies**
a)	Request assistance or resources from other agencies and/or organisations
b)	Notify other agencies and/or organisations for their information in line with Fire Service protocols.

Phase 1 Mobilising and en-route
Action
1.1 Assess the level, scale and type of incident
Considerations
(1.1a) Gather information from caller
• Where is the incident? Is it at a known risk or target/sensitive site/occupancy?
• Is there a site-specific plan for the location?
• Are hazardous materials involved? If unsure, are hazardous materials found or used at the location?
• What quantity is involved?
• Are there reports of any unusual odours, explosions or other unusual reactions?
• Are there any injuries or casualties? Are the causes/reasons known? **NOTE:** STEP 1-2-3
• Are other emergency services in attendance/involved?

STEP 1 – 2 – 3

'STEP 1-2-3' – Safety Triggers for Emergency Personnel:

- STEP 1 – Single casualty, no logical explanation or cause – deploy as for normal collapsed casualty
- STEP 2 – Two casualties, no logical explanation or cause – tell crews to approach with caution and send full informative and CHALETS information ASAP
- STEP 3 – Three or more casualties, no logical explanation – should trigger crews not to go to scene

NOTE: Unless there is identified saveable life and a dynamic risk assessment has been undertaken, designate/ascertain a safe rendezvous point for further resources and Command and Control, CHALETS information must be provided.

NOTE: An additional flow chart explaining STEP 1-2-3 and CHALETS is explained in Arriving and gathering information 2.1d

(1.1b) Match incident details to site specific predetermined attendances, operational plans, multi-agency plans etc

- Mobilising control staff and systems should be able to quickly and accurately match the information given by callers to site specific predetermined attendances, hazardous materials specific operational plans and hazardous materials related multi-agency plans
- The weight and scale of attendance should reflect the foreseeable risks posed by (a) the type of incident and (b) the site/location of the incident
- Develop a range of generic predetermined attendances for different types of hazardous materials incidents (eg small release in the open; large release in the open; small release within buildings; large release within buildings etc)
- Sites known to contain significant hazardous materials risks should have specific predetermined attendances based on, for example, the risk to human life; quantity and type of hazardous materials; processes carried out; risk of escalation; location in relation to inhabited areas and critical infrastructure etc.

(1.1c) Implement 'major incident' plan, if necessary

Fire and Rescue Services should have plans in place to deal with 'major incidents'. These should include guidance to all staff, including those responsible for mobilising, on the triggers for implementing the plans.

Action
1.2 Mobilise appropriate resources to the incident, marshalling areas or predetermined rendezvous points
Considerations
(1.2a) Consider use of pre-planned marshalling sites or rendezvous points for significant known hazardous materials risks/sites Fire and Rescue Services should develop pre-planned marshalling sites or rendezvous points for their significant hazardous materials risks. This should form part of their overall integrated risk management planning process. Where rendezvous points are designated within the possible initial cordoning distances for the substances that could be involved in an accident or release, responders must be made aware of this and a number of alternative rendezvous points should be planned so that an up wind one can be used. **NOTE:** At CBRN(E) events Services should be alert to the possibility of secondary terrorist devices being planted at known rendezvous points.
(1.2b) Utilise weather information (eg Firemet) and supply information to responders Mobilising controls should have protocols in place so that they can quickly access Firemet information. Basic information such as wind speed and direction should be used when mobilising the Fire and Rescue Service response. Possible uses: • Selection of up wind rendezvous points • Selection of up wind access routes • Adding weather information to turn-out instructions • Responding quickly to requests for weather information from Fire and Rescue Service staff.
(1.2c) Consider mobilising to up wind rendezvous points for significant incidents Pre-planned rendezvous points are usually in 'safe' areas a considerable distance away from any potential accident sites. However, this may not always be the case especially in highly built-up or industrialised areas. In such cases pre-planning may have identified a number of rendezvous points to take account of differing wind directions. If mobilising control staff believe, from the information given by the caller, that the incident may be of significant severity they should always mobilise resources to the up wind rendezvous points. Information on the wind direction can be gained through Firemet or by asking the caller.

(1.2d) Mobilise resources according to incident type, scale and location

Consider:

- 'Foreseeable risks' when mobilising, not 'imaginable risks' but react to a rapidly escalating incident (eg multiple calls, multiple casualties etc)
- Enhance predetermined attendances where known site-specific hazardous materials risks exist

  NOTE: Decontamination equipment, environmental protection equipment, competence of responders etc
- Early notification of hazardous materials advisers and other specialists. These may be needed at the mobilising centre as well as on-site
- Media/press officer or department for significant incidents or high profile sites
- Equipment/incident support department (eg specialist decontamination equipment).

(1.2e) Mobilise enhanced resources for 'major incidents'

Fire and Rescue Services should have triggers in place for implementing a 'major incident' procedure. This will involve additional mobilisations of Fire and Rescue Service's resources and resources from other agencies.

(1.2f) Mobilise enhanced resources to known CBRN(E) events

CBRN(E) events are by their nature extremely complex incidents. The National Resilience resources that Fire and Rescue Services need to deal with them are strategically located across the UK. CBRN(E) mobilising procedures should be based upon the *Mass Decontamination Mobilising Model Guidance Document*, developed and issued by the National Resilience *CBRN(E) Capability* in National Resilience Information Note 14/2011 (6 May 2011).

Action
1.3 Access incident specific information en-route
Considerations
(1.3a) Responders should request information on, and begin to think about, the likely hazards and control measures when mobilised to known substances and hazardous materials sites Consider: • Potential life risk, need for evacuation or other protective measures • Likelihood of explosion and fire-risk • Substance and hazard information provided by the mobilising centre or mobile data terminal • Communication with hazardous materials specialists • Geographical location and topography **NOTE:** Containment, water courses etc • Potential quantities involved • Physical properties (eg liquid, gas, vapour, dust/particulate, explosive limits etc) • Initial cordon distance.
(1.3b) Access site-specific risk inspection information Consider information from: • 7(2)(d) inspections • Fire Safety assessments **NOTE:** Health and Safety Executive reports, DESEAR, MSER, enforcement notices, prohibition notices etc • Notification and marking of sites (NAMOS) inspections and information • Notification of installations handling hazardous substances (NIHHS) information • British agrochemical standards inspection scheme (BASIS) inspections and pre-plans • Asbestos register • Significant control of substances hazardous to health (COSHH) assessments • Control of major accident hazards (COMAH) plans and information • CBRN(E) site-specific plans • Local resilience forum plans **NOTE:** Community Risk Register information • Partner agencies (eg Environment Agency hold site-specific information through the issuing of their permits etc.)

(1.3c) Request and use weather information (eg FireMet)

Consider:

- Approach from **UPWIND** direction

Operational key principle

Approaching hazardous materials incidents:

- Hazardous materials incidents should always be approached from the upwind direction. This reduces the risk of unprotected crews being exposed to airborne hazardous materials (eg gases, vapours, particulates etc)
- If possible the incident should also be approached from a higher ground level or up-slope. This is particularly important if the hazardous are in a liquid state.

- Wind strength and its effect on the initial cordon
- Ambient temperature and its effect on the physical properties of substances
- Downwind, dilution, obstacle, oscillation and retention (DDOOR) guidance on vapour cloud behaviour in urban areas
- Limitations of FireMet data. Always check the wind direction when approaching the incident location.

DDOOR

Acronym: DDOOR – stands for downwind, dilution, obstacle, oscillation and retention. It serves to highlight key factors to remember when dealing with a hazardous release in an urban environment[1]. In particular the effect that the built environment and the wind can have on a dispersion plume. Operational commanders and hazardous materials advisers should consider these factors when developing their risk assessment and response plan for dealing with a hazardous material incident within an urban area.

- **D**ownwind – the largest part of the plume moves downwind, and becomes wider and higher
- **D**ilution – the gas/vapour dilutes as it mixes with the air around it: the concentrations decrease downwind and at the sides and top of the plume
- **O**bstacles – the movement of the plume is strongly influenced by obstacles such as buildings and other structures. Some parts of the plume go up and over the buildings; some parts zigzag along the streets in the downwind direction. The plume may quickly fill street 'canyons'

  NOTE: Some parts of the plume spread upwind.
- **O**scillation – the plume will oscillate; its position and course will not remain constant but will vary over time. It will follow different routes downwind often in response to minor changes in environmental factors
- **R**etention – some parts of the plume can be retained, and gradually released later, even after the source has been dealt with.

1 For further information see the DDOOR DVD (Rex Britter, Home Office, 2007).

(1.3d) Assess and review marshalling/rendezvous points arrangements

Consider:

- Pre-planned marshalling locations – Are they safe and appropriate for the incident in question?
- Pre-planned control of major accident hazards (COMAH) and other site-specific rendezvous points – Are they safe and appropriate for the incident in question?
- Pre-planned tactical and strategic holding areas for CBRN(E) or other 'major incidents'
- Separate rendezvous points should be identified for specialist mass decontamination resources
- Designate marshalling area(s) en-route and inform oncoming responders

NOTE: Potential for escalation, weather changes, explosions etc.

Action
1.4 Notify relevant agencies
Considerations

(1.4a) Request assistance or resources from other agencies and/or organisations

Consider:

- Mutual aid schemes and specialist responders (eg Chemsafe, Radsafe, Chloraid, Bromaid etc)
- Environment Agency (eg environmental protection equipment)
- Local authorities
- Private hazardous material waste disposal and clean-up contractors
- Government Decontamination Service.

(1.4b) Notify other agencies and/or organisations for their information in line with Fire Service protocols

Consider informing:

- Police
- Ambulance
- Local authority (eg Environmental Health, Highways etc)
- Environment Agency
- Water companies
- Health Protection Agency
- Maritime Coastguard Agency
- Emergency Planning officer/department
- Local Resilience Forum coordinator
- Mutual aid schemes and specialist responders (eg Chemsafe, Radsafe, Chloraid, Bromaid etc).

Phase 2: Arriving and gathering information

Emergency incident response phases

Phase 1	**Mobilising and en-route**
Phase 2	**Arriving and gathering information**
Phase 3	**Planning the response**
Phase 4	**Implementing the response**
Phase 5	**Evaluating the response**
Phase 6	**Closing the incident**

Summary of actions whilst arriving and gathering information at a hazardous materials incident

DEFINITION:

The structured and safe attendance of staff and resources at the incident or rendezvous point, and the systematic process of obtaining and interpreting information; carrying out risk assessments and prioritising emergency action.

Phase 2 **Arriving and gathering information summary**	• Incident information • Resource information • Hazard and safety information
2.1	**Approach the incident safely and estimate the potential hazard zone**
a)	Use weather information (eg FireMet) and visual indicators of wind strength and direction (eg wind blown tree foliage etc) to plan your approach to the incident from the upwind direction so that crews are not exposed to hazardous vapours or gases
b)	If possible and safe to do so without additional personal protective equipment, approach the incident from higher ground (ie up-slope) especially if hazardous liquids are known to be present
c)	Ensure response vehicles approach the vicinity of the incident at slow speed
d)	When approaching the vicinity of the incident use senses to assess 'incident-indicators' to assist in estimating the extent of the hazard zone
e)	Estimate the potential hazard zone, and position staff and vehicles outside it
f)	Establish command/contact point in a safe location.

2.2	**Recognise hazards and risks from a safe location and implement an initial cordon**
a)	Identify the potential of the hazardous materials to cause harm to people by inhalation, ingestion, direct skin contact, absorption through the skin or eyes or entry through cuts and grazes
b)	Identify the potential of the hazardous materials to cause harm to property and the environment
c)	Recognise any additional hazards and risks
d)	Establish an initial cordon.
2.3	**Liaise with persons on and off-site**
a)	Gather information about the emergency or accident from witnesses
b)	Liaise with other persons/agencies to gain specific knowledge about the event, substance, site, process, treatment of casualties or containment system.
2.4	**Consider the immediate life risk** **NOTE: Immediate life risk = immediate human life saving rescues; immediate evacuation to prevent serious injury; prevention of catastrophic escalation likely to endanger life.**
a)	Assess any immediate life-saving rescues NOTE: STEP 1-2-3
b)	Consider effective control measures
c)	Carry out rescues
d)	Assess the need for any immediate evacuation and/or identify places of relative safety
e)	Assess the likelihood of a catastrophe occurring.
2.5	**Identify the problem and the likely impact**
a)	Carry out full survey of the site
b)	Retrieve and interpret hazard and incident information
c)	Assess the condition of damaged hazardous materials containment systems
d)	Predict the likely behaviour of the hazardous materials involved
e)	Estimate the size of the endangered area
f)	Estimate the potential harm/impact
g)	Review the position of the Initial cordon with regard to the information gathered and the predicted hazard zone.

2.6	**Estimate the resource requirements** **NOTE: Make-up, if necessary**
a)	Consider requesting Fire and Rescue Service assistance based on the information gathered and the actions already known to be required. Further assistance can be requested after the response plan has been formulated.
b)	Consider requesting assistance from non-Fire and Rescue Service organisations
c)	Consider declaring a 'major incident' which should mobilise significant Fire and Rescue Service and other agency resources.
2.7	**Implement the incident command system**
a)	Implement the operational risk philosophy
b)	Strictly implement 'line of command' principle within incident command system at all hazardous materials incidents
c)	Implement command support and ensure it is properly resourced
d)	Limit the Incident Commandr's spans of control
e)	Carry out effective and appropriate sectorisation
f)	Ensure that appropriately trained commanders operate in Bronze (Operational), Silver (Tactical) and Gold (Strategic) command roles if required, and use a recognised decision making model and recording system
g)	Adopt a multi-agency approach to incident resolution
h)	Designate a clean area with washing facilities for hydration and welfare.

Phase 2
Arriving and gathering information

Action

2.1 Approach the incident safely and establish the potential hazard zone

Considerations

(2.1a) Use weather information (eg Firemet) and visual indicators of wind strength and direction (eg wind blown tree foliage etc) to plan your approach to the incident from the UPWIND direction so that crews are not exposed to hazardous vapours, gases or particulates

- Use local knowledge of topography and mapping systems to choose the safest approach road
- Be aware of the limitations of Firemet and cross-check the information using visual indicators at the site
- Always bear in mind that wind strength and direction can change. So ensure staff and vehicles have clear, immediately available means of egress
- Remember built up urban environments may have the following gas cloud/plume dispersion characteristics (Acronym: DDOOR)
- Deploy improvised wind monitoring devices (eg tie a number of 1-2m lengths of traffic/fire tape to vertical objects or suitable portable Fire and Rescue Service' equipment such as lighting tripods)

- Remember, just because you cannot see it or smell it does not mean that it is not there.

DDOOR

Acronym: DDOOR – stands for downwind, dilution, obstacle, oscillation and retention. It serves to highlight key factors to remember when dealing with a hazardous release in an urban environment[2]. In particular the effect that the built environment and the wind can have on a dispersion plume. Operational commanders and hazardous materials advisers should consider these factors when developing their risk assessment and response plan for dealing with a hazardous material incident within an urban area.

- **D**ownwind – the largest part of the plume moves downwind, and becomes wider and higher
- **D**ilution – the gas/vapour dilutes as it mixes with the air around it: the concentrations decrease downwind and at the sides and top of the plume
- **O**bstacles – the movement of the plume is strongly influenced by obstacles such as buildings and other structures. Some parts of the plume go up and over the buildings; some parts zigzag along the streets in the downwind direction. The plume may quickly fill street 'canyons'

  NOTE: some parts of the plume spread upwind
- **O**scillation – the plume will oscillate; its position and course will not remain constant but will vary over time. It will follow different routes downwind often in response to minor changes in environmental factors
- **R**etention – some parts of the plume can be retained, and gradually released later, even after the source has been dealt with.

(2.1b) If possible and safe to do so without additional personal protective equipment, approach the incident from higher ground (ie up-slope) especially if hazardous liquids are known to be present

- It will not always be possible to approach a hazardous materials incident from higher ground and the upwind direction. Where it is not possible the safest approach route should be chosen based on the physical properties of the hazardous substance (eg liquids not vaporising or gassing-off – slope may be the most important factor; toxic gas release in windy conditions – wind direction will be the most important factor).

(2.1c) Ensure response vehicles approach the vicinity of the incident at slow speed

This will:

- Enable visual assessment of scene

  NOTE: plumes, liquid spills etc
- Reduce the probability of driving into a hazardous area
- Avoid collisions with casualties, people escaping the release and other members of the public who may be attracted to the incident.

2 For further information see the DDOOR DVD (Rex Britter, Home Office, 2007).

HAZARD ZONE

Hazard zone

- This is an area that contains hazards to which a risk assessment should be applied in order to determine a suitable inner cordon
- A hazard zone is not necessarily an 'exclusion zone' and would encompass both the 'hot' and 'warm' zones if they exist
- An exclusion zone is an area containing hazards that have been risk assessed as so dangerous to health that nobody, including Fire and Rescue Service staff, should be allowed to enter (eg blast area around explosives involved in fire)
- The hazard zone is sometimes referred to as the 'evacuation zone' by other agencies and generally means the area where they would seek to encourage all members of the public to leave or possibly shelter-in-place.

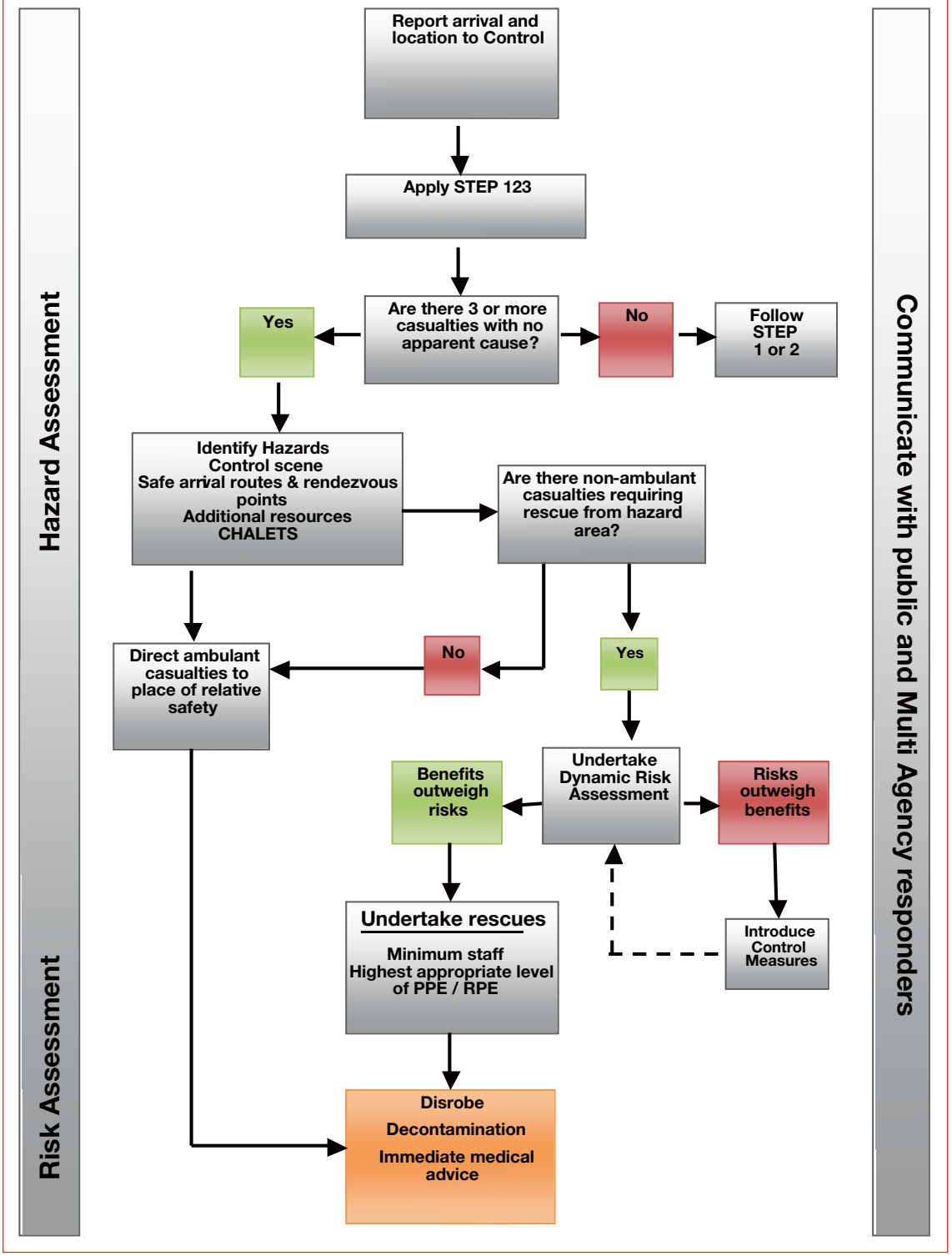
(2.1d) When approaching the vicinity of the incident use senses to assess the 'incident-indicators' to assist in estimating the extent of the hazard zone

Examples of 'incident-indicators':

- Gas and vapour clouds or plumes
- Visible smoke and other signs of fire
- Liquid spills, wet areas, patches, puddles, pools and streams/flowing liquids
- Unexplained noise (eg explosions, venting cylinders, site specific audible warnings etc) may indicate a more cautious approach and lager hazard zone
- Distinct odours (eg bleach, garlic, rotten cabbage, bad eggs etc.) If you can smell something out of place then you are probably too close
- Damaged containers and packages
- Biological indicators such as dead birds, animals, fish, insects, trees and vegetation
- Casualties and other 'involved people' may physically mark the hazard zone or they may be able to describe it based on their experience
- Remember the primary response protocol STEP 1-2-3 – Safety triggers for emergency personnel when the cause of harm to the casualties is unknown and there is no immediately apparent reason for their incapacity.

STEP 1 – 2 – 3	**'STEP 1-2-3' – Safety trigger for emergency personnel** • STEP 1 – Single casualty, no logical explanation or cause – deploy as for normal collapsed casualty • STEP 2 – Two casualties, no logical explanation or cause – tell crews to approach with caution and send full informative and CHALETS information ASAP • STEP 3 – Three or more casualties, no logical explanation – should trigger crews not to proceed, designate a safe rendezvous point for further resources and Command and Control. Park at a safe distance, following a risk assessment by the Incident Commander. Assess the scene and gather more information. Do not approach the casualties unless their lives are at risk and effective personal protective equipment is worn. CHALETS information must be provided. **NOTE:** See flow chart below.
• Complete CHALETS assessment as soon as possible.	
CHALETS	**'CHALETS' Assessment** • **C**asualties – Approximate number of casualties dead, injured, uninjured, number trapped • **H**azards – Present and potential • **A**ccess – Best access routes for emergency services and suitable provisional rendezvous point • **L**ocation – The exact location of the incident using map references if possible • **E**mergency – Emergency services present and required, consider attendance of hospital medical teams, specialist equipment and specialist services • **T**ype – The type of incident with brief details of types and numbers of vehicles, trains, buildings, aircraft involved • **S**afety – What personal protective clothing is required and ensure you are in a safe area.

Step 1-2-3 flow chart



(2.1e) Estimate the potential hazard zone, and position staff and vehicles outside it

- Incident Commanders should work to their standard operating procedures but when estimating the potential hazard zone, in relation to attending and parking at a 'no-notice' incident scene, they should consider the 'worst case foreseeable' not 'worst case imaginable'

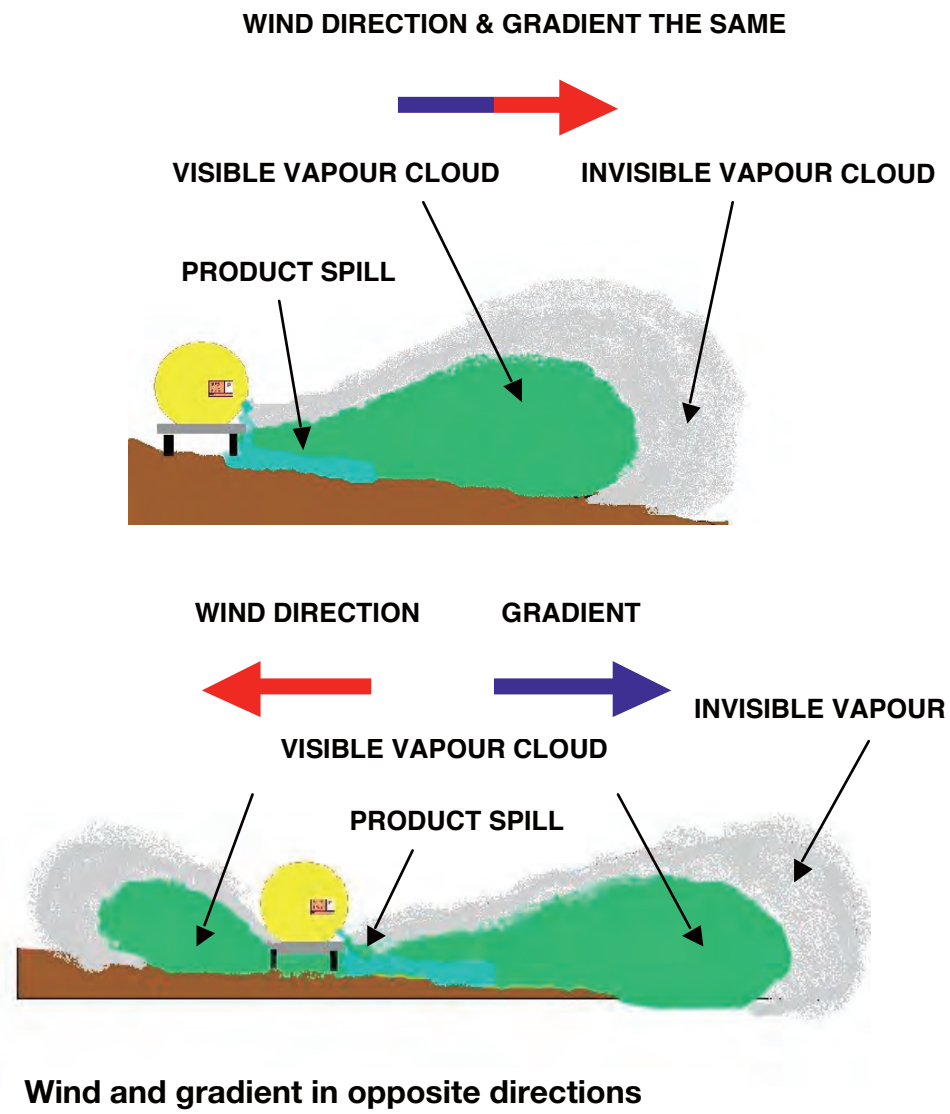
  NOTE: This is not the initial cordoning assessment but more about establishing a safe parking/marshalling point.

- At known hazardous materials risk sites 72(d) risk inspections and other pre-planning should have identified initial rendezvous points and/or marshalling sites.

(2.1f) Establish command/contact point in safe location

- Position command point vehicle in a safe area well outside the potential hazard zone to avoid re-positioning it during the incident
- Maintain contact with mobilising control
- Establish and maintain incident ground communications
- Begin recording incident and hazard information (eg staff and appliance details, substance information, analytical risk assessment etc).

Action
2.2 Recognise hazards and risks from a safe location and implement an initial cordon



Wind and gradient in opposite directions

Considerations	
CORDON CONTROL	**Cordon control** • Cordons are employed as an effective method of controlling resources and maintaining safety on the incident ground. They must be continuously monitored and adapted to reflect changes in hazards, weather etc • Cordons may be defined by a series of markers (eg cones, traffic tape, police, members of staff, etc) or a notional boundary (eg agreed line on a map, existing boundary lines or fences etc), where the boundary is not obvious it must be communicated to all responders • The Incident Commander must consider the safety of Fire and Rescue Service staff, the public, members of other emergency services and voluntary agencies attending incidents. However, it must be noted that overall responsibility for the health and safety of personnel working within cordons remains with the individual agencies. Such agencies should ensure that staff arriving at the site have effective personal protective equipment and are adequately trained and briefed for the work they are to undertake within the cordon. Where this is not the case the matter must be referred to the command level • At hazardous materials incidents strict cordon control is essential to manage the release and associated contamination issues. After the initial cordon has been established to secure and stabilise the site, the incident should be divided into two types of cordon – the inner and outer cordon. **Initial cordon** • It provides an initial means of controlling, safeguarding and coordinating the immediate response and adds an element of control to the incident. It must be flexible and be able to be moved if necessary. **Inner cordon** • The inner cordon surrounds the area where potentially hazardous activity may be conducted and encompasses both the 'hot' and 'warm' zones. It is used to control access to the immediate scene of operations. Access to the area controlled by an inner cordon, which by definition is the hazard zone, should be restricted to the minimum numbers required for work to be undertaken safely and effectively. **Outer cordon** • The outer cordon designates the controlled area into which unauthorised access is not permitted. It encompasses the inner cordon and the 'hot', 'warm' and 'cold' zones. It should be established and maintained by the police.

(2.2a) Identify the potential of the hazardous materials to cause harm to people by inhalation, ingestion, direct skin contact, absorption through the skin or eyes or entry through cuts and grazes

- Line before identify the hazards posed by the substance (eg toxic, corrosive, explosive etc)
- Identify how the substance could cause harm to people (eg inhalation, ingestion, direct skin contact, absorption through the skin or eyes or entry through cuts and grazes)
- Determine who is at risk
- Predict the likelihood of harm occurring
- Estimate the severity of the harm
- Identify or classify the hazardous materials by its hazards

  NOTE: This will be easier to do and more accurate with known substances rather than unknown or mixtures of substances
- Estimate the quantities involved and quantities present at the scene
- Recognise the hazardous material's physical properties

  NOTE: be aware of the limitations of using the senses to determine the presence of hazardous materials
- Identify the potential for chemical reactions (eg release of energy, heat, light, explosion etc)
- Identify the location of substance (eg inside or outside buildings, degree of packaging/containment, proximity to populated buildings etc)
- Ascertain the likelihood of containers rupturing if heated or subjected to an internal reaction
- Review the available pre-planning information, operational intelligence and 'incident-indicator' information to identify other significant hazards
- Identify typical occupancies and locations at the incident where hazardous materials are manufactured, transported, stored, used or disposed of
- Identify the primary hazards associated with the United Nations' hazard class and division of the hazardous materials present
- Identify and use transportation documents and material safety data sheets
- Recognise typical containers, and their hazards, generally used to store/transport hazardous materials (see Part C for further information – Transportation and storage section if necessary)
- Recognise typical hazardous materials packages by type (see Part C for further information)

- Identify site and transportation markings that indicate hazardous materials, including the markings, labels and placards provided under:
  - United Nations systems (United Nations hazard warning diamonds and United Nations numbers)
  - United Kingdom Hazard Identification System (UKHIS)
  - Registration, evaluation, authorisation and restriction of chemicals (REACH)
  - Globally harmonised system (GHS)
  - European Agreements concerning the International Carriage of Dangerous Goods by Road, by Rail and by Inland Waterways (ADR, RID or ADN)
  - International Maritime Dangerous Goods (IMDG) code
  - Air transport container markings
  - Biohazard package markings
  - Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP)
  - Classification, Labelling and Packaging of Substances and Mixtures (CLP) Regulations
  - Dangerous Substances (Notification and Marking of Sites) Regulations (NAMOS)
  - Military hazardous materials systems
  - Pipeline regulations

  NOTE: The Incident Commander and hazardous materials adviser should always consider the possibility of incorrect, inaccurate, missing or misleading information being gathered on the hazardous materials. Where ever possible 'triangulation of information' should be gained, this means trying to ensure that at least three sources are used to verify critical assumptions/decisions.

(2.2b) Identify the potential of the hazardous materials to cause harm to property and the environment

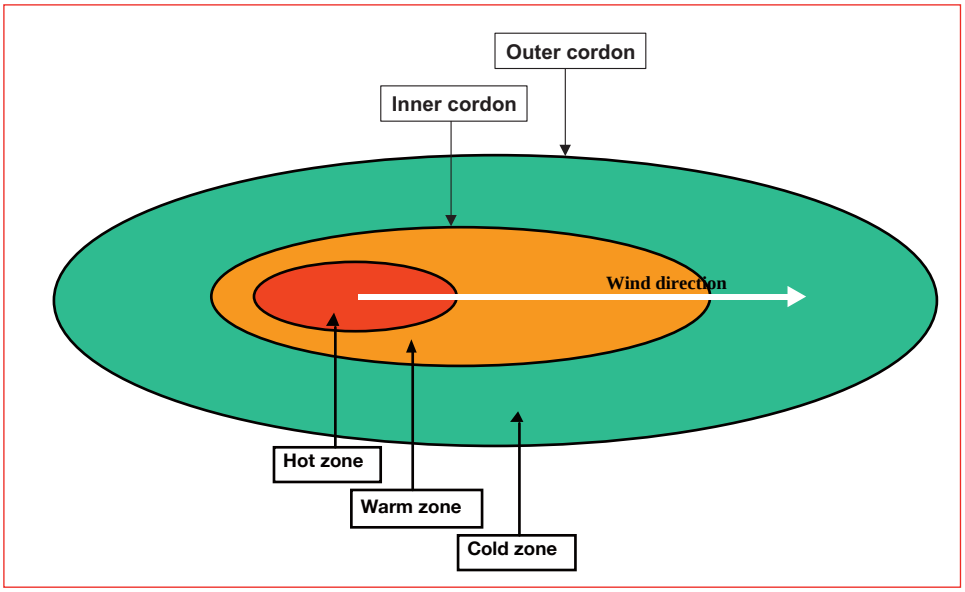
Consider:

- The proximity of drains and sewers and the presence/absence of any pollution control facilities
- Proximity and sensitivity of groundwater aquifers, rivers, reservoirs and other water sources used for drinking water and other uses
- Proximity to flora and fauna (eg environmental protected sites such as sites of special scientific interest)
- Fire and cooling run-off water, including fire fighting foam use. Are there firewater containment facilities available
- Soil contamination (eg Is there unmade ground?)
- Non-hazardous substances to humans which can damage specific environments (eg milk spillage running into fisheries etc).

(2.2c) Recognise any additional hazards

Consider:

- Fire, including actual and potential ignition sources
- Working at height
- Manual handling
- Heat exhaustion for staff wearing enhanced personal protective equipment
- Effects of fire, heating, cooling, water sprays etc on specialised hazardous materials containment systems
- Criminal or terrorist activity, including secondary devices.



HOT, WARM AND COLD ZONES

Hot zone

- This is the contaminated area(s) where the initial release occurs or disperses to. It will be the area likely to pose an immediate threat to the health and safety of all those located within it and is the area of greatest risk
- It is located within the inner cordon and is part of the hazard zone
- Effective personal protective equipment is required when working within the 'hot' zone. Each emergency service has differing specifications for personal protective equipment and will decide on the appropriateness of their own personal protective equipment. The effectiveness of each type of personal protective equipment for the 'hot' zone depends on the type and concentration of the contaminant. Any decisions made should be based on a hazard assessment
- There may be more than one area of release and therefore more than one 'hot' zone. Where possible all 'hot' zones should be encompassed within a single inner cordon. Where this is not possible for reasons such as scale, location, topography etc the establishment of two or more inner cordons should be considered. This may necessitate treating the cordoned areas as separate incidents with distinct command structures. This is potentially more likely at CBRN(E) events rather than hazardous materials incidents.

Warm zone

- This is the area uncontaminated by the initial release of a substance, which may become contaminated by the movement of people or vehicles
- It is surrounded by the inner cordon and is part of the hazard zone but usually contains lower risks than the 'hot' zone
- In the initial stages of an incident, the movement of contamination from the 'hot' zone to the warm zone will be uncontrolled. As soon as practicable, the warm zone will be managed and controlled by emergency responders wearing appropriate personal protective equipment
- The 'warm' zone will later be extended to include the managed area encompassing decontamination. This extended section of the 'warm' zone will be termed the decontamination area
- At small scale, low risk, low complexity hazardous materials incidents 'warm' zones may not exist. Responders should not designate them if there is no benefit from doing so.

Cold zone

- This is the uncontaminated area between the inner cordon and the outer cordon. It is the area within which key operational command positions and other essential activities will be set up.
- The Police Service, in liaison with the Fire and Rescue Service and the Ambulance Service, should decide whether members of the public need to be evacuated from the 'cold' zone. (See diagram opposite)

(2.2d) Establish an initial cordon

- The initial cordon is temporarily established by the first wave of unprotected emergency responders, before any detailed scene assessment or any other scientific analysis has been conducted. It provides an initial means of facilitating (controlling, safeguarding and coordinating) the immediate response and adds an element of control to the incident
- The initial cordon must be flexible and be able to be moved if necessary
- The initial cordon is an immediate precautionary measure and must be formed in a position of safety. Unprotected responders must never be deliberately deployed to a position where 'contamination' is suspected. However, it should be considered as enclosing a 'potential hazard' zone rather than an 'exclusion' zone. Only responders who have been briefed and equipped to deal with the hazards should be allowed to operate within it. Certain extremely high-risk incidents will require the establishment of an 'exclusion' zone in addition to the initial cordon (eg explosives involved in fire etc)
- Given the limited number of resources available in the early stages, it may be impracticable to position cordon staff around the entire 360° of the event. Commanders should initially aim, as far as practicable, to create an arc of containment of 90° either side of the upwind meridian. This is essential to protect responders and to prevent decontamination areas from being compromised by either the release or contaminated casualties
- Where the hazardous materials involved are toxic by inhalation it may be necessary to extend the initial cordon in the downwind direction to protect people from vapours, gases or dusts (**NOTE:** solids/liquids which produce toxic gases upon contact with water). The initial cordon should enclose the area in which persons may become incapacitated and unable to take protective action and/or incur serious or irreversible acute health effects. Areas where non-acute or possibly longer-term health risks may be present should be designated and dealt with by the Health Protection Agency.
- The initial cordon must be communicated to all first responders especially on-coming response vehicle drivers
- Use generic initial cordon distances as a basis for further risk assessment (eg Chemdata initial isolation distances, *Emergency Response Guidebook, IAEA Manual for first responders to a Radiological Emergency, Manufacture and Storage of Explosives Regs.* etc)
- Public Safety Hazard – An 'E' following the first two characters of an emergency action code (EAC) indicates that there may be an public safety hazard outside the immediate area of the incident, and that the following actions should be considered:
  - People should be warned to stay indoors with all doors and windows closed, preferable in upstairs rooms facing away from the incident. They should eliminate all ignition sources and stop any ventilation
  - Effects may spread beyond the immediate vicinity. All non-essential staff should be instructed to move at least 250m away from the incident
  - Police and Fire and Rescue Service Incident Commanders should consult with each other and with a product expert or a source of product expertise
  - The possible need for subsequent public evacuation should be considered, **but it should be remembered in most cases it will be safer to remain in a building than to evacuate.**

GENERIC INITIAL CORDON DISTANCES

NOTE: Continuous risk assessment should be carried out to ensure that the cordon remains appropriate and proportionate to the risks identified by the Incident Commander.	
Incident type (if known)	**Initial cordon distance** (metres radius)
Explosives – manufacture, storage, transport (**NOTE:** Pre-planning for known sites should include rendezvous points at safe distances) (see Part C-4)	100m for transport incident HD 1.4 200m for transport incident HD 1.3 600m transport HD 1.1, HD 1.2 and HD 1.5 (or when HD is not known) 100m for registered premises (fireworks only) 200m for incidents at other registered premises 600m for incidents involving licensed storage (under 2000kg) 1000m for incidents involving licensed storage (more than 2000kg)
Explosives – CBRN(E), terrorist (*Consider no Fire and Rescue Service attendance or treat as EXCLUSION distances for Fire and Rescue Service staff, take guidance from police and explosive ordnance specialists)	100m for an activated device Unexploded devices:* 100m for a suitcase size device 200m for a car size device 400m for a lorry (or when size of device is not known)
Cylinders involved in fire **NOTE:** shielding may reduce distances (see Part C-5)	Fireball up to 25m Cylinder may be thrown up to 150m Flying fragments up to 200m
Chemical or biological	Due to the diverse range of incidents likely to be encountered it is not possible to set a single initial cordon distance.
Radiation (see Part C-10)	**Outside buildings** 45m – unshielded or damaged potentially dangerous source 100m – Major spill from a potentially dangerous source 300m – fire, explosion or fumes involving a potentially dangerous source 400m or more to protect against an explosion – Suspected bomb (exploded or unexploded) **Inside buildings** Affected and adjacent areas (including the floor above and below) – Damage, loss of shielding or spill of a potentially dangerous source Entire building and outside distances detailed above – fire or other event that can spread a potentially dangerous source materials throughout the building (eg through the ventilation system).

Operational key principle	**Explosives known to be involved in fire** If explosives are known to be involved in fire then Initial Cordon distances should be treated as exclusion zones (ie nobody, including Fire and Rescue Service staff, allowed within the cordon).

Action
2.3 Liaise with persons on and off site
Considerations
(2.3a) Gather information about the emergency or accident from witnesses Consider: • Site staff • Driver • Eye witnesses (members of public) • Document/record information gained from witnesses.
(2.3b) Liaise with other persons/agencies to gain specific knowledge about the event, substance, site, process, treatment of casualties or containment system Consider: • Fire and Rescue Service hazardous materials adviser • Detection, identification and monitoring (DIM) advisers • Fire and Rescue Service CBRN(E) subject matter advisors • Independent scientific advisers • Site experts or technical advisers • National Chemical Emergency Centre • Chemical industry emergency responders and mutual aid schemes (eg Chemsafe, Radsafe, Chloraid, Bromaid etc) • Environment Agency staff • Water undertakers representatives • Health Protection Agency officers • Port or harbour authorities • Other emergency services and specialist military assets (eg EOD etc) • Site and company experts/technical advisers • Local authority emergency planning departments and local resilience forums **NOTE:** Ascertain information on any relevant history of problems, failures, releases, similar events etc.

Action
2.4 Consider the immediate life risk **NOTE: 'Immediate life risk' means – immediate human life saving rescues; immediate evacuation to prevent serious injury; prevention of catastrophic escalation likely to endanger life.**
Considerations
(2.4a) Assess any immediate life-saving rescues (NOTE: STEP 1-2-3) Consider: • Number, location and degree of entrapment of casualties • Whether conscious, unconscious, obviously dead • Likelihood/degree of contamination of casualties • Ability to survive if not rescued immediately • Known or apparent hazards from the emergency/accident • Known or apparent physical properties of the hazardous materials • Apparent fire/explosion risk • Additional hazards (eg mechanical processes, manual handling, working at height etc) **NOTE:** STEP 1-2-3.
(2.4b) Consider effective control measures • Incident Commander should survey the area around the casualties and take regard of any emergency action codes and additional personal protection codes (see Part C-3, Transportation, packaging and supply of hazardous materials, for further information) • Structural firefighting kit, gloves, fire-hood and self-contained breathing apparatus should be the minimum level of personal protective equipment • Use higher levels of chemical personal protective equipment if substance is obviously hazardous, the likelihood of contamination is high; and/or the time taken to rig is proportionate to the casualty's condition/survivability • Approach from up-wind and up-slope whenever possible • Avoid or minimise contact with hazardous materials • Minimise exposure time in the hazard zone • Designate the safest access route to minimise the probability of contaminating the rescuers • Effective decontamination and safe undressing procedures for the rescuers (see Part C-15, Decontamination, for further information)

- Improvised, interim or clinical decontamination for the casualties (see Part C-15, Decontamination, for further information)
- Use minimum number of rescuers, if possible limit the number of rescuers directly contacting any hazardous materials or casualties
- Incident Commander must give a specific safety brief to the rescuers detailing the:
  - likely hazards
  - actions to be taken
  - safe access and egress routes
  - time limit of deployment
  - team leader and lead rescuer
  - location of inner cordon and casualty hand-over area
  - decontamination/safe undressing procedure.
- If there are unacceptable risks, delay rescues until the hazards are controlled possibly by increased level of personal protective equipment.

(2.4c) Carry out rescues

Immediate life-saving rescues should be carried out if benefits outweigh the risk of harm to the rescuers.

(2.4d) Assess the need for any immediate evacuation

- Identify the inner cordon and the numbers of people (a) already exposed (b) potentially at risk
- Consider the realistic potential for the hazardous materials to spread whilst the response plan is being implemented

  NOTE: Dangers from the hazardous materials; weather conditions; physical properties; rates of dispersion; potential risk of escalation/explosion etc
- Assess 'sheltering in place' as an alternative to evacuation, factors:
  - health risks posed by the hazardous materials
  - size of the affected area
  - construction of buildings
  - time of day
  - number/condition/age of occupants
  - weather conditions
  - availability of safe and suitable accommodation
  - availability of responders
  - numbers of staff and other agencies required to carry out the evacuation

- risk to responders carrying out the evacuation

  NOTE: Respiratory personal equipment and personal protective equipment

- communicating the evacuation (eg fixed alarm system, responders with megaphones, door knocking, avoiding panic, radio and TV announcements etc)
- safe holding area required for members of the public being evacuated or dispersal plan.

(2.4e) Assess the likelihood of a catastrophe occurring

Consider:

- Multiple casualties or fatalities on arrival
- Large scale fire or explosion(s) threatening populated areas, or, safety critical systems, storage or processing units
- Imminent large scale explosion, fire or hazardous materials release into a populated area
- Imminent large scale release into sensitive environments (eg drinking water sources, etc)
- Declare 'major incident' if necessary.

Action
2.5 Identify the problem and the likely impact
Considerations

(2.5a) Carry out full survey of the incident ground

- Joint survey with the 'responsible person'
- Access, or carry out, a full hazardous materials inventory of the incident ground (ie find out what hazardous materials are there and what's actually involved or likely to be involved)
- Locate where the release(s) is coming from
- Identify site containment information (eg drainage, sewerage, interceptors etc)
- Draw up/acquire a site layout plan and annotate with all relevant information
- Identify if deliberate reconnaissance within the inner cordon is necessary, if it is it will need to feature in the response plan.

(2.5b) Retrieve and interpret hazard and incident information

Possible sources include:

- Emergency Response Guidebook
- Placarding and signage eg:
  - United Nations hazard warning labels

  - United Kingdom Hazard Information System
  - European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)
  - European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)
  - The European Agreement concerning the International Carriage of Dangerous Goods by Road and by Rail (ADR/RID)
  - Chemicals (Hazard Information and Packaging for Supply) Regulations 2009 (CHIP)
  - Classification Labelling Pancaking (CLP)
  - Notification and Marking of Sites (NAMOS)
  - International Maritime Dangerous Goods code, etc
- Dangerous Goods Emergency Action Code
- Technical reference databases, manuals, hazardous materials lists and other sources (eg Chemdata, Cirus etc)
- Scientific support and technical information specialists (eg Scientific advisers, DSTL, County Chemists, Bureau Veritas etc)
- Specific emergency response agencies (eg Chemsafe, Radsafe, Chloraid, Bromaid, NAIR, Health Protection Agency-poisons)
- Fire and Rescue Service Detection, Identification and Monitoring teams
- Material safety data sheets (MSDS)
- EH40 Workplace Exposure Limits
- Transportation documents
- Hazchem Emergency Response Service (HERS).

(2.5c) Assess the condition of damaged hazardous materials containment systems

Consider:

- Construction and operation of road, rail and other transport containers
- Construction and use of fixed storage tanks
- Construction and operation of intermediate bulk containers
- Pressurised containers are inherently higher risk than non-pressurised
- Type of stressors involved (eg direct flame impingement, heat, cold, chemical, mechanical, shock, friction etc)
- Ability of the container to tolerate the stresses upon it
- Identify if deliberate reconnaissance within the inner cordon is necessary, if it is it will need to feature in the response plan.

(2.5d) Predict the likely behaviour of the hazardous materials involved

- The more complex the incident, the higher the level of knowledge required to perform this task
- Consult product and process specialists

Consider:

- Physical and chemical properties
- Quantity, concentration, release rate and surface area
- Weather/ambient conditions
- Fire/explosion risk
- Topography and site layout (eg slopes, spacing of tanks)
- Method of containment
- Will containment system cope?
- Beware mixtures of hazardous materials
- Combinations of additional hazards.

(2.5e) Estimate the size of the endangered area

- The more complex the incident, the higher the level of knowledge required to perform this task
- Consult product and process specialists
- Predict dispersal pattern

  NOTE: Downwind, dilution, obstacle, oscillation and retention (DDOOR) guidance in urban areas; Chemet plume predictions; high risk sites may have fixed or transportable monitoring equipment; Environment Agency provide a mobile air monitoring response service etc
- Quantity, concentration, release rate and surface area
- Weather, likelihood of change
- Fire/explosion risk
- Emergency Response Guidebook and Chemdata guidance

  NOTE: Isolation distances for significant releases
- Identify the hazard zone.

(2.5f) Estimate the potential harm/impact

- The more complex the incident, the higher the level of knowledge required to perform this task
- Consult product and process specialists
- Worst case foreseeable not worst case imaginable

- Determine:
  - Who will be affected and what will happen to them?
  - What property will be damaged or lost and how will this affect production, services and transportation?
  - How will the land and air be affected?
  - How will the water resources be affected?

    NOTE: Consider both drinking water/other abstractions and impact on fisheries/aquatic and fauna and flora
  - How long will the emergency last?
  - How long will it take to recover from the incident?
  - Can the financial cost be estimated?
- Explosion hazards
- Fire/flammable hazards
- Cryogenic hazards
- Water reactive hazards
- Other chemical reactive hazards (eg oxidisation, toxicity, corrosivity)
- Biological hazards
- Radiological hazards

  NOTE: Contamination and irradiation risks
- Asphyxiant hazards
- Carcinogenic hazards
- Mechanical hazards
- Electrical hazards
- Physical and ergonomical hazards
- Contamination – casualties, responders, property and the environment
- Secondary contamination
- Acute and chronic effects of substances
- Environmental toxicity/persistence.

(2.5g) Review the position of the initial cordon with regard to the information gathered and the predicted hazard zone

- Is the cordon too close due to changing weather conditions, escalation of the emergency/accident and/or greater knowledge of the hazards?
- Is the cordon too far away? This may be because; the initial cordon was 'precautionary' and further information has been gathered; the call was a false alarm; the 'responsible persons' or other agencies have dealt with the emergency/accident etc
- Only move the cordon at this stage if safety is compromised.

Action
2.6 Estimate the resource requirements
Considerations
(2.6a) Consider requesting Fire and Rescue Service assistance based on the information gathered and the actions already known to be required. Further assistance can be requested after the response plan has been formulated. Consider: • Numbers of casualties/rescues **NOTE:** Mass decontamination • Scene safety and safety officers • Cordoning and possible evacuation • Need for specialist hazardous materials advice • Future need for deliberate reconnaissance. Estimate: • Number of firefighters required • Number and level of command roles required • Number and level of hazardous materials specialists • Additional personal protective equipment requirements • Type and amount of decontamination equipment and competent staff **NOTE:** NRAT *Mass Decontamination Mobilising Model Guidance* document • Amount of firefighting foam • Type and amount of neutralising agent, absorbent, over-size containers, drain seals and other pollution control equipment held by Fire and Rescue Services • Detection, identification and monitoring units required?
(2.6b) Consider requesting assistance from non Fire and Rescue Service organisations Consider: • Police for outer cordoning requirements **NOTE:** Inner cordon at CBRN(E) events • Specialist hazardous materials, scientific or process advice • Environment Agency and Water / Sewerage Undertakers • Risk to public health (eg local authority environmental health department, Health Protection Agency etc)

- Industry led response/advice schemes (eg Chemsafe, Radsafe, Chloraid, NAIR etc)
- Specialist waste disposal assistance

  NOTE: Ensure this is requested through the consigner/owner/occupier or responsible authority so that the Fire and Rescue Service does not become liable for the costs
- Type and amount of neutralising agent, absorbent, chemical containers, other pollution control equipment.

(2.6c) Consider declaring a 'major incident' which should mobilise significant Fire and Rescue Service and other agency resources

Individual Fire and Rescue Services should assess their local risks in conjunction with their local resilience forum partners to develop appropriate and proportionate 'major incident' triggers and procedures.

Action
2.7 Implement the incident command system
Considerations
(2.7a) Implement the operational risk philosophy
Operational key principle **Operational risk philosophy** • The benefits of proceeding with a task must be weighed carefully against the risks • It is important to think before you act, rather than, act before you think.
(2.7b) Strictly implement 'line of command' principle within incident command system at all hazardous materials incidents
Operational key principle **Line of command principle** • All commanders must know who they are responsible for • All staff must know who they report to • All staff must know what their operational brief is. The incident command system relies upon a single unified command line. With the exception of urgent safety related issues staff should not take control of operations outside their assigned responsibility and should ensure all information and instruction is passed via the relevant command line officers.

(2.7c) Implement command support and ensure it is properly resourced

- Accurate information exchange and communication is required between command support and the mobilising centre
- Good incident ground communications are essential

  NOTE: Multi-agency communications (eg Airwave interoperable channels etc)
- Maintain accurate records of all staff in the 'cold', 'warm' and 'hot' zones as well as any exposure to hazardous materials.

(2.7d) Limit the Incident Commander's spans of control

- The span of control for tactical command roles should be as narrow as possible
- Limit to a maximum of five lines of direct communications
- Reduce lines of direct communication to three or four in high-risk, complex, significant or developing situations.

(2.7e) Carry out effective and appropriate sectorisation

- Ensure the degree of sectorisation is appropriate to the size and complexity of the incident
- Incidents are best managed if they are kept as simple as possible
- Beware of over complicating simple hazardous materials incidents or under sectorising complex incidents
- Limiting spans of control to ensure the close monitoring of staff and safety, is the key to effective sectorisation and delegation of responsibility
- Significant hazardous materials incidents are more likely to require the following functional or support sectors:

  Marshalling

  NOTE: Must be pre-planned for known risks – level 3

  Hazardous materials information

  NOTE: Designate responsibility for collating and interpreting information to a dedicated competent person possibly supported by a team, remember it may be necessary to have an off-scene hazardous materials specialist as well as on-scene

  Decontamination

  NOTE: Mass decontamination sector(s)

  Logistics

  NOTE: Chemical protective clothing requirements, high turn-over and fatigue of breathing apparatus wearers, decontamination resources

  Welfare

  NOTE: Operating in chemical protective clothing will increase fatigue and dehydration

Press liaison

NOTE: Evacuation/shelter-in-place warnings, increased need for public reassurance

Safety

NOTE: Ensure each working sector has a nominated safety officer with the necessary level of hazardous materials competence, at a large incident these may be coordinated through a safety sector.

(2.7f) Ensure that appropriately trained commanders operate in Bronze (Operational), Silver (Tactical) and Gold (Strategic) command roles if required, and use a recognised decision making model

Further comprehensive guidance on the Fire and Rescue Service incident command system is contained in the *Fire and Rescue Manual, Volume 2 – Fire Service Operations, Incident Command, 3rd edition 2008*.

(2.7g) Adopt a multi-agency approach to incident resolution

Fire and Rescue Services should work with their local resilience forum partners to develop, test and exercise multi-agency protocols.

(2.7h) Designate a clean area with washing facilities for hydration and welfare

- Ensure there is clear separation from operational areas/sectors
- Designate a welfare officer supported by a team where necessary
- Designate staff to monitor hand-washing and other basic hygiene requirements
- Consider multi-agency collaboration
- If no clean area can be established then no eating, drinking etc should be allowed on-site as a precaution against the risk of accidentally ingesting hazardous materials.

Phase 3: Planning the response

Emergency incident response phases

Phase 1	**Mobilising and en-route**
Phase 2	**Arriving and gathering information**
Phase 3	**Planning the response**
Phase 4	**Implementing the response**
Phase 5	**Evaluating the response**
Phase 6	**Closing the incident**

Summary of actions and considerations whilst planning the response to a hazardous materials incident

DEFINITION:

The systematic process of agreeing response objectives, risk assessing options and developing a sequence of actions, based on a safe system of work, to favourably change the situation.

Phase 3 Planning the response summary	• Think • Prioritise objectives • Plan
3.1	**Identify the objectives**
a)	Identify any on-going risks to people from the hazardous materials following the initial assessment (ie those not controlled during the reactive period of the incident) **Set any human rescues as a critical-priority objective**
b)	Identify any fires or fire risks. Set firefighting as a high-priority objective due to the Fire and Rescue Service's responsibilities under the *Fire and Rescue Services Act 2004*
c)	Identify property that can be saved and also property that is already lost
d)	Identify the extent of environmental harm and the potential for intervention
e)	Agree and prioritise the objectives in consultation with the relevant agencies/people.

3.2	Develop a response plan with specialist advisers and other agencies
a)	Identify the options to achieve the objectives
b)	Risk assess the options and select the best course of action
c)	Develop the response plan
d)	Identify the tactical mode
e)	Ensure there is sign-up to the response plan from other emergency services, other statutory authorities, responsible persons, site operators, land owners, specialist commercial responders, waste contractors, local resilience forum, military etc where this practicable.
3.3	**Identify the level and type of personal protective equipment required**
a)	Assess the tasks and associated hazards
b)	Select the most effective personal protective equipment
c	Select the most appropriate/capable staff.
3.4	**Identify effective decontamination procedures**
a)	Establish the responsibilities of the Fire and Rescue Service for decontamination
b)	Assess the hazards posed by the hazardous materials, the site and the tasks being carried out, then select the most effective type of decontamination
c)	Identify the resources and procedures required for decontamination
d)	Identify procedures and precautions to deal with any decontamination run-off to prevent or minimise environmental pollution.

Phase 3 Planning the response	
Action	
3.1	**Identify the objectives**
Considerations	

(3.1a) Identify any on-going risks to people from the hazardous materials following the initial assessment (ie those not controlled during the reactive period of the incident). Set any human rescues as a critical priority objective

- Are all persons accounted for?
- Are Initial cordons in place and effective?
- Has everyone been evacuated within the hot and warm zones?
- Review any decision to ask people to shelter in place
- What can be achieved with current levels of Fire and Rescue Service resources
- What can be achieved with additional Fire and Rescue Service and specialist resources.

(3.1b) Identify any fires or fire risks. Set firefighting as a high-priority objective due to the Fire and Rescue Service's responsibilities under the Fire and Rescue Services Act 2004

Consider:

- Extinguish fire if safe to do so
- Cool and protect exposure risks
- Protect un-ignited fire risks and control ignition sources
- Control water run-off
- Current levels of Fire and Rescue Service resources
- Additional Fire and Rescue Service and specialist resources.

(3.1c) Identify property that can be saved and also property that is already lost

Consider:

- Current levels of Fire and Rescue Service resources
- Additional Fire and Rescue Service and specialist resources
- Cost of interventions.

(3.1d) Identify the extent of environmental harm and the potential for intervention

Consider:

- Proximity of drains and sewers and the presence/absence of any pollution control facilities
- Proximity and sensitivity of groundwater aquifer, rivers, reservoirs and other water sources used for drinking water and other uses
- Proximity to flora and fauna
- Proximity of national parks, sites of special scientific interest, conservation areas and other protected sites
- Soil contamination and recovery periods
- Hierarchy of pollution control (Part C-16)
- Costs of interventions

  NOTE: Liaise with Environment Agency, water company and site operator if cooperative over cost recovery from the polluter.

(3.1e) Agree and prioritise the objectives in consultation with the relevant agencies/people

Consider:

- Achieving the best result for the most people
- Fire and Rescue Service hazardous materials adviser's assessment
- Responsible authorities' priorities
- Owners/occupiers' priorities
- Consigners priorities.

Action	
3.2	**Develop a response plan with specialist advisers and other agencies**

Considerations

(3.2a) Identify the options to achieve the objectives

- Use multi-agency approach to identify all options to achieve the objectives and resolve the incident, unless there are time-critical priorities
- For known hazardous materials risk sites, always consider implementing the pre-planned response but check it is relevant to the specific objectives
- **NOTE:** There will usually be more than one way to resolve the incident, that is:
  - Do nothing – always consider this option with regard to Fire and Rescue Service involvement especially if the risks to responders are high. Ask the questions – Is it an emergency? Is it the Fire and Rescue Service's responsibility? Should the 'responsible person', organisation or authority employ a specialist contractor?
  - Defensive containment – ie, Can the incident be resolved without committing staff to the hazard zone? eg valving-down, remote isolation, controlled burn etc
  - Offensive action – ie, proactive containment, leak sealing, decanting, dilution, etc.

(3.2b) Risk assess the options and select the best course of action

Consider:

- Identify the significant hazards
- Determine who is at risk
- Predict the likelihood of harm occurring
- Estimate the severity of the harm
- Choose the option that appears to deliver the most benefit for the least risk/cost.

(3.2c) Develop the response plan

Develop a sequence of actions with risk control measures appropriate to the complexity of the incident, consider:

- Scene assessment, control and management
- Rescues, evacuation/shelter in place
- Emergency control of any release, spill or leak
- Deliberate reconnaissance
- Mass decontamination
- Release, spill or leak containment
- Environmental protection
- Investigation and evidence gathering
- Responder decontamination
- Fire and Rescue Service equipment cleaning/removal
- Hand-over and Fire and Rescue Service closure
- Clean-up.

Ensure the response plan covers both on-site and off-site actions if the scale warrants it:

- Identify people and agencies that may provide additional advice and assistance
- Agree on-site accountability
- Agree off-site accountability

  NOTE: Mutual aid, secondary notifications, press releases, recovery tasks, etc)
- Establish protective actions for the public (ie shelter-in-place v evacuation)
- Inner cordon ('hot' and 'warm' zones)
- Outer cordon ('cold' zone)
- Casualty assessment and treatment
- Rest centres for evacuees
- Responder welfare
- Operational level hazard control measures
  (see 'actions' below for level of personal protective equipment and decontamination)
- Tactical level hazard control measures
- Environmental protection action and pollution control
- Environmental monitoring
- Agree a public information and notification strategy and who is responsible for leading and coordinating it

- Law enforcement, on-scene security and potential crime scene issues (eg evidence collection and handling etc)
- Minimise disruption to the community
- Record the plan and the rationale behind it

  NOTE: Complete the incident command system analytical risk assessment
- Traffic control.

(3.2d) Identify the tactical mode

Consider:

- Offensive
- Defensive
- Transitional.

(3.2e) Ensure there is sign-up to the response plan from other emergency services, other statutory authorities, responsible persons, site operators, land owners, specialist commercial responders, waste contractors, local resilience forum, military etc, where this is practicable

- If necessary, due to the scale of the emergency, seek acceptance of the plan from Strategic Coordinating Group (Gold) and/or Fire Gold Command
- Agree protocols for dealing with major or significant incidents through local resilience forums.

Action	
3.3	**Identify the level and type of personal protective equipment required**

Considerations

(3.3a) Assess the tasks and associated hazards

- Physical properties (eg vapour, liquid, solid etc)
- Will the physical properties change and affect the contamination of the responders? (eg changes in ambient temperatures – if gas tight suit wearers move from a very cold environment into a warm one, condensation may occur leading to a liquid hazard rather than a vapour)
- Concentration, temperature or potency of the hazardous materials
- Degree of contact with the hazardous materials
- Duration of contact with the hazardous materials
- Complexity of the tasks
- Degree of strength, physical effort required
- Likelihood of heat stress

- Manual handling risks
- Working at height risks
- Working conditions
  (eg hot/cold, light/dark, in the open/in a building, firm/level ground versus slippery/uneven ground etc).

(3.3b) Select the most effective personal protective equipment

Consider:

- Dust/particle masks or respirators and eye protection
- Powered respirator protective suits
- Self contained breathing apparatus
- Structural firefighting kit
- Chemical resistant gauntlets
- Splash suits
- Liquid tight suits
- Gas tight suits.

(see Part C-14, for further information.)

(3.3c) Select the most appropriate/capable staff

Consider:

- Competence in hazardous materials operations
- Experience in hazardous materials operations
- Size (eg entry into confined spaces etc)
- Physical condition and suitability for required operations/personal protective equipment

  NOTE: All staff selected to operate in enhanced personal protective equipment should be trained in its use and limitations.

Action	
3.4	**Identify effective decontamination procedures**
Considerations	

DECONTAMINATION

Contamination

- Contamination occurs when a substance adheres or is deposited on people, equipment or the environment, thereby, creating a risk of *exposure* and possible injury or harm. **NOTE:** Contamination does not automatically lead to *exposure* but may do
- Alpha, beta and gamma emissions in themselves cannot cause contamination, although the actual source materials may be able to depending on their physical properties and their containment.

Decontamination

- Decontamination is the physical and/or chemical process of reducing contamination to minimise the risk of further harm occurring and to minimise the risk of cross contamination to a level as low as reasonably practicable. (**NOTE:** It can be started by the disrobing of clothing.)

Exposure

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 (**NOTE:** Radioactive exposure does not automatically mean you are contaminated).

Firefighter decontamination

- Is the use of decontamination equipment in a planned and structured manner to minimise the risk of further harm occurring and cross contamination to a level as low as reasonably practicable. Firefighter decontamination may be divided into two categories, 'initial' and 'full'. These procedures usually involve two processes. Firstly, 'contamination reduction' and then 'safe undressing'.

Mass decontamination

- Is the planned and structured procedure delivered by the Fire and Rescue Service using purpose designed decontamination equipment where there are large numbers of contaminated casualties.

Improvised decontamination

- Is the use of an immediately available method of decontamination prior to the use of specialist resources.

DECONTAMINATION

Interim decontamination

- Is the use of standard equipment to provide a planned and structured decontamination process prior to the availability of purpose designed decontamination equipment.

Clinical decontamination

- Is the process where contaminated casualties are treated individually by trained healthcare professionals using purpose designed decontamination equipment.

(3.4a) Establish the responsibilities of the Fire and Rescue Service for decontamination

- Firefighter decontamination is always a requirement for the Incident Commander where contamination is reasonably believed to have occurred
- Decontamination of the general public is a Health Service responsibility, usually carried out by the ambulance service at emergency incidents. When the ambulance services' resources are unable to cope with the number of casualties, mass decontamination should be carried out by the Fire and Rescue Service

  NOTE: Improvised or interim decontamination in the initial stages whilst mass decontamination is being established may produce a more positive patient outcome
- Clinical decontamination is the process where contaminated casualties are treated individually by trained healthcare professionals using purpose designed decontamination equipment
- Non-firefighter responder decontamination (ie ambulance service, police, military etc) should be the responsibility of the respective employer, however, in certain emergency situations the Fire and Rescue Service may carry out this function.

Operational key principle

Availability of decontamination

- Fire and Rescue Service staff must never be committed to 'hot' or 'warm' zones without decontamination being available
- The scale, level and complexity of the decontamination set-up will depend on the Incident Commander's risk assessment but must be based on standard operating procedures.

(3.4b) Assess the hazards posed by the hazardous materials, the scene and the tasks being carried out, then select the most effective type of decontamination

Consider:

- Physical properties
- Risk (likelihood and severity) of potential harm to affected staff
- Degree of contamination of staff (eg the team leader may need less decontamination if he/she supervised the work and did not come into contact with the substance)

- Initial firefighter decontamination as opposed to full firefighter decontamination

NOTE:
Review the advantages and the limitations

- Topography of scene
- Drainage or the natural containment of the scene (eg Where will run-off drain too, or can/should run-off be contained on scene?)
- Decontamination methods:
  - physical
  - chemical.
- Firefighter decontamination (primary decontamination) initial or full depending on risk and scale of incident
- For CBRN(E) events, the Ambulance Service must be consulted on the most effective form of decontamination.

Operational key principle

Decontamination

- The outcome of decontamination is, as a minimum, to lower risk of harm/cross-contamination to an acceptable level, that is, as low as reasonably practicable
- It is not always possible to totally remove the contaminant or clean the personal protective equipment on-site.

(3.4c) Identify the resources and procedures required for decontamination

- Cordoning and location of decontamination zone in relation to the 'hot' and 'warm' zones
- Control of staff waiting to be decontaminated and the location of the holding area
- Communication with staff in the decontamination zone
- Resource management:
  - staff
  - supervision/accountability (Decontamination Officer/Sector Commander; Assistant Decontamination Officer; Decontamination BAECO etc)
  - personal protective equipment
  - respiratory protective equipment
  - ancillary equipment
  - water and cleaning agents
  - maintenance of equipment
  - management of personal effects

  NOTE: The police will be responsible for personal effects at a CBRN(E) event.

(3.4d) Identify procedures and precautions to deal with any decontamination run-off to prevent or minimise environmental pollution

Further information on environmental protection is contained in Part C-16 Environmental protection and the *Fire and Rescue Manual – Environmental Protection.*

Further detail can also be found in the *Contaminated Water Protocol V2.0* developed by the Environment Agency, Water UK and CFOA.

Phase 4: Implementing the response

Emergency incident response phases

Phase 1	Mobilising and en-route
Phase 2	Arriving and gathering information
Phase 3	Planning the response
Phase 4	Implementing the response
Phase 5	Evaluating the response
Phase 6	Closing the incident

Summary of actions and considerations whilst implementing the response to a hazardous materials incident

DEFINITION:

Taking action to improve the situation and achieve the objectives consistent with the response plan and standard operating procedures.

Phase 4 Implementing the response summary	• Communicate • Control
4.1	**Review and monitor cordons to control access at the scene**
a) Establish and monitor the inner cordon b) Ensure that an outer cordon is established c) Establish a clear path to the decontamination area from the 'hot' zone ensuring that the 'warm' zone is extended as necessary to encompass it.	
4.2	**Communicate and control the response plan**
a) Use the incident command system to effectively manage Fire and Rescue Service resources on-site b) Ensure the communications systems are in place and are effective c) Nominate Safety Officers d) Ensure all responders are briefed by their commanders on the response plan e) Designate clean areas with washing facilities for staff hydration and welfare f) Communicate with the local community to ensure public safety and reduce anxiety/ concern.	
4.3	**Establish and operate decontamination**
a) Establish and operate decontamination for Fire and Rescue Service staff b) Establish and operate mass decontamination **NOTE:** consider improvised or interim decontamination whilst mass decontamination is being set up c) Establish decontamination for other agencies.	
4.4	**Implement deliberate reconnaissance to gather further information**
a) Select, protect and brief the reconnaissance team b) Carry out deliberate reconnaissance c) Analyse reconnaissance information and amend the response plan if necessary.	
4.5	**Implement effective firefighting, containment and pollution control techniques**
a) Control or extinguish fires b) Carry out 'defensive' hazardous materials containment actions (ie the risk outweighs the benefit of committing staff within the Inner Cordon to control the release) c) Carry out 'offensive' hazardous materials containment actions d) Work with the responsible agencies to control pollution from the scene e) Ensure that all emergency actions are within the realm of reasonable response.	
4.6	**Work with people and agencies that may provide additional advice and assistance**
a) Work with people and agencies identified in Phase 3 – 'Planning the Response' that may provide additional advice and assistance. b) At protracted incidents consider implementing health surveillance of staff.	

Phase 4 Implementing the response	
Action	
4.1	**Review and monitor cordons to control access at the scene**
Considerations	

(4.1a) Establish and monitor the inner cordon

- Review the position and effectiveness of the initial cordon and define the inner cordon
- Designate the 'hot' zone and ensure staff required to work in, or adjacent to, it know its boundaries, hazards and decontamination procedures
- Designate the 'warm' zone and ensure staff required to work in, or adjacent to, it know its boundaries, hazards and decontamination procedures
- Carry out any remaining rescue or evacuation of people within the inner cordon
- Control the inner cordon for all agencies on-site, except where a crime is suspected (eg CBRN(E) events) when the police will assume this responsibility
- Establish 'gateways' through the inner cordon for Fire and Rescue Service staff

  NOTE: Other emergency services should establish their own entry procedures
- Ensure that staff entering the 'warm' zone:
  - have the correct personal protective equipment
  - are given a safety brief on the hazards, boundaries, emergency procedures and control measures
  - understand their task(s)
  - know where the decontamination area is and what procedures are to be used.

(4.1b) Ensure that an outer cordon is established

- Liaise with the police or site controller/owner over the Fire and Rescue Service requirements within the 'cold' zone (eg appliance positioning, command support facilities, welfare/hydration area, mass decontamination resources, detection, identification and monitoring unit plus support, urban search and rescue etc)
- Ensure the police establish, monitor and enforce the outer cordon
- Communicate the location and entry point(s) to the 'cold' zone to all staff.

(4.1c) Establish a clear path to the decontamination area from the 'hot' zone ensuring that the 'warm' zone is extended as necessary to encompass it

- The decontamination area is the area containing the emergency services' decontamination equipment/structures. It is a suitable area initially established outside the inner cordon, at first uncontaminated by the initial release, which becomes contaminated by the managed and controlled movement of staff/people who require decontamination
- Prior to decontamination commencing, the inner cordon will be adjusted to encompass the decontamination area
- The decontamination area will initially be positioned in an uncontaminated area that forms part of the 'cold' zone, but must be as close to the inner cordon as possible
- The area chosen must be of sufficient size to accommodate the 'footprint' of the Fire and Rescue Service, and possibly also Ambulance Service, decontamination structures, and be an area that the police are able to support in respect of their areas of responsibility.

Action	
4.2	**Communicate and control the response plan**

Considerations

(4.2a) Use the incident command system to effectively manage Fire and Rescue Service resources on-site

- Review all commanders' spans of control

  NOTE: Maximum of three to four direct lines of communication

- Review initial sectorisation
- Ensure Command Support is adequately resourced.

(4.2b) Ensure the communications systems are in place and are effective

- Designate specific incident ground radio/communications channels
- Designate specific members of Command Support to set-up and monitor on-scene channels
- Identify any radio safety related issues (eg intrinsically safe apparatus, unexploded device triggers etc)
- Utilise on-site communications systems if available
- Set-up secure, reliable communications with the mobilising control and any providers of specialist hazardous materials advice
- Ensure there is a back-up system (eg mobile phones, Command Support 'runners', use of other responders' systems/apparatus etc)

  NOTE: Noise from high pressure leaks, equipment operation or site processes may make the acme thunderer whistle ineffective as an evacuation signal. All staff committed into the hazard zone must be aware if an alternative evacuation signal is to be used.

(4.2c) Nominate Safety Officers

- Ensure Safety Officers are competent in hazardous materials operations
- Ensure they receive a focused briefing on their role, the hazards and the response plan
- Designate specific Safety Officer(s) to monitor the inner cordon
- Designate specific Safety Officer(s) to monitor decontamination.

(4.2d) Ensure all responders are briefed by their commanders on the response plan

- Ensure briefings are relevant to the responder's role
- Focused on hazards, control measures and actions
- Remember Fire and Rescue Service staff off-site, specialist advisers, other agencies, other emergency services etc.

(4.2e) Designate clean areas with washing facilities for staff hydration and welfare

- Fundamental to safety

  NOTE: Ingestion of hazardous materials

- May be situated outside the 'cold' zone for increased safety
- Monitor hygiene procedures (eg hand washing etc).

(4.2f) Communicate with the local community to ensure public safety and reduce anxiety/concern

- Multi-agency approach and spokes-persons
- Generally led by the police
- Evacuation/shelter in place broadcasts at significant incidents
- General safety advice (eg shelter in place, close doors and windows etc)
- Health Protection Agency should advise and lead on the health risk to the general public
- Control of major accidents hazards (COMAH) off-site plans should indicate the extent of the Public Information Zone
- Avoid scare tactics or misleading information.

Action
4.3 Establish and operate decontamination **NOTE:** Consider improvised or interim decontamination whilst mass decontamination is being set up.
Considerations

(4.3a) Establish and operate decontamination for Fire and Rescue Service staff

- Decontamination methods:
  - physical
  - chemical.
- Firefighter decontamination (primary decontamination) initial or full depending on risk and scale of incident
- Generic decontamination system, stages:
  - position and set-out decontamination zone
  - brief wearers
  - drop tools
  - remove/reduce contamination
  - undress safely
  - check for exposure
  - wash hands, face and any areas of exposure
  - re-robe and welfare
  - record any exposure (maintain records and document any exposure to hazardous materials through faulty/inadequate personal protective equipment or procedures)

- manage contaminated personal protective equipment and other equipment
- arrange secondary decontamination (ie further off-site cleaning/treating of personal protective equipment and other equipment to ensure it is safe to be brought back into operational use).

- Use of MD4 Firefighters' decontamination unit
- Contain decontamination run-off where ever possible unless agreement has been reached with the land owner and the Environment Agency regarding safe dilution/ disposal
- Maintain records and document any exposure to hazardous materials through faulty/inadequate personal protective equipment or procedures
- See Part C-15, Decontamination, for further information of the methods of decontamination.

Operational key principle

Decontamination

- The outcome of decontamination is, as a minimum, to lower risk of harm/cross-contamination to an acceptable level, that is, as low as reasonably practicable
- It is not always possible to totally remove the contaminant or clean the personal protective equipment on-site
- The decontamination area is the area containing the Fire and Rescue Service (and possibly other emergency services') decontamination staff, equipment and structures
- Decontamination is initially established outside the inner cordon, in an area uncontaminated by the initial release, which becomes contaminated by the managed and controlled movement of people who require decontamination
- Prior to decontamination commencing, the inner cordon will be adjusted to encompass the decontamination area
- The decontamination area should always be divided into 'clean' and 'dirty' areas to minimise cross-contamination. Additionally disrobing and re-robing areas may be designated.

(4.3b) Establish and operate mass decontamination

- Mass decontamination is a National Health Service responsibility that the Fire and Rescue Service carries out when requested to do so by them or their representatives the Ambulance Service
- Further information on operational mass decontamination is contained in Part C-15, Decontamination.

(4.3c) Establish decontamination for other agencies

- Other emergency services and the military have their own decontamination procedures, although may require provision of water from the Fire and Rescue Service
- Fire and Rescue Service should only carry out decontamination of other services in emergency situations.

Action	
4.4	**Implement deliberate reconnaissance to gather further information**

Considerations

(4.4a) Select, protect and brief the reconnaissance team

- Staff must be competent in hazardous materials operations
  NOTE: Complex tasks may require detection, identification and monitoring operatives or advisers
- Use personal protective equipment assessed as effective in Phase 3 – Planning the response
- Ensure the reconnaissance team is given a specific task and safety brief
- Select operating procedures to limit contamination of wearers.

(4.4b) Carry out deliberate reconnaissance

- Avoid or minimise contact with the hazardous materials to reduce contamination:
  - use the minimum number of wearers
  - limit the time of entry into the hazard zone
  - limit physical contact with the hazardous materials
  - if the task only requires one wearer to have contact with the hazardous materials then ensure this happens and avoid cross contamination between wearers.
- Decontamination must be established before crews are committed, and an agreed withdrawal strategy must be in place and understood by crews
- Ensure there is a swift procedure in place to accept and analyse the findings from the team.

(4.4c) Analyse reconnaissance information and amend the response plan if necessary

Fire and Rescue Service should have in place appropriate resources and procedures to analyse information gained by reconnaissance. Incident Commanders should liaise with hazardous materials advisers and other scientific advisers before amending the response plan.

Action	
4.5	**Implement effective firefighting, containment and pollution control techniques**

Considerations

(4.5a) Control or extinguish fires

- Duties under the Fire and Rescue Services Act 2004
- Effects of heat on personal protective equipment
  NOTE: Inability to use most chemical protective clothing whilst carrying out aggressive firefighting tactics
- Additional physical or chemical reactions with the hazardous materials (eg production of steam, rate of vaporisation etc)
- Fire run-off water – quantity and degree of contamination
- Fire-water recirculation
- Flame bending techniques using hand held spray branches
- Isolation and/or protection of structural exposures using water curtain branches
- Cylinder cooling using water spray
- Manual valve closure under the protection of water spray branches
- Foam attack on a pool of flammable liquid
- Foam attack on a running flammable liquid fire
- Dry agents
- Bulk carbon dioxide
- Protect surrounding risks and allow to burn out
  NOTE: Environmental considerations.

(4.5b) Carry out 'defensive' hazardous materials containment actions (ie the risk outweighs the benefit of committing staff within the inner cordon to control the release)

- Very close liaison with the site occupier/owner, Environment Agency and statutory water undertakers
- Remote isolation of the release
- Site drainage shut-down
- Interceptor systems
  NOTE: operational intelligence and pre-planning.

(4.5c) Carry out 'offensive' hazardous materials containment actions

- Spill control:
  - absorption
  - covering
  - damming
  - diking
  - dilution
  - diversion
  - dispersion
  - retention
  - vapour dispersion
  - vapour suppression.
- Leak control:
  - neutralising
  - over-packing
  - patching
  - plugging
  - pressure isolation
  - solidification
  - vacuuming
  - water bottoming.

(4.5d) Work with the responsible agencies to control pollution from the site

- Work with the Environment Agency (See Part B, Section 16 – Environmental protection, for further information)
- Contaminants entering the drainage system are the statutory water undertaker's responsibility (or possibly the Highways Agency or private owner) not the Environment Agency
- Hierarchy of control:
    1. Stem or reduce the leak at source (eg close valves, clay sealing putty, over-pack drums, leak sealing devices etc)
    2. Contain the release close to the source (eg absorbents, pop-up pool etc.)
    3. Prevent the release entering the drains (eg clay drain mats, polyboom, peristaltic pumps etc)
    4. Control the pollutant in the drainage system (eg pipe blockers, sewerage control systems etc)
    5. Boom water courses (eg Environment Agency 'Grab-Packs', booms, dams etc)

(4.5e) Ensure that all emergency actions are within the realm of 'reasonable' response

- Incident Commander must have a rationale or justification for their actions
  NOTE: Legal duties under *Fire and Rescue Service Act 2004*, environmental legislation etc See Section 4, Legal framework
- Implement the operational risk philosophy ("The benefits of proceeding with a task must be weighed carefully against the risks, it is important to think before you act rather than act before you think.")
- Act in the best interest of the community
- Assess and control the risks facing staff
- Use safe systems of work.

NOTE: The term 'reasonable' is a generic and relative one that applies to that which is appropriate, usual in the circumstances and justifiable for a particular situation. In the law of negligence, the reasonable person standard is the standard of care that a reasonably prudent person would observe under a given set of circumstances. An individual who subscribes to such standards can avoid liability for negligence.

Action	
4.6	**Work with people and agencies that may provide additional advice and assistance**

Considerations

(4.6a) Work with people and agencies identified in Phase 3 – 'Planning the response' that may provide additional advice and assistance

- Use the expertise of the Fire and Rescue Service hazardous materials adviser to interpret and understand technical information and guidance
- Beware conflicting and uncertain information and advice, try to verify by gaining three sources of advice
- Ensure you understand any conflicting or competing interests of particular agencies (eg avoidance of prosecution possibly by a site operator; avoidance of litigation by a trade association adviser etc)
- If joint working is agreed in hazard zones ensure systems of work and emergency procedures are understood by all parties prior to entry
- Record joint and/or agreed actions.

(4.6b) At protracted incidents consider implementing environmental monitoring and/or health surveillance of staff

- At major risks such as top tier control of major accidents hazards sites environmental monitoring and/or health surveillance systems may be made available to emergency responders by the operators
- The Health and Safety Laboratory, Buxton, may be able to offer advice on appropriate environmental monitoring and health surveillance and screening
- Health Surveillance should be conducted when a disease or health effect may be related to exposure or where there is a likelihood that the disease or health effect may occur. It also be carried as a precaution to reduce anxiety amongst responders
- Further information on radiation incident monitoring is contained in Part C-10, Radiation.

Phase 5: Evaluating the response

Emergency incident response phases

Phase 1	**Mobilising and en-route**
Phase 2	**Arriving and gathering information**
Phase 3	**Planning the response**
Phase 4	**Implementing the response**
Phase 5	**Evaluating the response**
Phase 6	**Closing the incident**

Summary of actions and considerations whilst evaluating the response to a hazardous materials incident

DEFINITION:

Assess the progress of the response plan to ensure the response objectives are being met safely, effectively, and efficiently. Review the effectiveness of the control measures and adjust the plan accordingly. Evaluation is not a one-off action but should be carried out continually throughout the incident as circumstances change or new information becomes available.

Phase 5 Evaluating the response summary	• Evaluate the outcome
5.1 Evaluate the effectiveness of the response	
a) Select competent staff to carry out evaluation b) Evaluate the effectiveness of 'reactive' stage actions c) Continually evaluate progress of the response plan d) Evaluate the effectiveness of decontamination e) Evaluate the effectiveness of the specialist hazardous materials advice f) Record significant findings.	
5.2 Adjust the response plan if necessary	
a) Adjust the response plan, implement additional control measures and communicate the changes.	

Phase 5: Evaluating the response	
Action	
5.1	**Evaluate the effectiveness of the response**
Considerations	

(5.1a) Select competent staff to carry out evaluation

- **NOTE:** For most small scale incidents this function will be carried out by the Incident Commander as part of the operational and tactical risk assessment and decision making processes
- At large or complex incidents allocate dedicated staff with the incident command system, hazardous materials operations and evaluation skills.

(5.1b) Evaluate the effectiveness of 'reactive' stage actions

- Was initial hazard recognition and risk assessment carried out effectively?
- Was there a safe approach?
- Was initial cordoning safe and effective?
- Were immediate rescues and evacuation/shelter in place actions taken?
- Were critical incident stabilisation actions taken/considered?

(5.1c) Continually evaluate progress of the response plan

- Are tasks being carried out safely?
- Are safety briefing arrangements effective?
- Are tasks on schedule?
- Have the hazards and risks changed?
- Are sufficient resources available?
- Are the objectives being achieved?
- Is the plan on schedule?
- Is command and control operating effectively? (eg risk assessment, tactical mode, inner/outer cordons, spans of control, sectorisation, multi-agency working etc).

(5.1d) Evaluate the effectiveness of decontamination

- Are hazard control zones being effectively managed?
- Are staff being effectively decontaminated?
- Is any cross-contamination occurring?
- Are sufficient resources available?
- Are the objectives being achieved?

(5.1e) Evaluate the effectiveness of the specialist hazardous materials advice

- **NOTE:** For most small scale incidents this function will be carried out by the Fire and Rescue Service hazardous materials adviser
- Consider any new information (eg results of deliberate reconnaissance etc)
- Review existing information, evidence and any assumptions
- Are conditions changing? (eg weather, quantity being released etc).

(5.1f) Record significant findings

- Contemporaneous notes
- Debrief templates/forms
- Staff performance and/or competence assessments.

Action	
5.2	**Adjust the response plan if necessary**

Considerations

(5.2a) Adjust the response plan, implement additional control measures and communicate the changes

- Incident command system decision making model
- Completion of analytical risk assessment
- Detection, Identification and Monitoring Deployment Plan and Risk Control form
- Effective lines of command and communication
  NOTE: Multi-agency approach, on and off-site.

Phase 6: Closing the incidents

Emergency incident response phases

Phase 1	**Mobilising and en-route**
Phase 2	**Arriving and gathering information**
Phase 3	**Planning the response**
Phase 4	**Implementing the response**
Phase 5	**Evaluating the response**
Phase 6	**Closing the incident**

Summary of actions and considerations when closing a hazardous materials incident

DEFINITION:

Safely and efficiently end Fire and Rescue Service involvement at an emergency hazardous materials incident, and communicate this to the appropriate responsible person, organisation or agency.

Phase 6: Closing the incident summary	
6.1	**Close down Fire and Rescue Service operations**
a)	Minimise the impact to the community by the Fire and Rescue Service leaving the incident
b)	Return equipment and other resources to the correct place and ensure they are secure and ready for re-deployment
c	Extract and clean equipment from the 'hot' and 'warm' zones
d)	Ensure that correct action has been taken if staff have been exposed to hazardous materials.
6.2	**Hand-over control of the incident site**
a)	Identify the responsible person, organisation or agency
b)	Document the hand-over.
6.3	**Facilitate incident debriefs**
a)	Carry out on-site debriefs
b)	Prepare for off-site debriefs.
6.4	**Anticipate post incident considerations**
a)	Ensure that arrangements are put in place for any post incident issues.

Phase 6: Closing the incident

Action	
6.1	Close down Fire and Rescue Service operations

Considerations

(6.1a) Minimise the impact to the community by the Fire and Rescue Service leaving

- Action should be appropriate to the scale and risk of the incident
- Assess the residual hazards and risks to the community
- Fire and Rescue Service has no duty or responsibility for the 'clean up' of pollution/hazards/wastes caused by others, but is responsible for wastes produced by itself
- Any general 'duty of care' to the general public concerning an incident that the Fire and Rescue Service did not create, on a site that the Fire and Rescue Service does not control or own, is only based on 'reasonableness' not specific legislation
- Ensure there is effective multi-agency/community liaison and engagement
- Support the police in terms of scene and evidence preservation
- Proactive media and communications
  NOTE: Protect the reputation of the Fire and Rescue Service.

(6.1b) Return uncontaminated equipment and other resources to the correct place and ensure they are secure and ready for re-deployment

- Fire and Rescue Services should have procedures in place for the repatriation of equipment and other resources
- After-use inspections and, if required, functional tests
- Repatriation procedures should be integrated into operational training
- At Hazardous materials incidents it is essential that these procedures include assessment of contamination by a competent person
- Report any faults or low levels of supplies.

(6.1c) Extract and clean contaminated equipment from the 'hot' and 'warm' zones

- Liaise with hazardous materials adviser, specialist and/or contractors over procedures and processes
- Determine financial liability for clean-up costs
  NOTE: Generally, the polluter pays and the Environment Agency can recover certain costs.

(6.1d) Ensure that correct action has been taken if staff have been exposed to hazardous materials

- Record and investigate any hazardous materials exposure to staff
- Exposure should only occur through:
  - staff being unaware hazardous materials were present
  - incorrectly positioned initial/inner cordons
  - incorrect level or type of respiratory personal equipment/personal protective equipment
  - failure of personal protective equipment (eg ripped gas tight suits etc)
  - ineffective decontamination.
- Differentiate between exposure to hazardous materials; working in the 'hot' or 'warm' zones in effective personal protective equipment/respiratory protective equipment and general attendance at the incident
- Notify others as appropriate (eg next of kin, Health and Safety Executive,[3] mobilising control, line manager, occupational health provider etc)
- Agree health monitoring if appropriate and communicate with and reassure the staff involved
- Assess any benefit from hazardous materials/air sampling to confirm exposure (eg suspected asbestos etc).

Action	
6.2	**Hand-over control of the incident site**

Considerations

(6.2a) Identify the responsible person, organisation or agency

- Owner/occupier if the incident is at a private site
- Consigner, supplier, manufacturer etc if a transportation incident
- Land owner, local authority, Highways Agency, Police Service etc if a 'dumping' or fly-tipping incident
- Police and Health Protection Agency if considered to be a public health issue
- Environment Agency if involving land or water pollution
- Statutory water undertaker if involving contamination of sewers or drains.

3 RIDDOR – *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*.

(6.2b) Document the hand-over

- Develop a standard procedure and form
- Record name, job/position and contact details of person accepting the site
- Supply relevant information:
  - time of arrival and departure
  - known residual hazards
  - fire and rescue service hazardous materials adviser's contact details
  - fire and rescue service action taken
  - other agency details if known.

Action	
6.3	**Facilitate incident debriefs**

Considerations

(6.3a) Carry out on-site debriefs

- Hot debrief of first responders (ie what went well, what could be improved, what 'lessons learned' need to be shared with other parts of the organisation etc.)
- Provide command/competence assessment feedback for key individuals
- Multi-agency debrief if there are immediate important or safety issues that need to be addressed
- Identify and record 'lessons learned' or risk assessment findings from the incident
- De-briefs will range in complexity and formality, proportionate to the scale of the incident and in line with individual Fire and Rescue Service procedures
- Feed significant outcomes into reviews of policy and procedures.

(6.3b) Prepare for off-site debriefs

- May not be required dependent on the scale of the incident
- Off-site incident debriefs should include all relevant agencies. Fire and Rescue Services may wish to hold internal Fire and Rescue Service-only command debriefs prior to multi-agency incident debriefs
- Arrange for staff to make a contemporaneous written record of their actions. This information may be used to assist in any internal or external investigations or enquiries that follow any incident eg Coroner's Court, public enquiry, etc
- Major incidents may be subject to criminal, coroners or other public investigations or enquiries. Where this is the case, the Fire and Rescue Service debrief or investigation manager should take advice from the Fire and Rescue Service's principal management before progressing with the investigation.

Action	
6.4	**Anticipate post incident considerations**

Considerations

(6.4a) Ensure that arrangements are put in place for any post incident issues

- Any safety events; personal injuries, exposure to hazardous substances or near-misses should be recorded, investigated and reported in line with legislative requirements such as *Reporting of Injuries Diseases and Dangerous Occurrence Regulations 1995*, etc
- Staff health monitoring/surveillance where exposure has occurred
  NOTE: Liaison/notification of occupational health provider
- Implementation of procedures to detect and deal with delayed health effects where this is foreseeable
- Arrangements should be in place to either remove all contamination from personal protective equipment or to ensure it's safe and appropriate disposal and to check that the equipment maintains the agreed levels of integrity and protection for the wearer throughout it's lifecycle
- Repatriation of impounded and/or contaminated equipment
- Trauma incident management – Staff should be supported and monitored to identify whether they are experiencing any adverse affects and to check whether they would benefit from accessing counselling and support services (eg reassurance briefings for potentially contaminated crews etc)
- Liaison with enforcing authorities where legislation/regulation may have been contravened
- Assess and report any post incident financial liability (eg negligent actions, asbestos contamination etc)
- Are changes required to safe systems of work, appliances or equipment in the light of any 'lessons learned' from debriefs or from safety events?
- Review existing information held on a premises or location, or the need to add a new premises or location into future preplanning (eg by adding to visit or inspection programme).

Part C

Technical considerations

Contents

SECTION 7

PART C-1

Information sources

Introduction

7C1.1 The initial response to an incident often dictates the success of the outcome. A risk assessment based on poor information is a poor risk assessment. So clearly access to clear and accurate information at the beginning of the incident is crucial. There can be many sources of information and it is therefore important to choose the ones most appropriate to the incident in hand. This section aims to make this process more efficient by outlining what information is available and where to obtain it.

7C1.2 This section outlines some of the key sources of information available to contribute to the successful management of a hazardous materials incident.

7C1.3 It is not an exhaustive list of such sources, neither will the available information be replicated here. The use and interpretation of this information is discussed in the following section.

7C1.4 The role of the hazardous materials adviser is to gather the relevant data to enable the appropriate decisions to be made by the Incident Commander. It is difficult to define exactly what 'relevant' information is, as this is the decision of the hazardous materials adviser. Nevertheless, there are some guiding points, namely:

- Different sources of information will be available during incidents on a site-based incident (eg chemical manufacturing, distribution or storage site) versus an off-site incident (eg on a highway or at a port)
- Common information can typically be obtained from written or electronic sources such as the material safety data sheet, databases or books. This type of information may require further interpretation
- Information obtained from either a product expert or scientific adviser will not usually require further interpretation
- Each has their advantages and disadvantages but the choice of information sources is the responsibility of the hazardous materials adviser based on the scale and nature of the incident
- Wherever possible advice from more than one source should be gained to corroborate the information, ideally the "rule of three", or "triangulation" of information sources should be used
- Sufficient information has been obtained at the point that a clear strategy begins to emerge in planning the response

- Do not underestimate the importance of safe direct observations.

7C1.5 In the case of trade name preparations (or mixtures), the starting point may need to be the material safety data sheet or the product expert as most common databases and printed information sources do not contain information on this type of product. There are however some exceptions, with Chemdata® and CIRUS being the most common ones.

Generic information resources

7C1.6 There are times when information may have already been collected, for example on the known risks at a site, which can be utilised in the all important initial phase of the incident. Another variable to consider is the location of the incident. Clearly, it is much more difficult to plan for an incident during the transport and distribution of a chemical, rather than on the site at which it is manufactured.

7C1.7 When considering where firefighters can gain generic information, hazardous materials incidents have been broadly categorised into ‘on-site’ and ‘off-site’ (or transport) incidents. The exact definition of these categories is less important than the intended purpose of offering guidance as to the information sources available for each as the incident progresses. While certain information sources may be common to all incidents, other sources will depend on the type of incident.

Incident Phase	On-site based incidents	Off-site or transport based incidents
Phase 1 – Mobilising and en-route	Control of Major Accident Hazard (COMAH) Plans* 7(2)(d) risk assessments* Firemet**	Notification call or report (eg 999 log) Firemet**
Phase 2 – Arriving and gathering information Phase 3 – Planning the Response Phase 4 – Implementing the Response **AT THE INCIDENT GROUND**	Observation Material safety data sheet Product experts Chemical databases Portable reference material, eg *Emergency response guidebook* Mobile Data Terminal based systems (eg Chemdata®, CIRUS etc) Level 2 and level 3 Scientific Adviser (eg CHEMSAFE etc) CHEMET** Detection, Identification and Monitoring (DIM) equipment	Observation Driver* Vehicle markings* Emergency action code list* Dangerous goods documentation* Portable reference material, eg Emergency response guidebook MDT based systems (eg Chemdata®, CIRUS etc) DIM equipment Level 2 and level 3 Scientific adviser/Team (eg CHEMSAFE, RADSAFE etc) Product specific aid schemes CHEMET**
AWAY FROM THE INCIDENT GROUND	Manufacturer or supplier Level 1 Scientific Adviser (eg CHEMSAFE, RADSAFE etc) Material safety data sheet Chemical databases CHEMSAFE Scientific advisers Internet sources Chemical/scientific reference books	Manufacturer or supplier Level 1 Scientific adviser (eg CHEMSAFE, RADSAFE etc) Material data safety sheet Chemical databases CHEMSAFE Scientific advisers Internet sources Chemical/scientific reference books

*where applicable to the incident

**Firemet and Chemical Meteorology (CHEMET) are accessed via the Met Office's Hazard Manager

Site emergency plans

7C1.8 Larger hazardous installations will be subject to the *Control of Major Accident Hazard (COMAH) Regulations*. They are applicable to any establishment producing, storing or otherwise handling large quantities of hazardous materials. Examples of these types of installations include chemical manufacturing, warehousing and distribution sites.

7C1.9 The regulations operate on two levels, 'lower' and 'upper' tier, with the site designated into the relevant category based on the inventory of materials.

7C1.10 Lower tier sites are required to document a 'major accident prevention policy'. An upper tier control of major accident hazard site is required to produce a full safety report which demonstrates that all necessary measures have been taken to minimise risks posed by the site with regard to the environment and the local population. In addition, upper tier sites have an off-site plan which is prepared by the local authority, or in metropolitan authorities by the Fire and Rescue Service and tested every three years.

7C1.11 These plans can therefore be a useful reference source for:

- obtaining an inventory of the types and quantities of hazardous materials held on site
- a map showing the location of the materials
- an assessment of the known risks and remedial strategies
- the location of equipment used to fight fires or prevent the release of materials from the site.

7C1.12 Further information is contained in Section 7, A42.

Risk assessments

7C1.13 Another source of information on smaller installations may have been obtained during the assessment of risks carried out as required by law. 7(2)(d) risk inspections, so-called as they are referred to in this section of the *Fire and Rescue Services Act 2004*, can also be a useful source of information on the nature and quantities of hazardous materials situated on the site as well as the known risks posed by the nature of the operation on the site.

Met Office Hazard Manager

7C1.14 The Met Office provides a range of services that help authorities prepare for and respond to emergencies that are caused or influenced by the weather. Linked to these services is advice, available from teams of Met Office forecasters, specialist scientists and advisors, on the interpretation and impact of the weather

during an emergency. This service is coordinated through the Met Office's team of regionally-based Public Weather Service Advisors who can be called upon to provide advice at a strategic command and control centre.

7C1.15 Hazard Manager is intended to be a one-stop information source for the emergency response community, allowing access to all services in one location, using a single username and password.

7C1.16 The services currently available on Hazard Manager are:

- Flood Forecasting Centre with Extreme Rainfall Alert updates (England and Wales only)
- Interactive Map Viewer with weather information
- National Severe Weather Warning Service
- Emergency support
- FireMet and Chemical Meteorology (CHEMET) services.

7C1.17 Hazard Manager is designed to supplement the role of the Pubic Weather Service Advisors in providing consistent weather-related information and interpretation for the UK emergency response community.

Accessing Hazard Manager

7C1.18 Anyone who works for a Category 1 or Category 2 organisation (as defined in the *Civil Contingencies Act 2004)* can access Hazard Manager. However, some of the services available through this portal are restricted to approved users. For example, Flood Forecasting Centre products are only available for England and Wales, and FireMet and CHEMET are only available for subscribed users.

7C1.19 Users need to register to access the services required. This is confirmed by an email with an activation link. The Hazard Manager site can be found at:

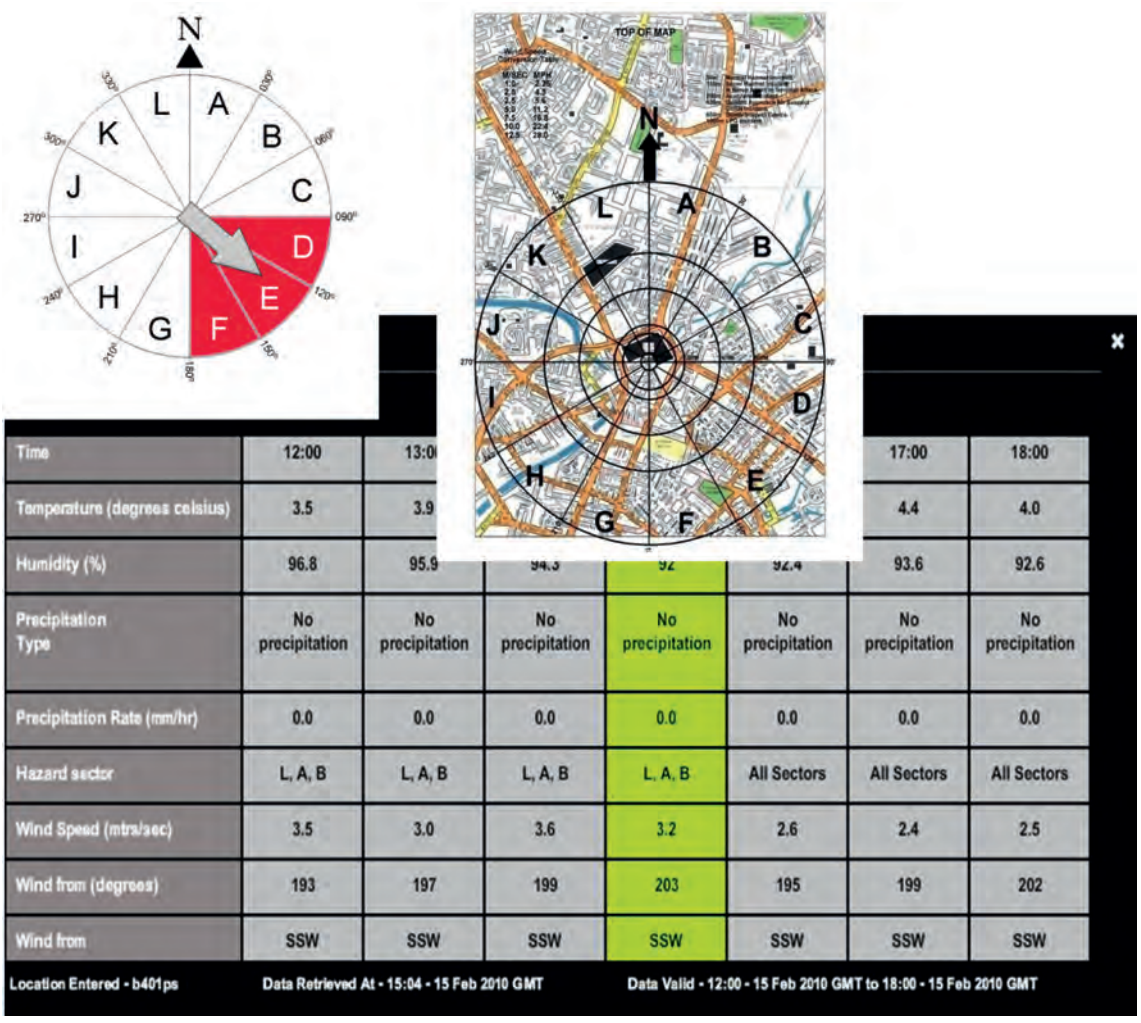
www.metoffice.gov.uk/publicsector/hazardmanager

FireMet

7C1.20 FireMet is a weather system designed by the UK's Met Office in collaboration with the Department for Communities and Local Government (DCLG) to provide Fire and Rescue Service responders with the latest weather information to help them identify a safe approach when dealing with a major incident. FireMet is a password-protected, web-based system available to all Fire and Rescue Service Incident Command Units, mobilising controls and detection, identification and monitoring units, as well as the National Coordination Centre. It is not available to the general public or other users.

7C1.21 The aim is to provide immediate access to forecast conditions, while they are waiting for a more detailed Chemical Meteorology (CHEMET) report. It also provides three hours of hindcast data, as well as three hours of forecast data.

7C1.22 Users log in to the site using a previously obtained username and password. They are then required to enter location information based on postcode, GB or NI OS grid reference or numerical grid reference. The outcome indicates the direction of the wind and sectors most likely to contain any wind-borne hazard which are coloured red. This can be overlaid on a map to indicate the routes of approach offering the least risk to the Fire and Rescue Service responders (see figure below).



Time	12:00	13:0				17:00	18:00
Temperature (degrees celsius)	3.5	3.9				4.4	4.0
Humidity (%)	96.8	95.9				93.6	92.6
Precipitation Type	No precipitation	No precipitation	No precipitation	No precipitation	No precipitation	No precipitation	No precipitation
Precipitation Rate (mm/hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazard sector	L, A, B	L, A, B	L, A, B	L, A, B	All Sectors	All Sectors	All Sectors
Wind Speed (mtrs/sec)	3.5	3.0	3.6	3.2	2.6	2.4	2.5
Wind from (degrees)	193	197	199	203	195	199	202
Wind from	SSW	SSW	SSW	SSW	SSW	SSW	SSW

Location Entered - b401ps Data Retrieved At - 15:04 - 15 Feb 2010 GMT Data Valid - 12:00 - 15 Feb 2010 GMT to 18:00 - 15 Feb 2010 GMT

CHEMET

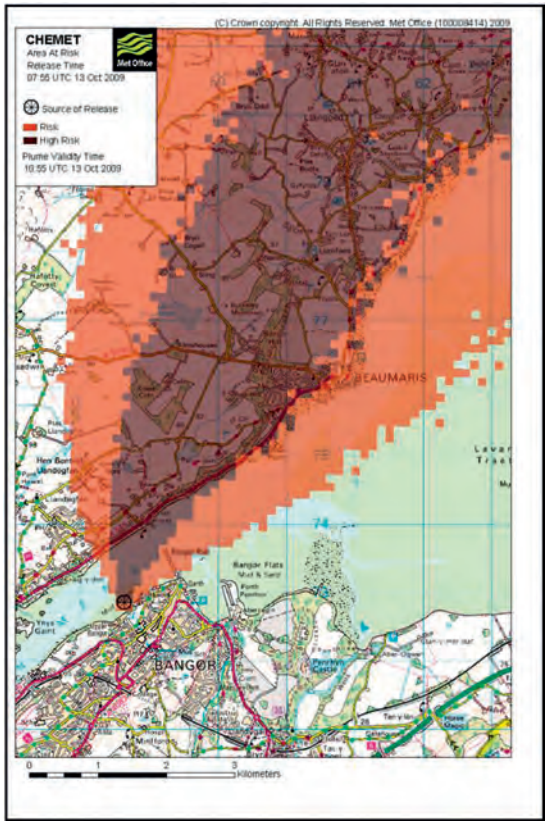
7C1.23 In the event of an incident involving hazardous chemicals, local Fire and Rescue and Police services can contact the Met Office Environment Monitoring and Response Centre. Typical scenarios could be a chemical spillage, a fire at a chemical plant or oil refinery, or a road traffic collision in which a hazardous

substance has been released. For small-scale events, the Environment Monitoring and Response Centre produces meteorological guidance and a plume prediction as a chemical meteorology (CHEMET) report. For larger release events, such as the Buncefield Oil Depot fire, more-sophisticated plume modelling techniques are utilised.

7C1.24 A chemical meteorology report is made of two parts.

7C1.25 CHEMET **Form A** contains the input data, which consists of the incident details including grid reference of the location, time of the event and any additional information on the chemicals involved. If available it can also include details of the current weather at the site. The Form As are completed by the emergency services and forwarded to the Met Office Environment Monitoring and Response Centre.

7C1.26 CHEMET **Form B** contains the weather forecast information along with an area at risk map. The figure below gives one example of a risk map.



© Met office

7C1.27 The advantages of using CHEMET:

- quick response – typically within 20 minutes of the provision of part A information

- can be delivered by fax or email
- easily identifiable area of risk
- sufficient for most short lived incidents.

7C1.28 The limitations of CHEMET:

- will not give information on chemical concentrations and therefore dilution down-wind
- does not take into account extreme heat
- does not take into account topography of the area (eg where the land down-wind is raised and thus has the potential to divert the plume from the predicted area
- no information is given on deposition
- provides short period information, the wind direction or weather can change suddenly.

'NAME' dispersion model

7C1.29 Numerical Atmospheric-dispersion Modelling Environment (NAME) is the title of an atmospheric pollution dispersal model which is a much more sophisticated tool than CHEMET for pollution forecasting. It has the capability to:

- simulate the effect of fires
- forecast air quality up to 36/48 hours ahead
- take into account the chemical involved
- show deposition, air concentration and height of the plume
- predict long-standing air pollution problems such as acid rain
- forecast international movement of pollutants.

7C1.30 It would generally be used for the more prolonged incidents as it takes longer to produce than CHEMET. It is ideally suited for incidents involving extreme heat, explosive releases where the contaminant is forced above the boundary layer (eg Buncefield) and nuclear incidents.

7C1.31 Further information on NAME can be found on the following web site:

www.metoffice.gov.uk/research/modelling-systems/dispersion-model

PACRAM (Procedures and communications in the event of a release of radioactive material)

7C1.32 As part of the procedures and communications in the event of a release of radioactive material (PACRAM) a weather forecast is prepared by the Met Office and sent to the site in question or to an off-site emergency room. The response is similar to that for a chemical incident using CHEMET.

7C1.33 The PACRAM form is similar to that used for CHEMET and provides details of the incident and may be sent, upon completion, to the Met Office when an incident occurs. The Met Office will then complete Part 2, which provides forecast meteorology and an area at risk map like those used for CHEMET.

7C1.34 Further information on PACRAM can be found on the following web site:

www.metoffice.gov.uk/publicsector/radiation

Environment Agency Air Quality Cell

7C1.35 The Environment Agency co-ordinate air quality data during a major incident in England or Wales, to assist the Health Protection Agency in providing fast and effective public health advice.

7C1.36 The Health Protection Agency will provide public health advice directly to an incident's tactical coordinating group (Silver) or via the Science and Technical Advice Cell (STAC) if there is a strategic coordinating group (Gold). The Air Quality Cell therefore requires a Silver or Gold multi-agency group to be operating in order to provide an appropriate communications route for their advice.

7C1.37 To do this the Air Quality Cell will:

- Form a virtual Air Quality Cell with key partners during the emergency phase of a major incident to provide specialist technical expertise (Emergency phase – From start of an incident until the Air Quality Cell hands control to the Recovery Co-Ordination Group. The Air Quality Cell is operational for a maximum period of five days or until the release has ceased or stabilised)
- Provide a new air quality data co-ordination service during the emergency phase of a major incident
- Develop and implement a dynamic air monitoring and air dispersion modelling plan
- Co-ordinate all available resources to deliver monitoring and modelling
- Provide a new air monitoring service to enhance existing arrangements
- Provide a coordinated air dispersion modelling service using new and existing arrangements

- Set response times for various elements of the new service to meet the needs of the emergency services and the Health Protection Agency
- Provide clear explanation of differences and assumptions for both modelling and monitoring outputs
- Provide timely and plain English briefings to support Silver Command or the Science and Technical Advice Cell
- Handover to the lead agency responsible for the recovery once the emergency phase is over.

7C1.38 The Air Quality Cell will not respond to:

- unidentified chemicals or chemical warfare agents, which we are unable to monitor
- hostile chemical, biological, radiological or nuclear events
- radioactive / nuclear incidents (except in a secondary capacity eg hydrogen fluoride release from enriched uranium source or fire involving manufactured products (smoke detectors etc)
- accidental biological release.

7C1.39 How to contact the Air Quality Cell

- Air Quality Cell operates 24/7 and can be contacted through the normal Environment Agency incident route
- Telephone the Environment Agency's Incident Communication Service or the Regional Communication Service (Wales)

  Incident Communication Service : **0800 163 300**
  Regional Communication Service Wales – **0292 0466 422**

- Air Quality Cell can also be contacted through the Centre for Radiation, Chemicals and Environmental Hazards.

  The 24/7 national hotline number : **0844 892 0555**

- The call will be passed to a competent officer who will assess the information against the triggering criteria:
  - Is it a major incident?
  - Does it involve a fire, explosion or chemical release?
  - Is there likely to be a significant risk to public health?

7C1.40 The key members of Air Quality Cell

- Environment Agency
- Met Office
- Health Protection Agency

- Food Standards Agency.

7C1.41 Other organisations may be invited to join Air Quality Cell depending upon the nature of the incident (eg local authority, Defence Science and Technology Laboratory).

7C1.42 The Air Quality Cell will develop and implement a monitoring and modelling strategy to support the Health Protection Agency in providing fast and effective public health advice. The strategies are dynamic and allow the Air Quality Cell to respond efficiently to questions from Silver Command or from the Science and Technical Advice Cell.

7C1.43 Working arrangements

- The Air Quality Cell is a virtual group communicating by Atlas Incident Management System and British Telecom's MeetMe
- Atlas Incident Management System is accredited to restricted level and allows the Air Quality Cell to share information security marked to this level. Everyone with a license can share/update information, log actions, decisions and communicate using this system. Operational instructions and protocols are provided
- The Air Quality Cell will provide air quality advice and information to the Food Standards Agency so that the implications for the safety of foods can be considered
- Gold/Silver are responsible for communicating Air Quality Cell air quality data to any regional or national strategic co-ordination centres
- No member of the Air Quality Cell will communicate directly with the media – communication will be through Silver or Gold Group.

Response times

7C1.44 The Air Quality Cell is functional:

- within two hours of notification of an incident (Mon-Fri 9-5 except public holidays)
- within four hours of notification (at all other times).

7C1.45 The Met Office will supply current and forecast meteorological data to suppliers of air modelling services within 30 minutes of notification of incident.

7C1.46 The two nearest monitoring teams will reach the incident rendezvous point :

- within three hours (Mon-Fri 9-5 except public holidays)
- within four hours (at all other times).

Enhanced air monitoring capability

7C1.47 Eight monitoring teams are available on 24/7 stand-by, and based across England and Wales. Each team has a vehicle containing hand-held kit for downloading real-time data.

7C1.48 In addition, there are two mobile monitoring labs, which contain more sophisticated equipment.

Close down

7C1.49 The Air Quality Cell will stand-down when the release to air has ceased or been stabilised. The Air Quality Cell will operate for a maximum of five days or until the release has ceased or stabilised (whichever is the soonest).

7C1.50 Co-ordination of air quality data, including monitoring and modelling during the recovery phase is managed and delivered by the recovery co-ordination group, usually lead by the local authority.

7C1.51 The Air Quality Cell review and agree all data before releasing them to the recovery co-ordination group.

Information available at the incident scene

7C1.52 After arriving at the incident, it is important to quickly survey the site to establish the circumstances and nature of the incident, depending on whether the incident is occurring on the site of a chemical manufacturer, storage facility or distributor (on-site) or while goods are being distributed (off-site or transport incident). The methods of ascertaining all of the relevant information will depend on the context and nature of the incident, but will typically include:

- direct observation from a distance judged to be safe, perhaps using binoculars
- interviewing other parties such as the driver of the vehicle involved or the site operator
- other responders such as police
- obtaining information from vehicle and/or product markings (eg Hazchem placard (used to indicate that the vehicle is carrying hazardous substances))
- product experts
- material safety data sheets or other information in writing.

7C1.53 Ascertaining whether dangerous goods are involved in transport incidents should be straightforward providing the consignor and transporter have complied with the relevant legislation. Where dangerous goods are being carried by road vehicle, for example, plain orange plates are displayed at the front and rear of

the vehicle or a Hazchem placard is displayed on the side and rear of the vehicle (see Part B, Section 3, Transportation). There are other similar marking schemes in place for dangerous goods being transported by rail, air or sea.

7C1.54 However, some initial caution should always be shown where there is some doubt as to the nature of the good being transported or if it is unlikely that the relevant legislation has been complied with. Examples include illicit drug or bomb making facilities or the illegal transporting of diesel fuel in unmarked intermediate bulk containers in unmarked vehicles. Inter-modal containers or ISO containers used to transport goods by container ship can also pose dangers where dangerous goods are not declared on the manifest. Due to their very nature, it is impossible to state how common these practices are. However, the likelihood of illegal practices should always be considered in the context of the incident.

7C1.55 It is also not the case that an absence of UN markings indicates that the goods do not pose any risk to the responders or to the environment. It merely indicates that the goods do not satisfy the criteria for labeling under the UN regulations (more information is available in Part B, Section 3, Transportation, packaging and storage of hazardous materials).

7C1.56 For transport based incidents, the driver (if available and able to do so) may be a valuable source of information on the goods being carried. For example in detailing where the vehicle has come from and where it is going to as well as information on what is being carried and any known hazards. Drivers of vehicles carrying dangerous goods are required to undergo relevant training.

7C1.57 The Dangerous Goods Note should be present where the vehicle indicates that it is carrying hazardous goods. Since July 2009, the driver of the vehicle no longer has to carry product specific instructions in writing on what action to take in the event of an incident. These instructions in writing were commonly referred to as “Tremcards®” and were also used by emergency responders as a means of identifying the load. Instead, the driver now has to carry only a generic instructions in writing, which cannot be used to identify the load on the vehicle. Drivers can still carry product specific information but this must be in addition to and not attached to the generic information.

Product specialists

7C1.58 Product specialists can be a useful source of advice, particularly where the product is a proprietary preparation (trade name product) or where the expert has particular knowledge of the site processes and can make suggestions for dealing with the incident.

7C1.59 However, a degree of caution should be used when involving product specialists who have a vested interest in minimising the disruption caused by the incident, perhaps at the expense of the emergency responders. It can also be the case that over familiarity with the product may cause the expert to become blasé to the risks it poses. If there is any doubt as to the probity or suitability of the advice

being offered by a product expert, seek alternative advice such as from an independent scientific adviser. It is in any case prudent to seek alternative views to those of a product specialist, even if you are so inclined to follow their advice.

Material safety data sheets

7C1.60 A material safety data sheet or safety data sheet is a document intended to provide occupational workers and emergency personnel with information on the material and procedures for handling or working with that substance in a safe manner. However it is worth remembering that the safety data sheet is primarily aimed at the occupational worker who will have potentially repeated and long-term exposure to the material or substance.

7C1.61 Safety data sheets are particularly important in the case of proprietary preparations where more than one product has been mixed or reacted, as other than the manufacturers or product expert, this will be the only source of information on the product (though note that some chemical databases such as Chemdata® and CIRUS do contain emergency response information on proprietary preparations that has been included based on the information provided by the manufacturer). This is because the act of mixing or reacting the constituent ingredients can have a marked effect on the final properties of the material. For example, both an acid and a base are corrosive but if mixed, the resulting product may have been neutralised and is no longer corrosive. Therefore it can be unreliable to assess the hazards of the product based on the individual ingredients.

7C1.62 The format of safety data sheets in the European Union is of a set format laid down by EC directive. The information is listed in the 16 standard headings given below.

Standard heading No.	Standard heading
1	Identification of the substance/preparation and company
2	Composition/information on ingredients
3	Hazards identification
4	First-aid measures
5	Fire-fighting measures
6	Accidental release measures
7	Handling and storage
8	Exposure controls / Personal protection
9	Physical and chemical properties
10	Stability and reactivity
11	Toxicological information

12	Ecological information
13	Disposal considerations
14	Transport information
15	Regulatory information
16	Other information

7C1.63 It is the responsibility of the person supplying the material (substance or preparation) to supply the information specified under these headings. The safety data sheet needs to be dated and any revisions marked.

Scientific advisers

General

7C1.64 Scientific advisers can be a useful resource particularly in instances where either the incident is complex or where other information cannot easily be sourced. Scientific advisers can also be used to obtain product information or to provide corroboration of other information sources. Other reasons for involving scientific advisers include providing reassurance or as a 'check' for the response plan that the hazardous materials adviser or Incident Commander has developed.

7C1.65 Scientific advisers can be situated remotely and accessed by telephone, fax or email or at the incident site. There are some common features that scientific advisers should offer:

- ability to understand the nature of the products and how this affects the actions taken
- assessment of the potential for reactions.

7C1.66 Scientific advisers may have expertise in the products involved in the incident, for example being representatives of the manufacturers, or they may have a more general chemical knowledge. There are several suppliers of general scientific advice on a commercial basis such as Bureau Veritas (who act as the primary scientific advisers to London Fire Brigade) as well as the 24-hour Chemsafe help-line operated by the National Chemical Emergency Centre (NCEC) and staffed by qualified chemists, which is free at the point of use to all UK Fire and Rescue Services.

7C1.67 When contacting scientific advisers it is advisable to obtain as much information on the chemicals and the incident as possible before calling. This may include names, part names, company names and product markings. Where this information is not available, supply the information that you have and call back with any subsequent information. The quality of the advice received is dependent on the information that you are able to provide to the scientific adviser.

Chemsafe

7C1.68 Chemsafe is a voluntary scheme run by the Chemical Industries Association and is an integral part of the chemical industry's Responsible Care initiative. It is also consistent with the objectives of Cefic's International Chemical Environment Programme.

7C1.69 Chemsafe has been developed to provide a rapid and co-ordinated response to minimise adverse affects to the public, property and the environment following a chemical distribution incident. Chemsafe sets down performance standards for responding to emergencies, based upon the following response levels:

- Level 1 – Provision of information
- Level 2 – Provision of advice at the incident scene
- Level 3 – Provision of practical assistance at the incident scene.

Chemsafe and the National Chemical Emergency Centre (NCEC)

7C1.70 As part of Level 1, participating companies are required to provide the National Chemical Emergency Centre with the details of all the chemicals they transport (all chemicals, not just those classified as hazardous). This means that if the emergency services cannot during an incident contact the company whose name appears on the label or placard for the chemical, they can call on the National Chemical Emergency Centre, via its Chemsafe Longstop service, to provide the necessary information – 24 hours a day.

7C1.71 The chemical information is normally provided as safety data sheets. The National Chemical Emergency Centre has over 400,000 safety data sheets and maintains a database of both current products and those that are no longer manufactured.

7C1.72 The National Chemical Emergency Centre is the Chemsafe Longstop centre. The Chemsafe Longstop centre provides expert advice and information in the event of chemical incidents. Although Chemsafe is primarily intended to cover distribution incidents, the National Chemical Emergency Centre's Emergency Responders provide advice to the emergency services on any incident involving chemicals, from minor spillages in homes and workplaces to major disasters.

7C1.73 Further information for emergency responders and the Chemsafe User Guide (in portable document format (PDF) can accessed at:

http://the-ncec.com/emergencyresponders/

Additional resources available through Chemsafe

7C1.74 **CHEMSAFE RESPONSE NETWORK**

A number of Chemsafe member companies have undertaken to operate a "Chemsafe Response Network" which will provide Level 2 assistance to the

Emergency Services on behalf of another Chemsafe member company who is remote from the scene. This assistance is available normally only in the event of a road transport incident and where the owner/supplier of the goods is a Chemsafe member company. The scheme can be activated directly between companies or by the Chemsafe Longstop centre.

7C1.75 **PRODUCT SPECIFIC MUTUAL AID SCHEMES**

For certain chemicals which may pose particular problems or for which special equipment may be required in the event of an incident, there are a number of product specific mutual aid schemes. These schemes may be activated by the owner/supplier of the goods, or by the Chemsafe Longstop centre. For more information on products covered by these schemes, contact the Chemsafe Longstop centre.

7C1.76 **INTERNATIONAL CHEMICAL ENVIRONMENT**

Information and advice on products originating outside the UK can be obtained by the National Chemical Emergency Centre Chemsafe Longstop centre via the International Chemical Environment Scheme, which includes a network of chemical emergency response centres across Europe.

7C1.77 Chemsafe emergency number : 0870 1906800

Detection, identification and monitoring equipment

7C1.78 The National Resilience Assurance Team have provided strategically positioned Fire and Rescue Services with a range of detection, identification and monitoring equipment. The use of this equipment should be considered in circumstances where it is appropriate, such as:

- Where there is a need for example to quickly ascertain the possibility of a chemical, biological, radiological or nuclear incident
- Where there are few other clues to the identity of the material, eg an unknown substance such as a ‘white powder’ is found
- To eliminate unlikely but serious consequence substances (eg the carrier for anthrax) and enable the incident to be quickly down-scaled
- Where it is thought likely that a positive identification can be made
- Where for known substances, equipment is available to monitor the levels of a particular hazard. This can support the correct establishment of safety cordons or identify when safe levels have returned to a location.

7C1.79 Where the use of detection identification and monitoring equipment would merely add delay without affecting the outcome of the incident, ie where the identity of the substance is already known or strongly suspected and there is a plan to deal with it, then the use of the equipment should be avoided.

7C1.80 Where the results obtained from detection identification and monitoring equipment are inconclusive or contradictory, further advice on their interpretation can be sought from some scientific advisers.

Electronic information sources

7C1.81 There are many electronic and database systems available, each with its advantages and disadvantages. The merits of each source is not discussed in detail here but the following table is intended as a signposting guide as to the type of information available from each reference source.

Key (note that this is not a ranking order)	
Electronic source	
1	Chemdata®
2	CIRUS
3	Emergency Response Guide Electronic Version
4	Wireless Information System for Emergency Responders (WISER)
5	Computer-Aided Management of Emergency Operations (CAMEO)
6	HAZMASTER G3
7	Emergency Response Intervention Cards (ERICards)
8	Chem-Exper
9	ChemIDplus
10	Pesticide Register of UK approved products
11	European Chemical Substances Information System (ESIS)
12	Sigma Aldrich MSDS
13	International Chemical Safety Cards

Electronic sources	1	2	3	4	5	6	7	8	9	10	11	12	13
General hazardous materials response	✓	✓	✓	✓	✓	✓	✓						✓
Chemical identification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chemical properties	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓
Reactivity data and guidance	✓	✓	✓	✓		✓			✓	✓		✓	✓
Toxicological and exposure data	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
First aid	✓	✓	✓	✓					✓	✓		✓	✓
Environmental data	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓

7C1.82 A short summary of each reference source is provided below:

1. **Chemdata**® is a chemical hazards and identification database developed by the National Chemical Emergency Centre specifically with Fire and Rescue Service users in mind. It is the most widely used chemical database within the UK Fire and Rescue Service. It is searchable by name, part name, UN number etc It contains information on both hazardous (UN no) and non-hazardous products and trade name products (mixtures) as well as pure chemicals. Designed around the emergency action code approach, it gives clear advice as well as information on the associated chemical hazards and required personal protective clothing, adverse chemical reactions and hazardous combustion by-products, exposure guidelines and first aid advice. Protective action distance information from the *Emergency Response Guidebook* (see below) is also included. The software is available as a standalone personal computer application, as part of a networked system or as an application for most Fire and Rescue Service mobile data terminals. Chemdata® is also available on palm-top personal organisers (Pocket Chemdata®) and is licenced to users on an annual subscription.

   For further information:

   www.the-ncec.com/chemdata

2. **CIRUS** (Chemical Information Retrieval Update System) is a risk and hazard information database that was designed and built by London Fire Brigade for use by its firefighters, although it is now more widely used. Because it was specifically developed for use by firefighters rather than for wider use throughout chemical industry, it focuses on the actions to be taken when dealing with a particular material rather than the properties of the material and requires no interpretation of instructions. It lists an emergency action code and decontamination code for almost every entry, the exceptions being the majority of the explosive and radioactive material entries. The Chemical Information Retrieval Update System also gives storage emergency action codes to support London by-laws. These are considered useful for downgrading incidents when smaller amounts than the transport threshold for emergency action codes (3000 litres) are encountered.

   The Chemical Information Retrieval Update System is available on a licence subscription from London Fire Brigade.

3. **Emergency Response Guide** is a database based on the *Emergency Response Guidebook*, designed to provide emergency responders with an interactive version of the book. The information contained in the personal computer version is the same as in the book. The program enables users to search by UN hazard symbol (warning diamond), UN number, class or by named substance. Information is provided in the form of numbered guides which are designed to apply to substances with similar hazards

and properties. One key feature is the additional tables showing suggested protective action distances (note not 'evacuation' distances as they are commonly referred to).

Download and installation instructions for the current version can be found at:

www.tc.gc.ca/eng/canutec/guide-ergo-221.htm

4. **Wireless Information System for Emergency Responders** (WISER) is a system designed to assist first responders in hazardous material incidents. WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice. WISER displays the appropriate advice based on designated role (eg 1st Responder, hazardous materials adviser). WISER also includes some information from the *Emergency Response Guidebook*. It is available as a free download for personal computers or for some personal digital assistants. Where an internet connection is available, WebWISER allows the user to utilise their web browser to access the same functionality as the standalone applications. WebWISER includes support for personal digital assistant's browsers including BlackBerry, pocket personal computers, palm and some telephones.

   Further information and to download:

   www.wiser.nlm.nih.gov/

5. **Computer-Aided Management of Emergency Operations** (CAMEO) is a suite of programs freely provided through the United State Environmental Protection Agency, which includes:

   a. CAMEO, which contains response recommendations for over 6,000 chemicals. The database also contains over 100,000 American chemical synonyms and identification numbers, which aid emergency responders to identify substances during an incident. The search engine gives access to datasheets on each chemical providing physical properties, health hazards, information about air and water hazards, and recommendations for firefighting, first aid, and spill response.

   b. The CAMEO Chemicals Database includes information about the intrinsic hazards of each chemical and about whether a chemical reacts with air, water, or other materials. It also includes case histories on specific chemical incidents, with references. This free resource can be downloaded and installed on a desktop or laptop computer. The CAMEO Chemicals Database uses the same chemical database as Computer-Aided Management of Emergency database.

   c. A reactivity worksheet database of reactivity information for more than 6,000 common hazardous chemicals, which details the dangers from accidental mixing.

d. **ALOHA** – Aerial Locations of Hazardous Atmospheres is an atmospheric dispersion model used for evaluating releases of hazardous chemical vapours. ALOHA allows the user to estimate the downwind dispersion of a chemical cloud based on the characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release.

e. **MARPLOT** – is a mapping program and was developed jointly by National Oceanic and Atmospheric Administration and the Environmental Protection Agency, and it runs on both Windows and Macintosh computer operating systems.

f. **CAMEO – Companion**, developed by the Arizona Emergency Response Commission, is designed to provide a written help resource for all CAMEO suite users, particularly those who utilize the software on an occasional basis. The CAMEO-Companion provides explanations and step-by-step instructions to help CAMEO users perform emergency response and planning activities learned in CAMEO training classes.

For further information and download:

www.epa.gov/OEM/content/cameo/index.htm

www.cameochemicals.noaa.gov/

6. **HAZMASTER G3** is a commercial software that incorporates its own graphical user interface to provide a common search and 'look' to access a number of other, mainly free, databases packages available. Hazmaster includes not just information on chemical hazards but also information on specific radioactive nuclides. Users are able to select material attributes observed on-scene, which the system uses to instantly identify hazardous materials from its database of over 625,000 material attributes.

   For further information, visit:

   www.hazmatlink.com/hazmasterG3.html

7. **Emergency Response Intervention Cards** (ERICards) is a database of initial actions for the first responders when they arrive at the scene of a chemical transport accident. They were developed to be based on the UK emergency action codes and on the *Accord européen relative au transport international des marchandises Dangereuses par Route* (ADR) Hazard Identification Number. ERICards are therefore intended to deal with chemical accidents involving a substantial amount of product, occurring during land transport only and may therefore not be appropriate for other incidents. They are also not available for every UN number. Searches can be made by searches relating to substance name, UN Number, ADR label, the hazard identification number or the ERICard reference if known. ERICards is available as a free download for both personal computers and as a personal digital assistant version. For further information:

   www.ericards.net

8. **Chem-Exper** – The aim of this website is to compile a freely accessible online database of chemicals. It is an open site that invites participation from chemical manufacturers and laboratories to register their products and supply material safety data sheets. The website provides links to the organisation that registered the product should further information wished to be sourced directly by the user. The website currently contains information on over 200,000 chemicals and formulations, with 10,000 MSDS and 10,000 infra-red spectra. The directory can be searched by chemical name or synonyms (in different languages), registry number (Chemical Abstracts Service or European Commission numbers) and by physical or chemical characteristics. For further information:

   www.chemexper.com/

9. **ChemIDplus Advanced** is produced by the US National Library of Medicine. It is a search engine for databases of chemical physical and toxicological properties. Further information can be found at:

   www.chem.sis.nlm.nih.gov/chemidplus/

10. **Pesticides Register of UK Approved Products** is produced by the Health and Safety Executive. This online application allows the user to search for information on plant protection products with on-label approvals. Searches of the application can be made by specific approval features, changes in the Pesticide Register and by searches relating to products subject to phased revocation. For further information visit:

    www.pesticides.gov.uk/databases.asp

    Banned pesticides:

    www.pesticides.gov.uk/approvals.asp?id=55

11. **European Chemical Substances Information System (ESIS)** is produced by the European Union Joint Research Centre. This free online application is a database of chemical substances registered by the European Union. The information presented includes chemical names (in English, French, German and Spanish), and for "annexed" materials, the risk (R) and safety (S) phrases will be displayed. Searches can be made by substance name, CAS Registry Numbers and EINICs Registry Numbers. It should be noted that this database focuses on pure chemicals and not commercial formulations. Further information can be found by visiting:

    http://ecb.jrc.ec.europa.eu/esis/

12. **Sigma Aldrich** provides an accessible material data safety sheet search engine through its website. It should be noted that a log-in user name may be required for repetitive searches. For more information visit:

    www.sigmaaldrich.com/sigma-aldrich/home.html

13. **International Chemical Safety Cards (ICSC)** are short summaries of health and safety information about chemical substances designed to be used by workers handling these chemicals. They are produced by the International Programme on Chemical Safety in collaboration with the European Commission and various national bodies. An ICSC is designed to complement a material safety data sheet, and to be used by individual workers rather than safety specialists. The cards are produced in a standard format, which eases translation between languages. The cards are currently available in web enabled format or portable document format (PDF) in sixteen languages, and in paper format in other languages. As of April 2005, 1491 cards are available in English. For further information visit:

    www.ilo.org/legacy/english/protection/safework/cis/products/icsc/dtasht/index.htm

More internet links

Databases on toxicology, hazardous chemicals, environmental health, and toxic releases:

http://toxnet.nlm.nih.gov/

Profiles of some very common hazardous materials:

www.ccohs.ca/oshanswers/chemicals/chem_profiles/

Health Protection Agency Compendium of Chemical Hazards:

www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListDate/Page/1153846673455?p=1153846673455

The Control of Substances Hazardous to Health (COSHH) and exposure limits:

www.hse.gov.uk/coshh/index.htm

Chemicals (Hazard Information and Packaging for Supply) Regulations 2008 (CHIP Regulations) and a handy list of symbols, abbreviations, risk and safety phrases:

www.hse.gov.uk/chip/index.htm

Health and Safety Executive asbestos information:

www.hse.gov.uk/asbestos/

Health and Safety Executive radiation information:

www.hse.gov.uk/radiation/ionising/index.htm

National Chemical Emergency Centre (NCEC):

www.the-ncec.com/

NIOSH database:

www.cdc.gov/niosh/database.html

Documentation for Immediately Dangerous to Life or Health Concentrations (IDLH):

www.cdc.gov/niosh/idlh/intridl4.html

Chemical Safety Information from Intergovernmental Organisations:

www.inchem.org/

Materials Safety Data Sheets Links:

www.ilpi.com/msds

Printed information sources

7C1.83 The following table is intended as a signposting guide to the type of information available from each reference source.

Key (note that this is not a ranking order)	
Printed sources	
1	The Dangerous Goods Emergency Action Code (EAC) List
2	Emergency Response Guide (ERG)
3	EH40 Exposure Limits
4	The UN Modal Regulations
5	Physics and Chemistry for Firefighters – Fire Service Manual
6	Petrochemical Incidents – Fire Service Manual
7	Hazardous Chemicals Handbook (2nd Edition)
8	Bretherick's Handbook of Reactive Chemical Hazards (Volumes 1 & 2, 7th Edition)
9	Wiley Guide to Chemical Incompatibilities
10	Hazardous Materials Incidents, guidance for fire services
11	Sax's Dangerous Properties of Industrial Materials (11th Edition)
12	The UK Pesticide Guide
13	Emergency Handling of Hazardous Materials in Surface Transport
14	Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods
15	Hazardous Materials Chemistry for Emergency Responders

Printed sources	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
General Hazardous Materials Response	✓	✓				✓				✓			✓	✓	✓
Chemical Identification	✓	✓		✓			✓	✓	✓	✓		✓		✓	
Chemical Properties				✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
Reactivity							✓	✓	✓		✓		✓		✓
Toxicological and Exposure Data		✓	✓	✓			✓	✓			✓				
First Aid		✓											✓		
Environmental Data		✓					✓					✓	✓		

1. **The Dangerous Goods Emergency Action Code (EAC) List**

   Provider: NCEC. Published by TSO

   The book is revised every two years to be in line with any changes made to the *Transport of Dangerous Goods Regulations* (RID and ADR Agreements). The purpose of the publication is to provide the first responder with rapid advice when confronted with a bulk transport incident involving hazardous materials. Duty holders are required to use the publication for the application of emergency action codes to 'bulk' loads containing dangerous goods. This is required under the *Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009* (CDG 2009).

   2. Emergency action codes are a valuable tool for the first responder as the code provides immediate initial information. The document also supplies information on the additional personal protection codes that may be assigned to a hazardous material. The assignment of emergency action and additional personal protection codes is based upon the physical and chemical properties of a given material.

2. **Emergency Response Guidebook (ERG)**

   Provider: US Department of Transportation (DOT), Transport Canada and the Secretariat of Communications and Transportation of Mexico (SCT), (New edition every four years)

This publication is written for first responders, firefighters, police and ambulance crews when responding to a transport emergency involving hazardous materials. It is updated and re-issued every four years. The book is divided into five-colour-coded sections and has been written to be used during the first thirty minutes of an emergency situation by those agencies that may be the first to arrive at an incident. After identifying the substance, the relevant guide number to follow is selected. The book also contains details of initial isolation and protective action distances, commonly but erroneously referred to as 'evacuation distances'.

3. EH40 Workplace Exposure Limits and Amendments

Provider: The Health and Safety Executive

This is the hard copy of the list of workplace exposure limits for use with the *Control of Substances Hazardous to Health Regulations 2002* (as amended). The exposure limits contained therein are therefore legally binding.

The 2005 edition of these regulations detailed a departure from the old system for the setting of occupational exposure limits. The old system utilised occupational exposure limits set as maximum exposure limits and occupational exposure standards. The new format now utilises a single occupational exposure limit which are workplace exposure limits.

It should be noted that until 2005 it had been standard practice for the Health and Safety Executive to publish a new edition of the EH 40 document, or an amendment, each year. However, with the increased use of the internet the Health and Safety Executive no longer publishes a revised hard copy. Hence, there was an amendment to the document in 2006 and again in 2007. These revisions should have been sent out to the recipients of the hard copy published in 2005. However, the emergency responder can source the updated tables from the following web link:

www.hse.gov.uk/coshh/table1.pdf

4. The U.N. Modal Regulations for the Transport of Dangerous Goods

Provider: UN

The regulations can be utilised by the emergency responder to identify materials at an incident that have been classified as hazardous for transport. From the UN Number identification, further information can be determined regarding the product's possible toxicity, reactivity, flammability and environmental impact from additional information such as the packing group.

5. **Physics and Chemistry for Fire-Fighters – Fire Service Manual**

Provider: HM Fire Service Inspectorate. Published by The Stationery Office (TSO).

The purpose of this publication is to provide an introduction to the basic science required for an understanding of the way in which fires behave and how they can be extinguished. The book is divided into three parts: In Part 1 some of the physical properties of materials are discussed as these greatly affect the way that materials behave when involved in fire. Any combustion process essentially involves a chemical change and in Part 2 the burning process is described in some detail for different materials together with an indication of the hazards involved. Finally in Part 3 (the shortest part) the various modes of fire extinction are described.

The language used in the book is straightforward to read and the terminology defined as it is encountered in the text. The text itself is never too long and broken down into readily digestible paragraphs. Together with clear, coloured photographs, diagrams and an occasional sprinkling of simple exemplar calculations, the result is a good quality 'first reader' in this subject area.

6. **Petrochemical Incidents – Fire Service Manual**

Provider: HM Fire Service Inspectorate. Published by The Stationery Office (TSO).

Although this manual is entitled *Petrochemical Incidents* it contains more than procedures for fighting petrochemical fires. There is a useful amount of fundamental information about the refining processes, layout and typical storage arrangements to be found on sites. References are made to potential incidents which might occur (eg boiling liquid expanding vapour explosions (BLEVEs), boil-overs, tank fires etc), although there are no specific references to actual incidents which have occurred in the past.

7. **Hazardous Chemicals Handbook (2nd Edition)**

Provider: Phillip Carson and C.J. Mumford, Published by: Elsevier

This publication aims to raise awareness and to help users identify, assess and control the hazards of chemicals to permit optimum exploitation whilst minimizing the dangers. The publication provides look-up data, and concise, clear explanations of general chemical principles, physiochemical and reactive properties, toxicities and exposure limits, flammability characteristics, monitoring techniques, personal protection and other parameters and requirements relating to compliance with safe practice, control of risks to public health and limitation of environmental impact.

As a handbook it is particularly useful to emergency responders as a reference source either to supplement their existing knowledge or as a data source. Users must be aware that changes in the legislation impacting on hazardous materials frequently affect not only quantities (eg occupational exposure limits) but the listings as well.

8. **Bretherick's Handbook of Reactive Chemical Hazards – Volumes 1 & 2**

Provider: Peter Urben, Published by Elsevier

This publication is designed to provide information which relates to chemical risks, either alone or in combination, that result from chemical reaction. The toxicological information cited is for hazardous chemical reaction by-products.

There is extensive referencing to the primary literature. It is designed to improve safety in laboratories that perform chemical synthesis and general research, as well as chemical manufacturing plants. Entries are ordered by empirical formula and indexed under both name(s) and Chemical Abstract Service registry numbers.

This publication references chemical incidents where an accident or adverse chemical reaction may have occurred.

9. **Wiley Guide to Chemical Incompatibilities**

Provider: Wiley Interscience.

This publication contains nearly 9,000 chemical incompatibility profiles with nearly 250 new entries. These entries cover flammability, violent and explosive binary reactions, chemical incompatibilities, and reactions that may result from physical changes.

10. **Hazardous Materials Incidents, guidance for the fire service**

Provider: HM Government. Published by The Stationery Office (TSO).

This is this publication. It provides a generic standard operating procedure for the Fire Service emergency response. It also gives more detailed technical operational guidance on the 9 UN classes of hazardous materials as well specific sections on; information sources; interpreting and using chemical information; and transportation, packaging and storage of hazardous materials.

11. **Sax's Dangerous Properties of Industrial Materials (11th Edition, Volumes 1-3)**

Provider: Richard J. Lewis Sr. Published by Wiley Interscience

This publication provides information on the dangerous properties of industrial materials, with references to 26,000 substances and associated toxicological information. Also included in the publication is information relating to industrial hygiene, safety, emergency response, law, and policymaking.

12. The UK Pesticide Guide 2010

Provider: CABI & BCPC.

This publication provide a pesticide index and profiles, other registered products, adjuvant information, supplier listing and further information for pesticide users.

13. Emergency Handling of Hazardous Materials in Surface Transport (2010 Edition)

Provider: The North American Bureau of Explosives

This publication contains information on over 3,600 regulated chemicals and is designed for use by first responders. Sections include information on the basic properties of the chemicals, recommended methods for dealing with hazardous materials in the early stages of an emergency, a listing of emergency environmental mitigation procedures and first-aid information. Information regarding chemical personal protective equipment compatibilities is also included. It should be noted however, that the publication is written to be inline with the U.S. and Canadian regulations.

14. Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods (2009/2010 Edition)

Provider: International Civil Aviation Organization. Published by The Stationery Office (TSO).

Designed to for use with the International Air Transport Association air transport regulations, this publication provides information on UN numbers, basic response procedures and drill codes.

15. Hazardous Materials Chemistry for Emergency Responders (2nd Edition)

Provider: Robert Burke. Published by CRC Press.

The second edition of this publication includes chapters that are organized by the nine U.S. Department of Transportation's hazard classes. Within each class, the publication discusses individual chemicals that are commonly involved in emergency situations along with their physical and chemical characteristics. Additionally, each chapter addresses the multiple perils of hazardous materials, including "hidden" hazards. The "top fifty"

hazardous industrial chemicals are considered throughout the book. The publication also provides incident reports and statistics to underscore the effects that specific chemicals can have on incident outcomes.

The publication also addresses potential chemical and biological terrorist agents. This resource is written to be appropriate for response personnel without a strong chemistry background by conveying the information in understandable terms.

Product specific aid schemes

7C1.84 There are a number of industry led schemes in operation for specific chemical products where, due to the nature of the hazards of the material or the specific expertise needed to effect a response, the manufacturers cooperate to provide emergency assistance to the emergency services. The schemes known to be operating in the UK are detailed below.

7C1.85 It is emphasised that in the case of the specialist aid schemes listed, generalist scientific advisors may have neither the expertise nor the experience to handle them in the quantities likely to be involved in an incident. Immediate contact with the specialist organisation is essential as a major incident could easily result from incorrect actions

NOTE: In the event of needing to invoke a response from one of these schemes, use the contact details where provided or where these are not available contact the NCEC Chemsafe line (0870 1906800). Further information on Chemsafe is contained in Chapter 4, Scientific advisers.

Acrylonitrile/medical

7C1.86 For acrylonitrile/medical, an *Emergency Response Manual and a Mutual Aid Scheme of the European acrylonitrile/medical producers* exists. All Acrylonitrile/medical producers involved in transporting acrylonitrile/medical in Europe should have an established procedure for receiving transport incident reports and for being able to give expert advice on how to minimize any danger arising from an incident on road, rail or waterway/sea.

7C1.87 The underlying features of this scheme are that the firm delivering the acrylonitrile/medical (the supplying company) is under an obligation to take action when notified of any transport incident. Another firm (the assisting company) can be requested by the supplying company to take action, for example if the assisting company is closer to the scene of the incident.

7C1.88 The assisting company takes the place of the supplying company on its behalf until the representatives of the supplying company reaching the scene of the incident.

Bromine (Bromaid)

7C1.89 Bromaid is a pan-European organisation of the three main bromine suppliers to provide mutual emergency response support to the emergency services on a geographic basis, regardless of whose bromine equipment may be involved in an incident.

7C1.90 In the UK, the response is provided by Chemtura and its agents, who have received bromine specific training and have the appropriate equipment to provide support to the emergency services at the scene of an incident. The target is to attend the scene within four hours and for the equipment (based at Droitwich, West Midlands) to be at the scene within eight hours. For further details, visit:

www.bromaid.org

7C1.91 The 24-hour emergency number for Chemtura in the UK is: 0208 762 8322

Chlorine (ChlorAid)

7C1.92 ChlorAid is a product specific scheme for providing mutual assistance for incidents involving chlorine. The scheme provides three levels of emergency support:

- Level 1 – Telephone advice
- Level 2 – Incident attendance by a product specialist
- Level 3 – Incident attendance by an emergency response team. INEOS ChlorVinyls will provide the response to the incident.

7C1.93 INEOS ChlorVinyls provides an External Chemical Emergency Service (ECES), primarily for all products manufactured at its sites in the UK. This response capability consists of a specially equipped vehicle and safety equipment for attendance at the scene of an incident involving chemicals. INEOS ChlorVinyls personnel are specifically trained in assisting with such emergencies and can be made available at the request of customers, local authorities and the emergency services.

7C1.94 In case of a UK distribution or chemical emergency involving exposure, leaks or spills, the contact details are:

ChlorAid (INEOS ChlorVinyls External Chemical Emergency Service)
01928 572000

INEOS ChlorVinyls Runcorn Site Emergency Services Department:
01928 512222

Further information is available at:

www.chloraid.srst.co.uk

www.ineoschlor.com

Ethylene oxide

7C1.95 Shell Chemicals Europe transports ethylene oxide from the supply point at Wilton, and occasionally from the Netherlands, to a number of customer sites across the United Kingdom. In the event of a distribution emergency involving ethylene oxide, Shell Chemicals Europe will initiate their emergency procedures and provide assistance.

7C1.96 In the event of an incident involving ethylene oxide, the requirement is to ensure a competent responder can be at the scene as quickly as possible. With that objective, in the UK ethylene oxide customers participate in a mutual aid scheme for ethylene oxide distribution emergencies. This facilitates a more rapid response when the incident is remote from the location of the response team.

7C1.97 Shell Chemicals Europe accepts the general obligation to respond to the Ethylene Oxide distribution emergency and remains in charge of the overall incident response and co ordination. The mutual aid company acts on behalf of Shell Chemicals Europe until a nominated responder reaches the scene.

Isocyanates (ISOPA)

7C1.98 ISOPA represents the manufacturers in Europe of aromatic diisocyanates and polyols, the main raw materials for polyurethanes. The European isocyanate and polyol producers who are members of ISOPA have established a system of mutual aid to deal with potential emergencies arising during the transportation of toluene diisocyanate, diphenylmethane diisocyanate or their derivatives in Europe.

7C1.99 In the event of any difficulty occurring during transportation of a shipment of either toluene diisocyanate (UN- Number 2078) or diphenylmethane diisocyanate or their derivatives forwarded by one of the participating companies, then the said company may request another company closer to the scene of the incident to intervene on their behalf.

7C1.100 In this context, “transportation” is taken to mean all of the activities associated with the transport unit, including unloading.

7C1.101 Each of the companies may be requested to provide assistance from an appropriate emergency response centre.

www.isopa.org/isopa/

Titanium tetrachloride

7C1.102 Assistance in the event of incidents involving titanium tetrachloride, TiCl4 or “tickle” is organised by the Titanium Dioxide Manufacturers Association (TDMA). The main UK member is Huntsman Pigments (Grimsby and Teesside). The scheme can be invoked by contacting the NCEC Chemsafe number.

PART C–2

Interpreting and using chemical information

General information

Introduction

7C2.1 For the purpose of this operational guidance the information included in this section is based on what a hazardous materials adviser needs to know to assist him/her to develop the incident response plan with the Incident Commander. It assumes that the reader is already familiar with the basic scientific information contained in the *Fire Service Manual (Volume 1 – Fire Service Technology, Equipment and Media) Physics and Chemistry for Firefighters.*

The importance of information in managing the incident

7C2.2 The successful management of an incident is dependent on sufficient information being collected to determine the risks involved to the emergency responders and to other persons in the vicinity, and the appropriate actions being taken to mitigate those risks.

7C2.3 The type of information needed, in addition to the circumstances of the incident, will be the identification of the materials involved and understanding their behaviour.

7C2.4 Answers to questions such as:

- What are the names of the materials and quantities involved?
- What are the hazards?
- What is the physical form and is it likely to change during the incident?
- Will there be a reaction?
- Is a vapour cloud likely or toxic products of combustion?
- Will the product float, sink, be dissolved in or react with water?

7C2.5 Will then translate into the initial actions relating to:

- selection of personal protective equipment to prevent casualties
- first-aid measures to treat any casualties

- firefighting measures (eg foam or water spray)
- spillage control and accidental release measures – how to protect the environment.

7C2.6 As the incident develops there may be a requirement to involve a scientific adviser or a product specialist to provide specific advice. The company whose products are involved may need to be notified to activate emergency plans and after the incident is stabilised to arrange clean-up.

7C2.7 Many of these specific actions may be determined by the information gathered about the incident and the substances involved and each person involved in the process will require a full and accurate briefing of the situation. Therefore understanding the nature of the hazardous materials involved is key information.

7C2.8 Where people have been exposed to hazardous materials the 'risk assessment' is not only important in terms of the 'quality of the information' but its timeliness is also crucial to its usefulness. This is because of the high toxicity of some hazardous substances, more precisely, the high speed in which intoxication in humans develops. Risk assessment must show results within the shortest possible time frame. Numerous toxic agents can cause irreversible effects in humans within minutes after inhalation or contamination of the skin. It is therefore essential that the crucial information that has to serve as the basis for proper and adequate countermeasures is available as soon as possible.

Chemical names (nomenclature) and numbers

7C2.9 The first step in obtaining information on the nature of the hazardous materials involved in the incident is their correct identification.

7C2.10 Identification can be more difficult in the case of chemical substances, not least because of the range of names, numbers and symbols used to identify them. There are various types of chemical name used to describe both pure chemical substances (ie not containing a mixture) and preparations (which are usually a mixture of other chemical substances).

7C2.11 This section provides a broad overview of the range of chemical names (chemical nomenclature) in common use.

Key operational principle	Emergency responders should always use the phonetic alphabet to spell any chemical or product name as the misspelling of a single letter can have significant safety implications.

Systematic or International Union of Pure and Applied Chemistry (IUPAC)

7C2.12 These names are designed to give the fullest possible information about the molecular structure of a substance. Systematic naming of an organic compound generally requires the identification and naming of a parent structure. This name may then be modified by prefixes, infixes, and suffixes, which convey precisely the structural changes required to generate the actual compound from the parent structure.

7C2.13 Systematic names for complicated molecules can themselves be very complicated and many attempts have been made in the past to tackle the problem. The most important system of systematic names currently in use is that devised by the International Union of Pure and Applied Chemistry (IUPAC).

7C2.14 For example, the name *1,1,1 – trichloroethane* tells us that the substance is a chloroalkane (chloro – means it contains chlorine and the – ane ending means it is an alkane) with two carbon atoms (-eth-, short for ethyl) and three chlorine atoms (trichloro-), all situated on the first of the two carbon atoms (1,1,1-) denoting their position.

7C2.15 The exact spelling of systematic names may be important when retrieving chemical information from electronic databases, although some databases are able to cope with, for example, missing numbers or similar spellings as well as trivial name alternatives.

Trivial

7C2.16 These are names given to a substance that may be in common use but do not usually describe the chemical structure of the substance. Trivial names are used because they are simpler to remember and/or are shorter.

7C2.17 Examples (with their systematic names) include:

Trival name	Systematic name
Formic acid	methanoic acid
Common salt	sodium chloride
Formaldehyde	methanal
Toluene	methyl benzene
MEK or methyl ethyl ketone	2-butanone

Commercial and trade names

7C2.18 These are names that have been designated by a chemical manufacturer usually to describe a proprietary preparation, although sometimes they can be used to describe a pure chemical substance – some of which enter into common usage

(nylon, aspirin and Teflon® being famous examples). These names have the advantage of being unique and usually more memorable than systematic or even trivial names.

7C2.19 Other examples of trade names include:

- Roundup
- Jeyes Fluid
- Castrol GTX.

7C2.20 Usually the only sources of information on trade name products is a material safety data sheet completed by the manufacturer or a product expert. However the two main chemical databases used in the UK – Chemdata and CIRUS – both contain information on a number of trade named products.

Synonyms

7C2.21 Stated simply, a synonym is an alternative name for a substance. Synonyms can be a combination of systematic, trivial or even trade names. A possible difficulty encountered when seeking information about a substance lies in the fact that the substance may have many synonyms and some reference sources may list the information under a different synonym with no cross-referencing given. Better reference sources list the various synonyms and offer cross-referencing.

Chemical formulae

7C2.22 Chemical formulae list the proportions of the constituent elements within a compound. There are several ways in which chemical formulae can be displayed. The usual way is to subscript the ratio numbers, eg CO_2. Another option is not to subscript the ratio number, eg CO2. This method is computer compatible and allows electronic searches by formula for databases that have this feature (eg Sigma Aldrich). However, several different substances may share the same computer compatible formula (eg C_2H_6O).

7C2.23 Other ways of presenting the chemical formula can convey some structural information and uniquely identify the material (eg CH=CH symbolising a carbon-carbon double bond). The Sigma Aldrich material safety data sheets Library provides this information.

7C2.24 The use of chemical formulae to identify the properties of a material is limited.

Chemical Abstracts Service (CAS) registry numbers

7C2.25 Chemical Abstracts Service registry numbers are unique numerical identifiers for chemical elements, compounds, polymers, biological sequences, mixtures and alloys. They are commonly referred to as CAS numbers. The Chemical Abstracts

Service, a division of the American Chemical Society, assigns these identifiers to every chemical that has been described in the literature. The intention is to make database searches more convenient, as chemicals often have many names. A Chemical Abstracts Service registry number is separated by hyphens into three parts, the first consisting of up to seven digits, the second consisting of two digits, and the third consisting of a single digit serving as a check digit. The numbers are assigned in increasing order and do not have any inherent meaning.

United Nations (UN) numbers

7C2.26 UN numbers are discussed in 7C3-23. However, these four digit numbers can be a means to identify either a specific substance or a group of substances sharing the same characteristics (eg flammable liquids that are not listed individually). These numbers can then be used to access emergency response advice from reference sources such as Chemdata, CIRUS or Emergency Response Guide.

EC numbers

7C2.27 The European Commission number, or EC number, also known as EC-No and EC#, is the seven-digit code that is assigned to chemical substances that are commercially available within the European Union.

7C2.28 The EC number is made up of seven digits according to the pattern xxx-xxx-x, with the single digit operating as a check digit as in the Chemical Abstract Service system (but using a different check algorithm).

Interpreting material safety data sheets

7C2.29 Material safety data sheets or safety data sheet can be a key document for providing emergency responders with information on the hazardous material. However, it is worth remembering that the safety data sheet is primarily aimed at the occupational worker.

7C2.30 Safety data sheets are important sources of information particularly in the case of proprietary preparations where more than one product has been mixed or reacted other than by the manufacturer or product expert. The safety data sheets will be the only source of information on the product (though note that some chemical databases such as Chemdata and CIRUS do contain emergency response information on proprietary preparations that has been included based on the information provided by the manufacturer). This is because the act of mixing or reacting the constituent ingredients can have a marked effect on the final properties of the material. For example, both an acid and a base are corrosive but if mixed, the resulting product may be neutralised and no longer be

corrosive. Or a flammable liquid that mixes with water may be diluted sufficiently to no longer possess flammable properties. It can, therefore, be unreliable to assess hazards based on the individual ingredients.

7C2.31 The format of safety data sheets can vary according to the region where the product is produced, but in the European Union a set format is laid down. The information in the safety data sheet has to be provided in the 16 standard headings given below. The type of information included in each section is shown below:

Section number	Heading	Useful information
1	Identification of the substance/ preparation and company	Name of the product Name and contact details of the manufacturer or distributor Contact details and possibly an emergency telephone number.
2	Composition/information on ingredients	May help to understand the nature of preparations. However, should be used cautiously as the final properties of the material may significantly differ from its constituent ingredients.
3	Hazards identification	Summarises the main hazards of the product – or indicating it does not pose a significant hazard. A good starting point when referring to the safety data sheet.
4	First-aid measures	Should offer advice on exposure to eyes, by inhalation or ingestion. Pay particular attention to when medical intervention or assistance is recommended.
5	Fire-fighting measures	The writer is unlikely to be aware of the equipment and procedures adopted by the Fire Service, so treat this section with some caution. May give an indication of whether foam or water should be used to fight the fire. If unsure, also check physical properties such as density in Emergency Action Code.

6	Accidental release measures	This section should usually be considered in the context that is aimed at dealing with a smaller occupational spill or release, so the advice may not apply to the incident.
7	Handling and storage	Typically conditions to avoid and how best to store the material. May indicate conditions under which a reaction may occur, for example due to heat, impurities or degradation. Other phrases to look out for include “Fumes/vapour/ powder can form explosive mixtures with air”.
8	Exposure controls / personal protection	Exposure limits, if these apply to the substance, are shown. These are based on repeated occupational exposure usually on a timed average period. The levels of personal protective equipment recommended are unlikely to be considered in the Fire and Rescue Service context. Therefore treat the advice in this section with caution. May be more useful when downgrading levels of protection from chemical protective clothing.
9	Physical and chemical properties	Potentially a useful source of information in planning the response, but does require interpretation of the information provided. Further information is given in this chapter on interpreting physical and chemical properties.
10	Stability and reactivity	Will detail any known reactions, particularly if likely to be violent or producing toxic or flammable gases. Most safety data sheets contain phrases in this section such as “avoid contact with strong acids, bases or oxidisers”. However most materials will react with these substances.

		Should indicate the known products of combustion. While all smoke should be considered as toxic, particular attention should be taken to the toxicity of smoke where it contains more than oxides of carbon (eg Cl, HCl, S, N, P, K, F, Br, I, CN).
11	Toxicological information	Values are indicated by route of exposure and measured in either LC50 or LD50, ie the lethal dose per kg of bodyweight required to kill 50 per cent of the sample size (typically rats). Lower values therefore indicate more toxic substances.
12	Ecological information	Typically indicates the eco-toxicity of a material, for example in removing dissolved oxygen in the marine or freshwater environments, or gives an indication of persistence or bioaccumulation. Further information is available elsewhere in this section. As per Section 11, is best used to assess the degree of the hazard.
13	Disposal considerations	Will detail how hazardous waste involving the substance should be disposed. Typically the advice will be to contact the local authority or a waste management company.
14	Transport information	If the substance has a UN number, it will be given in this section. Emergency action codes should also be listed if applicable.
15	Regulatory information	If the substance is classified as hazardous for supply (or use), ie it has risk and safety phrases, then these will be listed in this section. Risk and safety phrases will indicate potential longer term health effects, which are not reflected in UN number criteria (eg carcinogens, mutagens).

16	Other information	Any other information that the author wishes to consider. Will usually contain the date and revision number of the document.

Interpreting physical and chemical properties

7C2.32 There are many sources of explanation of the various physical and chemical properties of materials that are commonly to be found in Section 9 of a material safety data sheet. The purpose of this chapter will not be to replicate or elaborate on these explanations but to consider the salient points in the context of hazardous materials incident response.

Physical state (solid, liquid, gas)

7C2.33 The physical state of the material will have a bearing on the risks it poses and on how it should be dealt with effectively at the incident. This refers both to the physical state of the material at ambient temperature (ie the background temperature, which of course will vary depending on the climate and season) and the state in which the material is either stored or transported. For example, gases are stored under pressure and if stored under sufficient pressure, they will liquefy.

7C2.34 Gas is one of three classical states of matter. Near absolute zero, a substance exists as a solid. As heat is added to this substance it melts into a liquid at its melting point, boils into a gas at its boiling point, and if heated high enough would enter a plasma state in which the electrons are so energized that they leave their parent atoms from within the gas.

7C2.35 A pure gas may be made up of individual atoms (eg a noble gas or atomic gas like neon), elemental molecules made from one type of atom (eg oxygen), or compound molecules made from a variety of atoms (eg carbon dioxide). A gas mixture would contain a variety of pure gases much like the air. What distinguishes a gas from liquids and solids is the vast separation of the individual gas particles.

7C2.36 Vapour refers to a substance in the gas phase at a temperature where the same substance can also exist in the liquid or solid state, below the critical temperature of the substance.

7C2.37 Gases and vapours have no fixed size or volume; they will expand to fill their container or in the open spread out until they are equally distributed throughout the space available to them. The physical behaviour of gases is described by the gas laws. Properties, notable for those who have to manage incidents, include:

- gases and vapours exert an increasing pressure on their containers as they are heated

- when a gas or vapour expands (perhaps as it escapes its container) its temperature falls.

Operatonal key principle

GASES

Gases other than oxygen present a health hazard to humans either by their toxic effects or by asphyxiation (breathing pure oxygen is also hazardous). **Gases also present the fastest route of exposure by respiratory intake.** Therefore particular care should be taken to reduce the risks from known releases of toxic gases or vapours.

MISTS AND AEROSOLS

Mists and aerosols are dispersions of liquids, and some cases solids, in the air and present similar hazards to gases and vapours. All such clouds are by their nature heavier than air and can sink into hollows and low-lying areas. They are also more likely to **present a significant contamination risk** than a true vapour or gas.

7C2.38 Liquefied and cryogenic substances present a particular hazard. Because of the relationship between pressure, volume and temperature, as liquefied gases are released (large increase in volume) there is a corresponding decrease in both its pressure and its temperature. Cold liquefied gases can cause severe frost and thermal shock on exposure. Cryogenic gas turns into liquid at -90°C or below and can instantly freeze material (ie human tissue). Any clothing saturated with a cryogen must be immediately removed.

7C2.39 Liquefied gases can also cause a boiling liquid expanding vapour explosion (BLEVE) if the container is heated. This is a container failure with a release of energy, often rapidly and violently, which is accompanied by a release of gas/vapour to atmosphere and propulsion of the container or container pieces due to an over pressure rupture. If the substance involved is flammable, it is likely that the resulting cloud of the substance will ignite after the boiling liquid expanding vapour explosion has occurred forming a fireball and possibly a fuel-air explosion termed a vapour cloud explosion. See Section 7, Part C5.120 for further information.

7C2.40 The expansion ratio of a liquefied or cryogenic substance is the volume of an amount of that substance in liquid form compared to the volume of the same amount in gaseous form at a given temperature. Substances with large expansion ratios (eg nitrogen 1:694; oxygen 1:860; liquefied petroleum gas 1:270 etc) can produce pressures that can rupture the pressure vessel. Hence the use of pressure relief valves and vent valves on liquefied petroleum gas containers.

Operatonal key principle

The physical state of the material can have a significant bearing on the strategy for dealing with the incident. Cryogenic and liquefied gases pose particular hazards to responders from the risk of freezing or boiling liquid expanding vapour explosion.

7C2.41 Liquids will flow in response to gravity when released and must therefore be contained safely in order to stabilise the incident and prevent further risk to persons, property and the environment. Volatile liquids will readily give off vapours (see vapour pressure) and this could present problems in creating flammable or noxious atmospheres.

7C2.42 Solids need further assistance to move greater distances and in general are easier to contain. In cases of fire, the surface area of the solid is important to consider. In other words, powders will burn more easily than solid blocks of material.

7C2.43 The physical nature of the material also has consequences for its spread, for example, solids in the form of dusts, fumes and smoke can be quickly carried by the air and present a risk to anyone situated in the path of dispersion.

Operatonal key principle

Solids in the form of dusts, fumes and smoke can be quickly carried by the air and present a risk of contamination to anyone situated in the path of dispersion.

NOTE: Finely divided, flammable dusts can also present an explosion risk.

Density and specific gravity

7C2.44 The density of the material needs to be considered in relation to the surrounding environment. For example in the case of gases, the main consideration is whether it is lighter or heavier than air. Gases that are lighter than air will disperse more easily, although care should be taken where the gas is released in a confined space as it can collect in ceiling voids and spaces (for example the space between a false ceiling and the roof).

7C2.45 Most gases are heavier than air. The ones that are not can be remembered according to the following mnemonic **HA HA MICE**:

Helium (He)

Acetylene (C_2H_2)

Hydrogen (H_2)

Ammonia (NH_3)

Methane (CH_4)

Illuminating gases (eg neon Ne)

Carbon monoxide (CO)

Ethane and ethylene (C_2H_6 and C_2H_4)

7C2.46 Gases that are heavier than air can collect in low-lying spaces (such as cellars or the holds of ships) and present an asphyxiation hazard. Therefore it is important to wear adequate respiratory protection (breathing apparatus) when entering confined spaces where it is suspected there has been a build up of a gas.

7C2.47 For liquids, the relative density to water (as well as solubility) will determine the fate of the material in drains and watercourses.

7C2.48 The specific gravity of a liquid is determined by comparing the weight of an equal amount of water (Water = 1.0). If the specific gravity is less than 1.0 then it will float, if greater than 1.0 it will sink.

7C2.49 Liquids that float on water (such as oil) can be recovered using booms, whereas materials that sink or dissolve cannot.

Water solubility

7C2.50 The ability of a material (gas, liquid or solid) to dissolve in water. Solubility is expressed in a figure of g/100ml water. Materials can be insoluble, sparingly soluble or soluble. This has implications for the nature and management of the incident in terms of containing pollution, fighting fires and the subsequent clean-up.

7C2.51 Soluble materials (such as acids) may be more easily dispersed in the marine and aquatic environments, but this solubility can pose threats to aquatic life such as fish. The release of quantities of soluble contaminant materials into the water course is very likely to have an adverse effect (eg fish kill).

7C2.52 Sparingly soluble or insoluble materials (eg petrol) on the other hand may be spread by flowing water. This could result in vapours or fumes being transported some distance away from the incident. However, as explained above insoluble materials that float on water can be contained by using booms.

7C2.53 Decontaminating people and equipment of soluble materials can be carried out with water alone, otherwise detergents and/or physical removal will be required.

Operatonal key principle	Solubility and density will determine if a material will float, sink or dissolve in water, which will in turn determine the risks of it spreading and deciding whether the material can easily be contained.

Behaviour due to solubility and specific gravity			
Chemical	**Soluble in water**	**Specific gravity**	**Behaviour in water**
Petrol	No	0.7	Floats
Trichloroethane	No	1.3	Sinks
Sulphuric acid	Yes	1.8	Dissolves

Partition constant or partial coefficient (octanol/water)

7C2.54 This gives an indication of relative solubility of a material (compound) in water and in octanol. These two liquids do not mix (are immiscible) and materials or compounds that are more likely to dissolve in octanol means the compound also will not mix with water and is said to be hydrophobic (literally, “fear of water”).

7C2.55 The value is expressed as a logarithmic value (eg log P_{ow}). Negative values indicate that the compound is hydrophilic (likes water). Higher positive values indicate the substance is hydrophobic.

7C2.56 The hydrophobicity of a compound can give scientists an indication of how easily a compound might be taken up in groundwater to pollute waterways and its toxicity to animals and aquatic life.

7C2.57 Materials that are hydrophobic are more difficult to clean-up and decontamination cannot be carried out with water alone, as water itself will not remove the material from chemical protective suits or equipment.

Operatonal key principle	Decontamination is more difficult for hydrophobic compounds.

Corrosivity and pH

7C2.58 The pH of an acid or base is not an indication of its strength as, for example, weak acids can still show low value pH values. Therefore it is important to consider the strength of acids and bases as well as the pH value.

7C2.59 The terms “strength” and “concentration” are frequently confused when used in the context of acids / bases or alkalis that dissociate into ions to a limited extent when dissolved in water. The confusion is caused by the fact that in common usage “strength” and “concentration” are interchangeable terms.

7C2.60 However, when referring to acids or bases (also called alkalis), the terms “strong” or “weak” refer to the relative amount of substance present in ionic form compared to the amount of the same substance present in (non-ionic) molecular form. An acid or base is “strong” if it is entirely or almost entirely present in solution in ionic form cations (+) and anions (-). Hydrochloric acid (HCl) is a “strong” acid because in water, it dissociates almost entirely as H+ and Cl- ions. Acetic acid (vinegar) on the other hand, is only slightly dissociated into ions when dissolved in water. Most of the acetic acid dissolved in water is present in the non-ionic molecular form.

7C2.61 This distinction matters as stronger acids or bases are more reactive and corrosive and therefore pose more of a hazard to the responders, requiring measures to be taken to reduce the risks posed.

Examples of strong acids	Examples of weak acids
Hydrochloric acid (HCl) Hydrobromic acid (HBr) Nitric acid (HNO3) Sulphuric or sulfuric acid (H2SO4) Perchloric acid (HClO4)	Organic acids such as carboxylic acids (R-COOH) of which acetic acid or vinegar (CH_3COOH) is a very common example Hydrofluoric acid (HF) – note that although HF is a weak acid, it still poses very serious hazards Hydrocyanic acid (HCN) Carbonic acid (H_2CO_3) Sulphurous or sulfurous acid (H_2SO_3) Nitrous acid (HNO_2)

Examples of strong bases	Examples of weak bases
Potassium hydroxide (KOH)	Aniline, $C_5H_5NH_2$
Barium hydroxide ($Ba(OH)_2$)	Ammonia, NH_3
Sodium hydroxide (NaOH)	Methylamine, CH_3NH_2
Calcium hydroxide ($Ca(OH)_2$)	Pyridine, C_5H_5N
Lithium hydroxide (LiOH)	Sodium carbonate $NaCO_3$
Magnesium hydroxide ($Mg(OH)_2$)	

Operatonal key principle

The strength of an acid or base is linked to its corrosivity, but strength is not the same thing as concentration for acids and bases.

The pH scale

Acidic						Neutral								
Alkaline														
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hydrochloric acid		Coffee	Orange juice	Beer		Urine	Pure water	Blood	Baking soda	Milk of magnesia			Caustic soda	

Chemical reactivity

7C2.62 Whether two (or more) chemicals will react when they come into contact will depend on the properties of the chemicals concerned as well as some other factors such as:

- Temperature – an increase in temperature increases the rate of reaction
- Concentration or pressure – the higher the concentration or pressure, the faster the rate of reaction
- Surface area – gases and liquids (having the greater area for reaction) react more readily than solids
- The energy or heat content (enthalpy) needed to initiate the reaction – with reference to the above
- Whether the net result of the reaction is to give out more heat than it consumes (exothermic) or to absorb more heat than is given out (endothermic) – exothermic reactions are more hazardous and more likely to occur.

7C2.63 Chemical reactivity is therefore usually predictable, based on the chemicals involved and the circumstances of them mixing.

7C2.64 Common reactions include:

Acid + Base = Salt (soluble) + Water

eg HCl + NaOH = NaCl + H_2O

Acid + Insoluble Carbonate = Salt + Water + Carbon Dioxide

eg $2HNO_3 + CaCO_3 = Ca(NO_3)_2 + H_2O + CO_2$

Oxidizer + Organic compound = Fire + Water + Carbon Dioxide + Other Products

Concentrated Acid + Organic compound = Dehydrated Organic + Water + Concentrated Acid

Base + Organic compound = Soapy Salt + Water

eg Caustic Soda (NaOH) + Stearic Acid = Sodium Stearate + water

7C2.65 There are other specific types of reaction that pose particular hazards. These are discussed below.

Polymerisation reactions

7C2.66 Polymerisation reactions involve the linking of molecules (monomers) together chemically. In controlled conditions polymerisation is safe, in uncontrolled conditions it can lead to a runaway reaction resulting in an increase in volume and pressure with the risk that containers of these materials can suddenly burst releasing the material and/or toxic gases. Examples include vinyl chloride, toluene diisocyanate and epichlorohydrin.

7C2.67 The reaction can be triggered by heat, pressure or the presence of contamination or a catalyst (a substance that initiates a chemical reaction without being changed itself).

Reactions with water

7C2.68 Water reactive substances react with water to produce secondary products that are hazardous. Possible reactions include the production of flammable gas, toxic gas or a large amount of energy.

7C2.69 Examples include sodium which when reacting with water produces hydrogen gas and calcium carbide which when reacting with water gives acetylene gas: $CaC_2 + 2H_2O = C_2H_2 + Ca(OH)_2$.

Water reactive materials	
Material	**Hazard of reaction**
Sulphuric acid	Heat
Potassium, sodium	Flammable hydrogen gas
Calcium carbide	Corrosive and flammable products
Aluminium chloride	Hydrochloric acid burns
Sodium peroxide	Oxygen and heat

Reactions with air (pyrophoric substances)

7C2.70 Pyrophoric substances ignite spontaneously in air often liberating vast amounts of energy and causing combustion which can also lead to noxious products of combustion. They are sometimes also water reactive. Examples of pyrophic substances include white or yellow phosphorus and iron sulphide.

Operatonal key principle

The likelihood of reaction can usually be predicted based on the properties of the reactants and the environmental conditions. Beware materials that can undergo spontaneous reactions such as polymerisation or react with air or water.

Neutralisation reactions

7C2.71 The most common example of neutralisation is reacting an acid with a weak base (alkali) such as soda ash (sodium carbonate).

7C2.72 The advantage of neutralisation is the reduction in corrosivity of the material that is being neutralised, making the material (and the waste products) easier to handle.

7C2.73 However there are distinct disadvantages of neutralisation reactions that usually outweigh the advantages.

7C2.74 For instance, to neutralise a strong acid requires either a strong base or a very large quantity of a weak base such as soda ash. Adding soda ash to acid creates carbon dioxide and is therefore a ‘frothy’ reaction. This increases the quantity of waste materials that must be disposed of as well as incurring the costs and trouble of sourcing the neutralising agents, for seemingly little advantage.

7C2.75 There should never be an attempt to neutralise concentrated acids or bases (>30%). These can react violently with any neutralising agent added, with the reaction getting increasingly more violent as the concentration increases. This can be very dangerous and should be avoided.

7C2.76 In dealing with small residues of acid once other measures (such as pumping into a separate container or absorbing in an inert material) have been taken to remove the bulk of the acid spill neutralisation can be considered.

Operatonal key principle

Neutralisation of an acid (or alkali) spill usually carries more disadvantages than advantages. It is better instead to look at the neutralisation of residues. You should never look to neutralise concentrated acids or bases and if in doubt don't do it!

Concentration

7C2.77 The concentration of solutions is expressed as Molarity (M) or moles (measured in mols it is a unit used to express the amount of a substance) per litre of solution.

7C2.78 Concentrations are always percentage ratios of solute (the solid substance) to the solvent (usually water). The most commonly used chemistry concentration unit is Molarity.

- Molarity = mols of solute/litres of solvent (water).

7C2.79 The concentration of a solution greatly influences the rate of chemical reaction. Higher concentrations mean faster reactions. More concentrated solutions (eg acids or bases) are therefore more reactive and more hazardous.

7C2.80 There may be the temptation to 'reduce the hazard' by either diluting concentrated acids or bases with water or by neutralising an acid with a base or vice versa. Dilution of concentrated (>30%) acids or bases with water should be avoided if possible. This is because the concentrated acid or base will react with the water added producing heat which will in turn speed up further reactions. Dilution of concentrated acids or bases can be safely carried out by adding the acid or base to water and not the other way around. Clearly in the event of a spill of an acid or base, this is not practicable.

Operatonal key principle

Concentrated (>30%) acids or alkalis (bases) should not be diluted or attempts made at neutralisation.

Flash point

7C2.81 Flash-point refers to the lowest temperature at which a liquid or solid gives off vapour to a degree that a flammable mixture is formed when the vapour combines with air near the surface of the liquid or solid. Hence, the lower the flash-point, the more flammable the material. Flash-points are determined by experiment with two main methods used – open cup and closed cup. Closed cup flash-points are typically a few degrees lower than open cup flash-points for the same material.

7C2.82 Flammable liquids are defined by possessing a flash point of 60°C or lower. Liquids that have a flash point above 60°C are termed combustible. Highly flammable or extremely flammable liquids have flash points lower than 23°C, which is close to normal ambient temperatures. This means that an ignition source (electrical spark, static electricity, naked flame etc) can trigger a fire where there are flammable liquids present. However this likelihood also depends on the flammable limit range of the flammable liquid.

Flammable limit range

7C2.83 The flammable limit range of a substance is the range of concentrations of the substance in air that are flammable. Flammable limits are also called flammability limits or explosive limits. The lower flammable limit or lower explosive limit describes the leanest mixture that is still flammable, while the upper flammable limit or upper explosive limit gives the richest flammable mixture. increasing the fraction of inert gases in a mixture raises the lower flammable limit and decreases the upper flammable limit. Vapour monitoring at an incident scene can determine if the vapour cloud is within the flammable range. If the values found are above the upper flammable limit, then there will be a risk of ignition when the vapour has further dispersed so that the concentration falls below the upper flammable limit.

7C2.84 An analogy can be given with a petrol-engine powered car. A carburettor or fuel-injection system in the engine ensures the correct mixture of fuel to air. If the fuel mixture is too rich (too much petrol) or too lean (too little petrol) then the mixture will not burn and the car doesn't work.

7C2.85 Substances with wider flammable ranges are more hazardous than those with narrow ranges. Isopropyl alcohol for example, has a flammable range of 2–12 per cent in air whereas acetylene has a flammable range of 2.5–80 per cent, making vapour clouds of acetylene much more likely to be flammable in air.

Operatonal key principle

Be wary of materials with a wide flammable limit range. Vapour concentrations above the upper flammable limit / upper explosive limit pose a risk of ignition as the vapour disperses.

Ignition (auto-ignition) temperature

7C2.86 The auto-ignition temperature (sometimes called the kindling point) refers to the temperature at which the substance will ignite in the absence of a source of ignition such as a spark or flame. Auto-ignition temperature decreases as the pressure increases or where oxygen concentration increases. An analogy can be given of a diesel-engine powered vehicle where the mixture of fuel and air is compressed sufficiently for the diesel to self-ignite and power the vehicle.

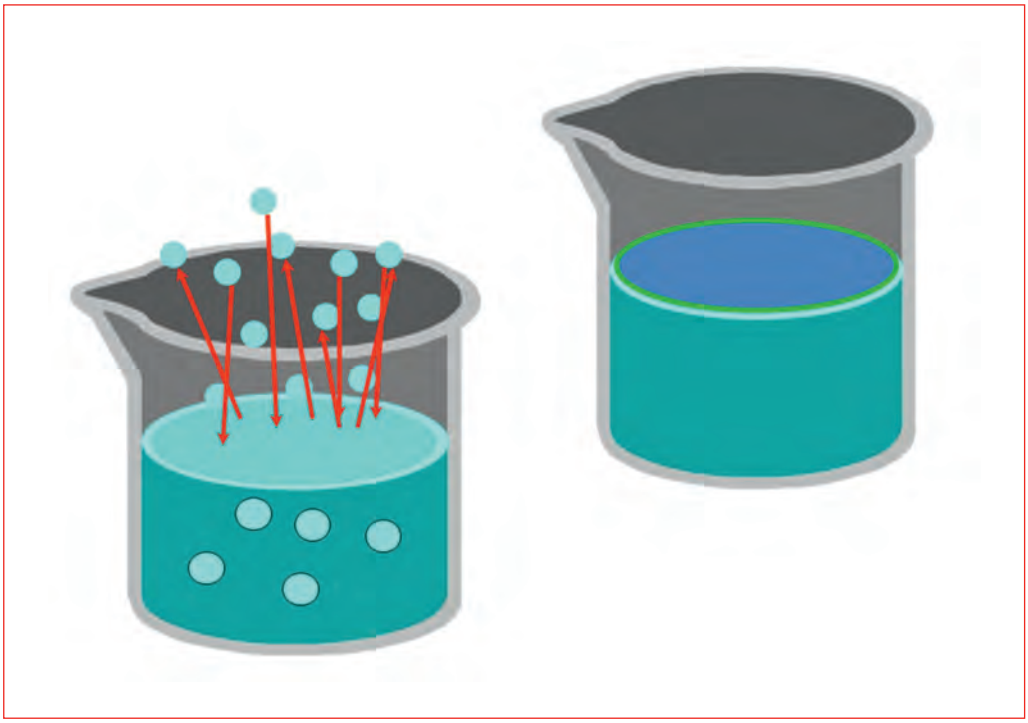
7C2.87 Pyrophoric substances such as silanes and phosphorus have low auto-ignition temperatures.

Vapour density

7C2.88 This refers to the relative weight of a gas or vapour compared to air (or sometimes it can be compared to hydrogen gas). Air is assigned an arbitrary value of 1 and if a gas has a vapour density of <1 it will generally rise in air. If the vapour density is >1 the gas will generally sink in air. All vapours tend to be heavier than air.

Vapour pressure

7C2.89 Vapour pressure is a measure of how easily a liquid evaporates or gives off vapours. It is displayed using the units of pressure such as Pascals (or kPa) or sometimes mm Hg or in reference to atmospheric pressure (bar). The higher the vapour pressure the more vapour will be produced. Vapour pressure is also temperature dependent with more vapours being produced as temperature rises. Where the vapours being given off by a liquid pose a hazard (eg flammable vapours), these can be suppressed by covering the surface. Sheets, beads and fire-fighting foam are examples of materials that can be used for this purpose.



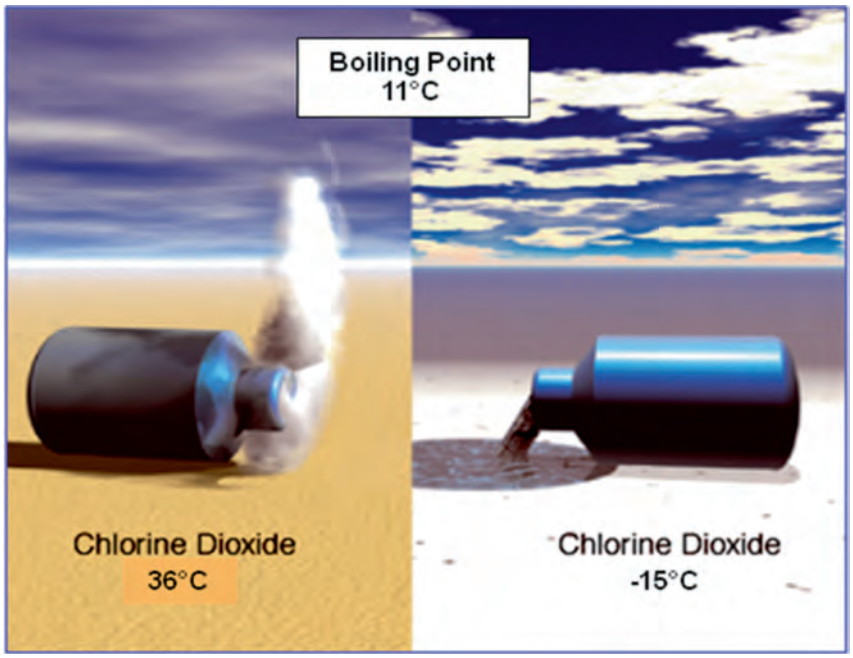
7C2.90 The figure above illustrates that for any pool of liquid, there is always a small amount of vapour being given off at the surface. There is an equilibrium between the vapour coming off (arrows up) and the vapour being re-absorbed into the liquid (arrows down). Vapours can be suppressed by covering the surface with a suitable material.

Operatonal key principle

Materials with high vapour pressure may require suppression of the vapours produced by applying foam or fixed materials (eg sheeting etc) to the surface of the liquid. Minimising surface area will minimise vapour production. Therefore, avoid the use adsorbents (eg sand etc) as this will increase the production of vapours through increased surface area.

Boiling point

7C2.91 Boiling point is the temperature at which a liquid's vapour pressure equals atmospheric pressure and the liquid starts to turn to vapour. Low boiling point substances tend to be either gases or very volatile liquids at ambient temperature. Ethers, most alcohols and atmospheric gases such as nitrogen and oxygen are examples of this.



Toxic products of combustion

7C2.92 When a material burns (combusts) it undergoes a chemical reaction that usually involves atmospheric oxygen. This results in products of combustion, some of which may pose particular hazards to health. Hydrocarbons and many common materials such as paper, wood and plastic contain carbon. When burned they produce oxides of carbon – carbon dioxide and carbon monoxide. If smoke is produced in a fire, it will contain particulates – usually of carbon. As carbon monoxide is a toxic gas it can be assumed that all smoke is toxic and products of combustion will either be toxic or asphyxiant.

7C2.93 Particular concern needs to taken when the products of combustion are corrosive or acutely toxic. These tend to be produced when the chemical products undergoing combustion contain certain elements such as halogens (F, Cl, Br, I), metals and particularly alkali metals (Li, K, Na) or certain non-metallic elements (specifically N, S, P, As) in their compound structure. Compounds containing these elements are to be found commonly in products such as detergents, fertilisers and pesticides. If in any doubt as to whether fumes are likely to contain these species, consult the safety data sheet or seek further advice from the manufacturer or from a scientific adviser.

7C2.94 Chlorinated hydrocarbons, for example, produce hydrogen chloride fumes when they decompose at high temperatures (when exposed to a fire or hot surfaces). If the hydrogen chloride fumes are inhaled by responders, it will lead to the formation of acid in the lungs which will then affect the working of the lungs and could lead to more serious health effects such as pulmonary oedema which can

occur up to 48 hours after exposure and can result in death. Therefore anyone who is suspected of having breathed in toxic or corrosive fumes should seek immediate medical attention.

Toxicity

7C2.95 Toxicity is the intrinsic capacity of a chemical agent to affect an organism adversely.

7C2.96 Toxicity rating is an arbitrary grading of doses or exposure levels causing toxic effects. The grading can be "highly toxic," "toxic", "harmful" and so on, based on the lethal dose. The most common ratings concern acute toxicity (ie a short-term but potentially high exposure). Substances can also have chronically toxic effects (ie from repeat and cumulative exposure over time). The differences between acute and chronic toxicity are reflected in the criteria for classifying products for transport and supply. For example, cancer is much more likely to develop from repeated occupational exposure to a carcinogen than a one-off acute exposure.

7C2.97 The dose-effect relationship is the relationship between dose and effect on the individual level. An increase in dose may increase the intensity of an effect, or a more severe effect may result. A dose-effect curve may be obtained at the level of the whole organism, the cell or the target molecule. Some toxic effects, such as death or cancer, are not graded but are "all or none" effects.

7C2.98 A dose is often expressed as the amount of a substance entering an organism (such as a person) and is expressed in units such as mg/kg body weight. A dose threshold is a dose level below which no observable effect occurs. Thresholds are thought to exist for certain effects, like acute toxic effects; but not for others, like carcinogenic effects or exposure to radiation. The lethal dose (LD50 or LC50) is the dose causing 50 per cent death in an animal population. LD50 is given as a measure of the acute toxicity of the chemical substance. The lower the LD50 the higher is the acute toxicity. There is no necessary correlation between acute and chronic toxicity.

Operatonal key principle	Note the difference between acute and chronic toxicity. Toxicity is indicated by the lethal dose, which is measured in relation to body weight. The adverse effects are therefore minimised by eliminating or reducing the possible dose.

Eco-toxicity

7C2.99 Further information on eco-toxicity and how to interpret the various values such as chemical oxygen demand, biological oxygen demand, bioaccumulation and persistence can be found in *Fire and Rescue Manual (Volume 2: Fire Service Operations), Environmental Protection.*

Dispersal of chemicals in water

Predicting dispersal of chemicals in water				
Boiling point	**Vapour pressure**	**Specific gravity**	**Solubility**	**Expected behaviour in water**
Below ambient	Very high	Any	Insoluble	All liquid will rapidly boil from surface of water
Below ambient	Very high	Below that of water	Low or partial	Most liquid will rapidly boil off but some will dissolve. Some of the dissolved liquid will evaporate
Below ambient	Very high	Any	High	At least 50 per cent will rapidly boil off; the rest will dissolve. Some of the dissolved liquid will evaporate later.
Above ambient	Any	Below that of water	Insoluble	Liquid will float, forming a slick. Those with significant vapour pressure will evaporate over time.
Above ambient	Any	Below that of water	Low or partial	Liquid will float but will dissolve over time. Those with significant vapour pressure may simultaneously evaporate.
Above ambient	Any	Below that of water	High	Liquids will rapidly dissolve in water up to the limit (if any) of their solubility. Some evaporation may take place over time if vapour pressure is significant.
Above ambient	Any	Near that of water	Insoluble	Difficult to assess. May float on or beneath surface or disperse through the water column. Some evaporation may occur from surface over time if vapour pressure is significant.

Predicting dispersal of chemicals in water				
Above ambient	Any	Near that of water	Low or partial	Will behave as above at first and eventually dissolve. Some evaporation may take place over time.
Above ambient	Any	Any	High	Will rapidly dissolve up to the limit (if any) of their solubility. Some evaporation may take place over time.
Above ambient	Any	Above that of water	Insoluble	Will sink to the bottom and stay there. May collect in deep water pockets.
Above ambient	Any	Above that of water	Low or partial	Will sink to the bottom and then dissolve over time.
Above ambient	Any	Above that of water	High	Will rapidly dissolve up to the limit (if any) of their solubility. Some evaporation may take place from the surface over time if vapour pressure is significant.

PART C–3

Transportation, packaging and supply of hazardous materials

Introduction

7C3.1 This section provides a summary of the information that emergency responders will need to know regarding the storage, packaging, transportation and supply of hazardous substances (mostly commonly referred to as dangerous goods in the regulations that apply to their transportation). It is not intended to be a detailed guidance document on these regulations.

7C3.2 The section is intended to enable the reader to:

- recognise typical container shapes that would indicate the presence of hazardous materials whether in storage, packaging or being transported
- recognise containers for specific hazardous materials whether in storage, packaging or being transported
- identify the basic design and construction features, including closures for storage, packaging and transportation systems
- obtain an overview of the storage, packaging and transportation systems
- retrieve and interpret information retrieved from markings and information for storage, packaging, transportation and supply (or use).

7C3.3 Throughout the note, reference is made to other publications; these should be read in conjunction with this note to ensure a full understanding of the subject.

Operational considerations for transport incidents

7C3.4 The generic standard operating procedure detailed in Part A of this operational guidance should be considered when responding to any transport related emergency incident.

7C3.5 The types of stress that will affect packaging and the transport method are:

- accidental damage
- major stress of a road traffic collision, train crash or air crash
- direct involvement in fire
- heat transfer
- mechanical failure

- human error.

7C3.6 All of these stressors may well result in one or more of the following:

- damage to the structure of the packaging
- damage to the transport media
- a loss of product
- a fire/explosion
- casualties trapped in the immediate vicinity of the hazardous substance
- damage to the environment
- damage to the surrounding area
- damage to the local infrastructure.

7C3.7 As a transport-related incident implies, being away from a base site, there will be no operational plan to fall back on. Therefore the Incident Commander and the hazardous materials adviser will need to carry out a risk assessment and create a response plan suitable and sufficient in the circumstances.

Transportation of dangerous goods

Regulatory background

7C3.8 The regulatory framework for the global transport of dangerous goods is agreed by the UN Sub-Committee of Experts for the Transport of Dangerous Goods. Its provisions are set out in the UN Model Regulations (*Recommendations on the Transport of Dangerous Goods*, commonly known as the 'orange book') which are revised and republished every two years and form the basis of the internationally agreed mode-specific requirements.

7C3.9 Detailed rules for the international transport of dangerous goods by road are set out in the United Nations Economic Commission for Europe (UNECE) publication known, from its French title, as ADR (Accord dangereux routier). The text for each edition of ADR (re-issued every two years) is agreed by a UNECE committee which usually meets bi-annually in Geneva and the UK is represented at these meetings by the Department for Transport (DfT), which consults key dangerous goods interest groups before the UK position on the various agenda items is decided. Currently, including the UK, there are 46 'contracting parties' to ADR. This Agreement between States has no overall enforcing authority; in practice checks are carried out by contracting parties and non-compliance is dealt with by national authorities against offenders in accordance with their domestic legislation.

7C3.10 Detailed provisions for the international transport of dangerous goods by rail are published under the OTIF (Organisation intergouvernementale pour les Transports Internationaux Ferroviaires) convention in a document known from its French title, as RID (Reglement International concernant le transport de marchandises Dangereuses par chemin de fer). OTIF is an intergovernmental organisation with a mainly European membership that includes the UK. The RID Committee usually meets annually, at different locations, and the UK is again represented by DfT. The text of RID is almost identical to that of ADR, varying only to reflect modal differences.

7C3.11 The EU has adopted the UNECE / OTIF rules in a series of Directives, which extend the scope of ADR and RID to apply to national as well as intra-Community transport. A combined Directive for the inland transport of dangerous goods (covering road, rail and inland waterways) – 2008/68/EC – is transcribed into GB domestic legislation via *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009*.

7C3.12 The modal regulations lay out the requirements for the carriage of dangerous goods for the specific mode of transport. In summary they are:

- *The European Agreement concerning the International Carriage of Dangerous Goods by Road* (ADR)
- *The EU Regulation concerning the Carriage of Dangerous Goods by Rail (RID)*
- *The European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways* (ADN)
- *The International Maritime Dangerous Goods Code, published by the International Maritime Organisation*
- *Restricted Articles Regulations published by the International Air Transport Association*
- *International Civil Aviation Organisation Regulations.*

The UN system

7C3.13 The UN 'orange book' establishes a basic system for the safe transport of dangerous goods. The system is designed to reduce the risk of serious incidents involving dangerous goods and the impact of such incidents when they do occur.

7C3.14 Dangerous goods are substances which meet the criteria for one or more classes.

7C3.15 The regulations stipulate that dangerous goods are:

- classified (identified) according to their hazard(s)
- packaged to the required standards

- marked
- labelled
- documented.

7C3.16 The regulations also state that relevant personnel should be properly trained.

Classification

7C3.17 To accommodate the large number of dangerous goods and the consistent, rapid development of new substances, the unusual chemical names used to describe them and the different emergency response for them, the United Nations Economic and Social Council's Sub-Committee of Experts on the Transport of Dangerous Goods (UNSCETDG) devised tests and criteria to be used to determine which substances could be identified as dangerous goods in transport. This sub-committee then devised a system of nine classes for substances, based on the hazard or the most predominant of the hazards they pose in transport, with the objective of dividing all current and future dangerous goods into these classes. The system of classes was established keeping in mind the type of containment to be used, the chemical and physical characteristics of the substances and response procedures that would be most appropriate in the event of an accidental release.

7C3.18 Classification is a fundamental part of the UN system incorporating:

- UN class
- UN packing group
- UN number
- Proper shipping name.

7C3.19 Dangerous goods are firstly assigned to one of nine hazard classes, known as UN classes, according to their primary hazard. Secondly, an assessment is made of the relative hazard of a substance within the same class and the substance is assigned to one of three packing groups. Each substance is then allocated a substance identification number which is designed to allow identification of the substance in transit. These code numbers are commonly known as 'UN numbers'. The UN recommends that UN numbers appear on all transport documents and are displayed on packages, containers, vehicles, along with a description of the substance called the proper shipping name.

7C3.20 The nine UN hazard classes are numbered 1 to 9 and sub-divided into divisions The Regulations also contain rules on identifying the hazards and danger of the substances. Each class (and sometimes division) is therefore assigned a hazard symbol.

7C3.21 The nine classes are:

Class	
1	Explosives
2	Gases
3	Flammable liquids
4	Flammable solids; substances liable to spontaneous combustion; substances which, on contact with water emit flammable gases
5	Oxidizing substances and organic peroxides
6	Toxic and infectious substances
7	Radioactive material
8	Corrosive substances
9	Miscellaneous dangerous substances and articles

7C3.22 The classification of substances by type of hazard was developed to meet technical conditions while at the same time minimising interference with existing regulations. It should be noted that the numerical order of the classes does not indicate the degree of danger. The objective of the definitions is to establish which substances are dangerous and in which class, according to their specific characteristics, they should be included.

United Nations class, division and hazard symbol

Class 1 Explosives

(Divisions – 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 (1.6 not used in the UK))

Class 2 Gases

Division 2.1 Flammable gases

Division 2.2 Non-Flammable, compressed gases

Division 2.3 Toxic gas

Class 3 Flammable Liquids

Class 4 Flammable Solids

Division 4.1 Flammable solids, self reactive substances and solid desensitized explosives

Division 4.2 Substances liable to spontaneous combustion

Division 4.3 Substances which in contact with water emit flammable gases.

Class 5 Oxidising substances

Division 5.1 Oxidising substances other than organic peroxides

Division 5.2 Organic peroxides

(used until 2009)

Class 6 Toxic and infectious substances

Division 6.1 Toxic substances

Division 6.2 Infectious substances

Class 7 Radioactive material

Category I, Category II, Category III and Fissile material (capable of nuclear explosion)

Class 8 Corrosive substances

Class 9 Miscellaneous dangerous substances and articles

United Nations packing group

7C3.23 The UN developed a system to identify substances in a particular class or division according to the "degree of danger". This is known as the 'packing group', of which there are three levels

- Packing Group I: Very dangerous
- Packing Group II: Medium danger
- Packing Group III: Minor danger.

7C3.24 Goods are assigned to one of these groups based on the criteria. Packing group does not apply to explosives (Class 1), gases (Class 2), organic peroxides (Class 5.2), infectious substances (Class 6.2), radioactive material (Class 7) or self-reacting substances found in Class 4.1. Instead there are special packaging and transport provisions for these materials.

7C3.25 The international agreements for the carriage of dangerous goods require packaging to be of a design type certified by a national competent authority. This involves testing the packaging to ensure its suitability for the carriage of certain dangerous goods. Such packaging is often referred to as a 'type-approved' or 'UN Certified'. Such packaging is marked in particular ways, prefixed by the UN logo and followed by a set of codes which detail the standard of packaging.

UN number

7C3.26 Once a product has been assigned to an appropriate hazard class and packing group, a UN number can be selected. The UN number is a means of identifying a chemical substance or an article containing a chemical. A list of UN numbers can be found in the current version of the dangerous goods emergency action code list at:

http://the-ncec.com/resources/

7C3.27 In addition, several other organisations publish lists of additional numbers for use in their countries, or by a particular mode of transport:

- UK '7000 series', which included numbers for wastes, hot liquids, and several chemicals are not included specifically in the UN list and have not been used for some time
- 8000 series, published by International Air Transport Association includes entries for some additional substances and articles which are to be transported by air
- North American 9000 series also contains many additional numbers for substances and articles not otherwise classified for transport.

7C3.28 UN numbers also divide into two types:

1. **Single substance numbers** for pure chemicals – for use when transporting a chemical substance in its pure form, or for solutions or mixtures including those substance where the principal hazards of, and emergency response actions to, such a mixture do not differ significantly from those of the pure substance.

2. **Generic or not otherwise specified numbers** – for use in the transport of pure substances not specifically mentioned in the UN list and for mixtures of substances which meet the criteria of that number.

Proper shipping name

7C3.29 The name immediately following the UN number is the 'proper shipping name' and is the one that should be quoted on packages, tanks and in documentation. Even when the substance is known by more than one name it is the proper shipping nme that should always be used. Examples include UN 1035 Ethane and UN 1993 Flammable liquid, not otherwise specified.

Segregation

7C3.30 There are rules on segregation as a means keeping incompatible goods apart from one another, using a barrier or intervening space. Chemicals must be segregated when either stored or transported to reduce the likelihood of them mixing if an accident occurs. This is an essential element of the safe system of work designed to prevent fires, explosions and the release of harmful gases etc. The rules for sea transport (ie international maritime dangerous goods code) are stricter than for road or rail.

7C3.31 The regulations contain segregation tables that can be referenced to see if two materials can be transported together or if conditions apply if they are transported in the same shipment. These tables can be a useful guide for establishing some common incompatibilities or where additional hazards will result from chemicals mixing, eg a flammable material and an oxidising agent, which could result in a fire if mixed.

Documentation

7C3.32 There are slightly different rules for each mode of transport on the documentation that must accompany consignments of dangerous goods that describes the load. However, they are all based on the same principles. These documents are a very valuable means of identifying the load and hence obtaining hazard information that can be used to develop the incident response plan.

7C3.33 The documentation should contain the following information for each dangerous substance, material or article being carried:

- United Nations number preceded by the letters 'UN'
- Proper shipping name supplemented, when applicable with the technical name in brackets
- Packing group for the substance preceded by the letters 'PG' (eg PG II), or the initials corresponding to the words 'packing group' for other languages
- Total quantity of dangerous goods for different UN number, proper shipping name or, packing group (shown as by volume or mass (weight) as appropriate)
- Number and a description of the packages when applicable
- For dangerous goods in machinery or equipment, the total quantity of dangerous goods contained therein
- Name and address of the consignor (ie where it was sent from)
- Name and address of the consignee(s) (ie where it is going to). If this is not possible (eg multi-drop) then the words 'delivery sale' may be shown instead.

7C3.34 There are special provisions for explosives (Class 1) and radioactive material (Class 7).

7C3.35 The most common form of transport document likely to be encountered is the dangerous goods note accompanying the movement of dangerous goods by road. Since the removal of product specific instructions in writing for the driver (commonly known and referred to as Tremcards ®) from July 2009, which were used as a means of identifying the load by emergency responders, the dangerous goods note is the main means of identifying the contents of a vehicle carrying packaged dangerous goods.

Road transportation

Packaged goods transport labelling

7C3.36 There are different regimes used to placard and label dangerous goods transported in 'packages'.

7C3.37 Following classification, the manufacturer or importer will be able to produce an appropriate label for the substance. For transport purposes, this label will include:

- the designation of the product or proper shipping name
- the UN number
- and appropriate hazard warning symbols.

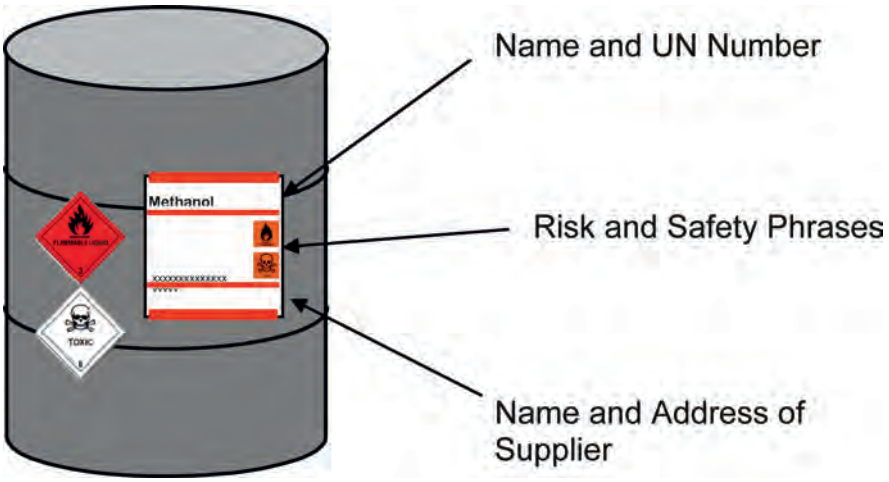
7C3.38 The designation of the goods is the proper shipping name for the goods. This is the official description listed in the regulations for a particular UN number.

7C3.39 If a product is not specifically listed in the Regulations, or the hazardous properties and emergency response procedures for a solution or mixture do differ significantly from those of the pure substance, then one of the generic not otherwise specified entries must be used. In such cases, the proper shipping name must be supplemented with the technical name of the goods. The technical name should be a recognised chemical name for the substance or substances which caused the product to be classified as hazardous. Normally not more than two ingredients are named, eg, UN 1992 Flammable liquid, toxic, not otherwise specified (gasoline and carbon tetrachloride mixture) or UN 2003 Metal alkyl, not otherwise specified (trimethyl gallium).

Example transport label

7C3.40 There are different requirements for the labelling of products for supply and use, which are covered later in this chapter. However, for some containers the labels for transport and supply can be combined.

A combined label for transport and supply



Combination packages

7C3.41 Packaged goods are usually transported in a combination package, consisting of inner packages of a size intended for supply (usage), packed into an outer box convenient for transport.

7C3.42 Packages for transport of hazardous goods are required to be fit for purpose, and be tested and marked with a UN symbol to show this.

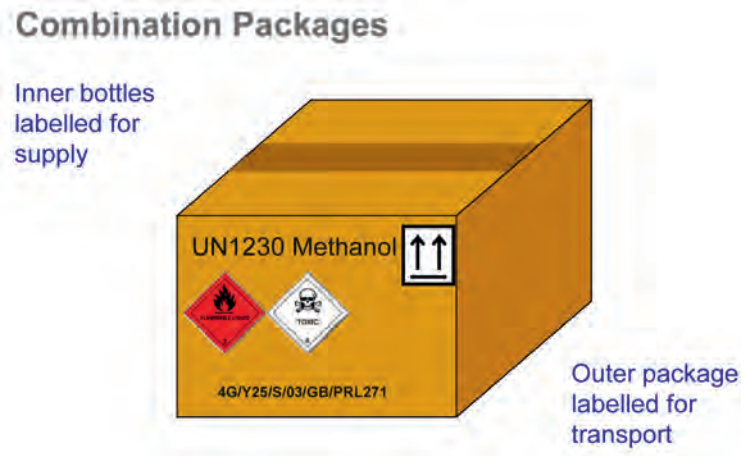
For example: 4G/Y25/S/03/GB/PRL271

7C3.43 The inner package will be labelled for supply purposes, while the outer package will be labelled for carriage. Because the regulations for transport and supply of hazardous goods cover different hazards, the labels that have to be provided on each layer of the package can be different for each purpose.

7C3.44 This can cause some confusion, particularly where the inner containers of a package may be labelled as toxic, because of their potential to cause adverse effects on long-term exposure, while the outer containers may not be labelled at all, because the product does not cause effects on short term exposure.

7C3.45 Further details of the labelling systems for supply (usage) of chemicals are given later in this part.

Combination package



Road transport regulations

7C3.46 The regulations concerning the carriage of dangerous goods by road apply from when the goods are being loaded on to a vehicle until they are removed, or in some cases, until any receptacle containing dangerous goods and/or the vehicle itself has been cleaned to a set standard so that there is no risk from the original product.

7C3.47 Duties are placed on different people; those consigning dangerous goods for carriage, vehicle operators, drivers and others such as those involved in the design and construction of vehicles. Many of the requirements in the regulations are placed on the operator of the vehicle, ie the person who has the management of the vehicle (has the vehicle operator's licence).

7C3.48 The requirements of the legislation only apply above certain quantity thresholds. These depend on whether the dangerous goods are being carried in packages, tanks or in bulk. The consignor of a load has the duty of classifying the dangerous goods in accordance with strict guidance and correctly packaging and labelling them.

7C3.49 Before responsibility for the safe carriage of these goods passes to the operator of the vehicle, there are further important requirements the consignor needs to fulfil:

- provide the operator with information
- ensure that the rest of the 'transport chain' – from the operator to the vehicle carrying the goods to the driver and the person who finally receives the consignment (the consignee) – has the necessary information to enable them to:
  - identify what is being carried and the hazards the goods pose

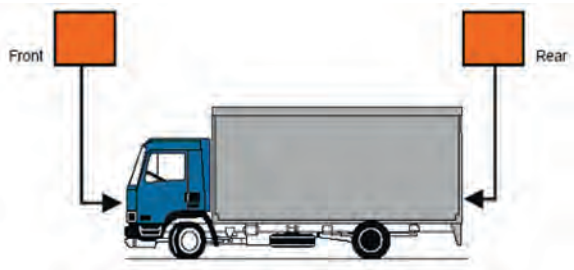
– ensure appropriate precautions are taken to prevent, as far as possible, any risk to the health and safety of anyone who might be affected by the carriage of the goods

– respond quickly and effectively in the event of an accident involving the carriage of dangerous goods and, in particular, provide the information to the emergency services so that they can act appropriately.

Marking of packaged goods vehicles

7C3.50 Vehicles that are used to transport dangerous goods in packages and which are within the scope of the regulations are required to display plain orange placards at both the front and rear. While this is an indication that the vehicle is carrying dangerous goods, it gives no indication of the nature of those goods. Further information regarding the load would need to be found on the driver's delivery schedule, dangerous goods note or on the packages themselves.

Vehicle carrying packaged dangerous goods



Voluntary marking of packaged goods vehicles

7C3.51 There are currently two examples of voluntary vehicle marking schemes in the UK set up by transport carriers of dangerous goods, with the agreement of the Health and Safety Executive, the Police Carriage of Dangerous Goods Practitioners Forum and the Department for Transport.

Hazchem Emergency Response Service (HERS)

7C3.52 The Hazchem Network is a group of member carriers that use a central hub depot and satellite depots to transport packaged dangerous goods on pallets. An initiative was started in 2007 called the Hazchem Emergency Response Service to put a decal on the rear of its member vehicles displaying the name of the scheme and a contact emergency telephone number. The telephone number can be used to access emergency advice, to potentially access details of what the vehicle is carrying (if the registration number is known) and to access clean-up arrangements already put in place.

Hazchem Emergency Response Service (HERS) Decal used by the Hazchem Network palletised dangerous goods carriers in the UK

DHL Hazchem Emergency Response Service

7C3.53 This HERS scheme was then adapted for use by DHL, another carrier of packaged dangerous goods, in May 2010. A similar decal was developed that would be displayed on the back and sides of the vehicles used to transport dangerous goods, initially for two vehicles but with the plan to extend it to further vehicles in the DHL fleet. The decal would be used on two 'transit' style vehicles. These vehicles are sometimes used to carry radioactive materials but the HERS decals are used when the vehicles are carrying packaged dangerous goods but not radioactive materials.

7C3.54 These decals will only be displayed if the vehicle is carrying dangerous goods of sufficient quantities that the vehicle is subjected to the requirements of the ADR Regulations. In other words, if the vehicle is carrying goods that fall under the *Limited Quantity Exemptions to ADR*, or the vehicle is not carrying dangerous goods at all, then the decals will not be displayed.

Hazchem Emergency Response Service (HERS) Decal used by some DHL vehicles while carrying dangerous goods in the UK

Type of vehicle used by DHL to transport packaged dangerous goods in the UK. The Class 7 and Radsafe labels would be replaced by the above Decal (the packaged goods will not be Class 7)

The placarding of road tankers and tank containers

7C3.55 Although the UK is a signatory to the international agreements on road transport movements (ADR) there are different requirements for the placarding of tankers and tank containers for purely domestic journeys (UK Hazchem). These do not apply to international movements of dangerous goods either starting or completing their journey in the UK.

7C3.56 While each system is described in more detail in this chapter, the table below summarises the differences between the two systems.

Road tankers placards

UK Hazchem placard

ADR placard

Tankers and tank container placarding		
Information	**UK Hazchem**	**ADR**
UN number	Yes	Yes
Hazard symbol	Yes	Yes
Emergency action code	Yes	
Emergency telephone number	Yes	
Hazard identification number		Yes

UK Hazchem hazard warning panel

7C3.57 UK Hazchem hazard warning panel or placard used in the United Kingdom contains information on the hazardous substance being carried by the vehicle.

7C3.58 UK Hazchem is not the ADR hazard identification number, also known as the Kemler Code, this is a different warning placard. The main difference is the ADR hazard identification number details the nature of the hazard presented by the goods as opposed to the actions to be taken when dealing with them.

7C3.59 The top-left section of the Hazchem panel gives the emergency action code, which advises the Fire and Rescue Service, what actions to take if there is an accident. The middle-left section gives the UN substance identification number. The lower-left section gives the telephone number that should be called if special advice is needed. The warning symbol at top-right indicates what UN hazard class the load presents. The bottom-right of the plate carries a company logo.

Hazchem panel

Emergency action code

7C3.60 On arrival at an incident, emergency responders have to make very quick decisions, the consequences of which will determine the success or otherwise of the operations carried out. However, information gathering is time consuming and it is therefore often necessary for responders to act only on the information immediately available.

7C3.61 The emergency action code (also known as the Hazchem code) is designed to cover the first vital step and gives an immediate indication of any actions that could be taken should it be necessary without the use of reference materials or expert advice.

7C3.62 Once any immediate action has been taken to save life, protect the environment and prevent the incident escalating, the next phase can be taken which will involve more detailed information from the operator or driver, the company, paperwork from the vehicle cab and various data sources.

7C3.63 There is more information on emergency action codes in the latest version of the *Dangerous Goods Emergency Action Code List* book. But the code can be explained as follows:

Emergency action codes

1	COARSE SPRAY		3	FOAM	
2	FINE SPRAY		4	DRY AGENT	
P	V	Liquid Tight Chemical Suits			DILUTE SPILLAGE
R					
S	V	Breathing Apparatus & Fire Kit			
T					
W	V	Liquid Tight Chemical Suits			CONTAIN SPILLAGE
X					
Y	V	Breathing Apparatus & Fire Kit			
Z					
E	PUBLIC SAFETY HAZARD				

7C3.64 The firefighting extinguishing medium is determined by reference to the first character of the emergency action code as follows:

1. denotes coarse water spray
2. denotes fine water spray
3. denotes normal foam ie protein based foam that is not alcohol resistant

4. denotes dry agent – water MUST NOT be allowed to come into contact with substance.

7C3.65 Where the second character of the emergency action code is **S**, **T**, **Y** or **Z** normal firefighting clothing is appropriate, ie self-contained open circuit positive pressure compressed air breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots.

7C3.66 Where the second character of the emergency action code is **P**, **R**, **W** or **X** liquid-tight chemical protective clothing conforming to BS 8428, in combination with breathing apparatus specified in paragraph shall be used.

7C3.67 An '**E**' following the first two characters of an emergency action code indicates that there may be a public safety hazard outside the immediate area of the incident and that the following actions should be considered:

- People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident
- Ignition sources should be eliminated and any ventilation stopped
- Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 metres away from the incident
- Police and Fire and Rescue Service incident commanders should consult each other and with a product expert, or with a source of product expertise
- The possible need for subsequent evacuation should be considered, but it should be remembered that in most cases it will be safer to remain in a building than to evacuate.

7C3.68 Where the emergency action code contains a **P**, **S**, **W** or **Y** there is a danger that the substance can be violently or explosively reactive or: there could be

- a violent or explosive decomposition of the material involved, including ignition or friction
- the ignition of a flammable gas or vapour cloud (this danger exists for all flammable gases and liquids with a flash point below 60°C)
- the rapid acceleration of combustion due to the involvement of an oxidiser
- a reaction with water which is itself violent, and may also evolve flammable gases.

7C3.69 In some cases, a higher level of personal protection is required than the one indicated on the emergency action code displayed on a vehicle or tank. In the list of emergency action codes, this is indicated by the presence of an additional personal protection code of A or B in Column 4 of the emergency action code list. This information also appears on the Chemdata and CIRRUS database entries for the material.

7C3.70 Code letter **A**: Indicates that fire kit (to the specified standards as indicated in the emergency action code list) should be worn in combination with gas-tight chemical protective clothing (again as specified). The fire kit is intended to protect against one or more of the following additional hazards which are indicated in the emergency action code list by the appropriate character(s) in brackets, following the 'A', as shown below:

(c) Liquefied gas with a boiling point below -20°C

(fg) Flammable gas

(fl) Flammable liquid

(cf) Liquefied flammable gas with a boiling point below -20°C

(h) The substance may be carried above 100°C

(co) Oxidising gas with a boiling point below -20°C

(!) The substance may have a particularly deleterious effect on chemical protective clothing

7C3.71 An additional personal protection code letter **B** indicates that the chemical protective clothing should be gas-tight conforming to BS EN 943 part 2 in combination with the breathing apparatus (as specified in the EAC list).

ADR Hazard identification numbers (HIN) or Kemler Code

7C3.72 The hazard identification number consists of two or three figures indicating the following hazards:

No.	Hazard
2	Emission of gas due to pressure or chemical reaction
3	Flammability of liquids (vapours) and gases or self-heating liquid
4	Flammability of solids or self-heating solid
5	Oxidizing (fire-intensifying) effect
6	Toxicity
7	Radioactivity
8	Corrosivity
9	Risk of spontaneous violent reaction

7C3.73 Duplicating of a figure (eg 55) indicates an intensification of that particular hazard.

7C3.74 Where the hazard associated with a substance can be adequately indicated by a single figure, this is followed by a zero.

7C3.75 If a hazard identification number is prefixed by letter 'X', this indicates that the substance will react dangerously with water.

7C3.76 The hazard identification number combinations have following meanings:

(* Water not to be used except by approval of experts)

Hazard identification numbers	
Number	**Meaning**
20	Asphyxiant gas or gas with no subsidiary risk
22	Refrigerated liquefied gas, asphyxiant
223	Refrigerated liquefied gas, flammable
225	Refrigerated liquefied gas, oxidising (fire intensifying)
23	Flammable gas
238	Gas, flammable corrosive
239	Flammable gas, which can spontaneously lead to violent reaction
25	Oxidising (fire-intensifying) gas
26	Toxic gas
263	Toxic gas, flammable
265	Toxic gas, oxidising (fire-intensifying)
268	Toxic gas, corrosive
28	Gas, corrosive
285	Gas, corrosive, oxidizing
30	Flammable liquid (flash-point between 23°C and 60°C inclusive) or flammable liquid or solid in the molten state with a flash point above 60°C, heated to a temperature equal to or above its flash point, or self-heating liquid
323	Flammable liquid which reacts with water, emitting flammable gases
X323	Flammable liquid which reacts dangerously with water, emitting flammable gases
33	Highly flammable liquid (flash-point below 23°C)
333	Pyrophoric liquid
X333	Pyrophoric liquid, which reacts dangerously with water*
336	Highly flammable liquid, toxic
338	Highly flammable liquid, corrosive

Hazard identification numbers	
Number	**Meaning**
X338	Highly flammable liquid, corrosive, which reacts dangerously with water*
339	Highly flammable liquid which can spontaneously lead to violent reaction
36	Flammable liquid (flash-point between 23°C and 60°C inclusive), slightly toxic or self-heating liquid toxic
362	Flammable liquid, toxic, which reacts with water, emitting flammable gases
X362	Flammable liquid, toxic, which reacts dangerously with water, emitting flammable gases*
368	Flammable liquid, toxic, corrosive
38	Flammable liquid (flash-point between 23°C and 60°C inclusive), slightly corrosive or self-heating liquid, corrosive
382	Flammable liquid, corrosive, which reacts with water, emitting flammable gases
X382	Flammable liquid, corrosive, which reacts dangerously with water, emitting flammable gases*
39	Flammable liquid, which can spontaneously lead to violent reaction
40	Flammable solid, or self-reactive substance, or self-heating substance
423	Solid which reacts with water, emitting flammable gas, or flammable solid which reacts with water, emitting flammable gases or self-heating solid which reacts with water, emitting flammable gases*
X423	Solid which reacts dangerously with water, emitting flammable gases, or flammable solid which reacts dangerously with water, emitting flammable gases, or self-heating solid which reacts dangerously with water, emitting flammable gases*
43	Spontaneously flammable (pyrophoric) solid
X432	Spontaneously flammable (pyrophoric) solid which reacts dangerously with water, emitting flammable gases*
44	Flammable solid, in the molten state at an elevated temperature
446	Flammable solid, toxic in the molten state, at an elevated temperature
46	Flammable or self-heating solid, toxic
462	Toxic solid which reacts with water, emitting flammable gases

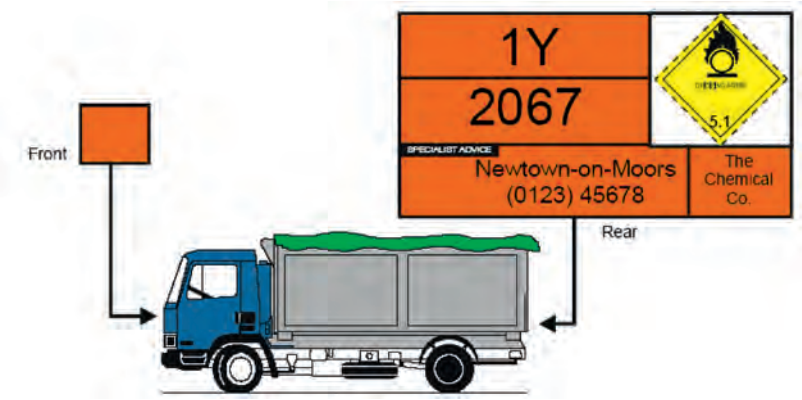
Hazard identification numbers	
Number	**Meaning**
X462	Solid which reacts dangerously with water, emitting toxic gases*
48	Flammable or self-heating solid, corrosive
482	Corrosive solid which reacts with water, emitting corrosive gases
X482	Solid which reacts dangerously with water, emitting corrosive gases*
50	Oxidising (fire-intensifying) substance
539	Flammable organic peroxide
55	Strongly oxidising (fire-intensifying) substance
556	Strongly oxidising (fire-intensifying) substance, toxic
558	Strongly oxidising (fire-intensifying) substance, corrosive
559	Strongly oxidising (fire-intensifying) substance, which can spontaneously lead to violent reaction
56	Oxidising substance (fire-intensifying), toxic
568	Oxidising substance (fire-intensifying), toxic, corrosive
58	Oxidising substance (fire-intensifying), corrosive
59	Oxidising substance (fire-intensifying) which can spontaneously lead to violent reaction
60	Toxic or slightly toxic substance
606	Infectious substance
623	Toxic liquid, which reacts with water, emitting flammable gases
63	Toxic substance, flammable (flash-point between 23°C and 60°C inclusive)
638	Toxic substance, flammable (flash-point between 23°C and 60°C inclusive), corrosive
639	Toxic substance, flammable (flash-point not above 60°C inclusive), which can spontaneously lead to violent reaction
64	Toxic solid, flammable or self-heating
642	Toxic solid, which reacts with water, emitting flammable gases
65	Toxic substance, oxidising (fire-intensifying)
66	Highly toxic substance
663	Highly toxic substance, flammable (flash-point not above 60°C inclusive)
664	Highly Toxic substance, flammable or self-heating
665	Highly toxic substance, oxidising (fire-intensifying)

Hazard identification numbers	
Number	**Meaning**
668	Highly toxic substance, corrosive
669	Highly toxic substance which can spontaneously lead to a violent reaction
68	Toxic substance, corrosive
69	Toxic or slightly toxic substance, which can spontaneously lead to a violent reaction
70	Radioactive material
78	Radioactive material, corrosive
80	Corrosive or slightly corrosive substance
X80	Corrosive or slightly corrosive substance, which reacts dangerously with water*
823	Corrosive liquid which reacts with water, emitting flammable gases
83	Corrosive or slightly corrosive substance, flammable (flash-point between 23°C and 60°C inclusive)
X83	Corrosive or slightly corrosive substance, flammable (flash-point between 23°C and 60°C inclusive), which reacts dangerously with water*
839	Corrosive or slightly corrosive substance, flammable (flash-point between 23°C and 60°C inclusive), which can spontaneously lead to violent reaction
X839	Corrosive or slightly corrosive substance, flammable (flash-point between 23°C and 60°C inclusive), which can spontaneously lead to violent reaction and which reacts dangerously with water*
84	Corrosive solid, flammable or self-heating
842	Corrosive solid which reacts with water, emitting flammable gases
85	Corrosive or slightly corrosive substance, oxidising (fire-intensifying)
856	Corrosive or slightly corrosive substance, oxidising (fire-intensifying) and toxic
86	Corrosive or slightly corrosive substance, toxic
88	Highly corrosive substance
X88	Highly corrosive substance, which reacts dangerously with water*
883	Highly corrosive substance, flammable (flash-point between 23°C and 60°C inclusive)
884	Highly corrosive solid, flammable or self-heating
885	Highly corrosive substance, oxidising (fire-intensifying)

Hazard identification numbers	
Number	**Meaning**
886	Highly corrosive substance, toxic
X886	Highly corrosive substance, toxic which reacts dangerously with water*
89	Corrosive or slightly corrosive substance, which can spontaneously lead to a violent reaction
90	Environmentally hazardous substance; miscellaneous dangerous substances
99	Miscellaneous dangerous substance carried at an elevated temperature

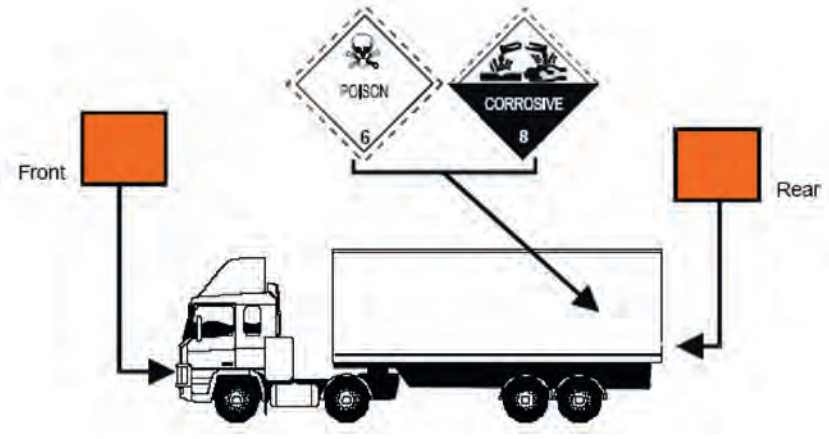
UK 'bulk' vehicle placarding

Single bulk load



7C3.77 The above figure shows the signage for a bulk single load (in excess of three cubic metres). The detailed signage will be on the sides and rear of the vehicle.

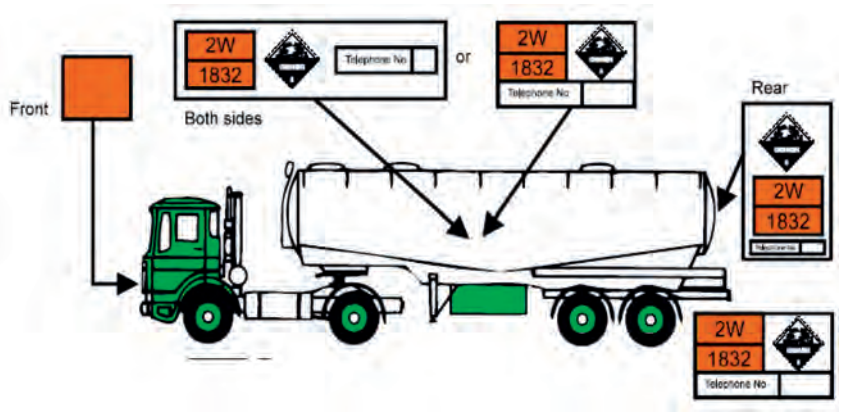
Single load in packages



7C3.78 The above figure shows signage for a vehicle carrying single load dangerous goods in packages. The side of the vehicle will have the standard warning symbols, according to the hazards posed by the load. The primary hazard is always the first symbol sign on the left.

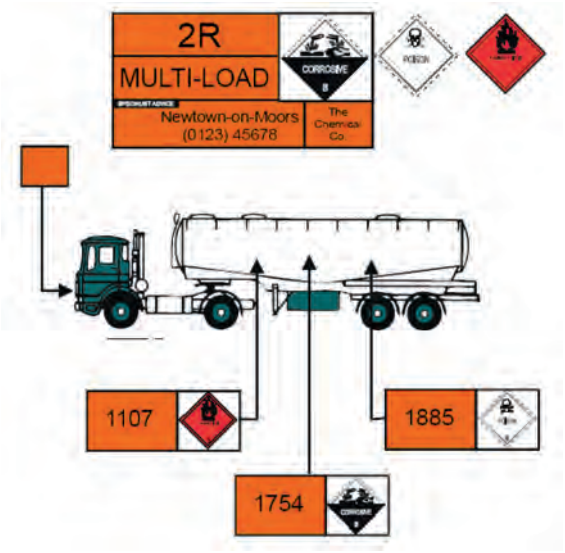
UK tank and tank container placarding

Single load tanker



7C3.79 The above figure shows a single load tanker. Note the variations in showing the key information.

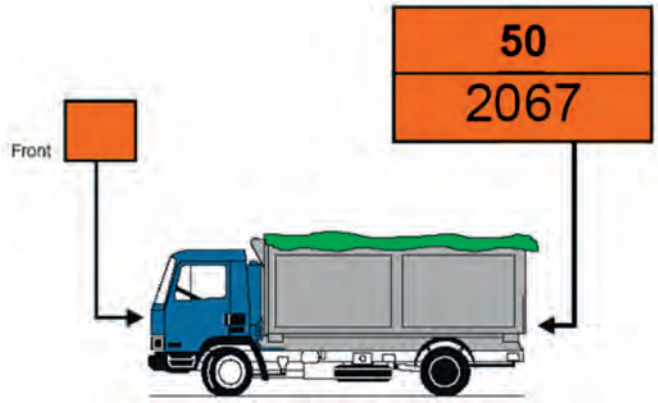
Multi load tanker



7C3.80 The above figure shows the signage for a multi load tanker. The main placard will state multi load but the hazard symbol(s) will show the hazard(s) of the load. Each individual compartment to the tanker will have its own sign giving the UN number for the substance and the hazard symbol denoting its specific hazard.

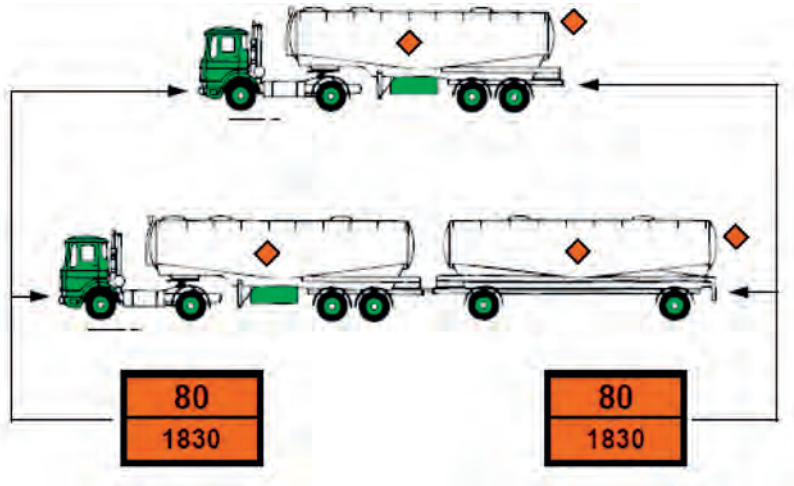
European ADR vehicle ‘bulk’ placarding

Single bulk load showing ADR markings for a bulk single load



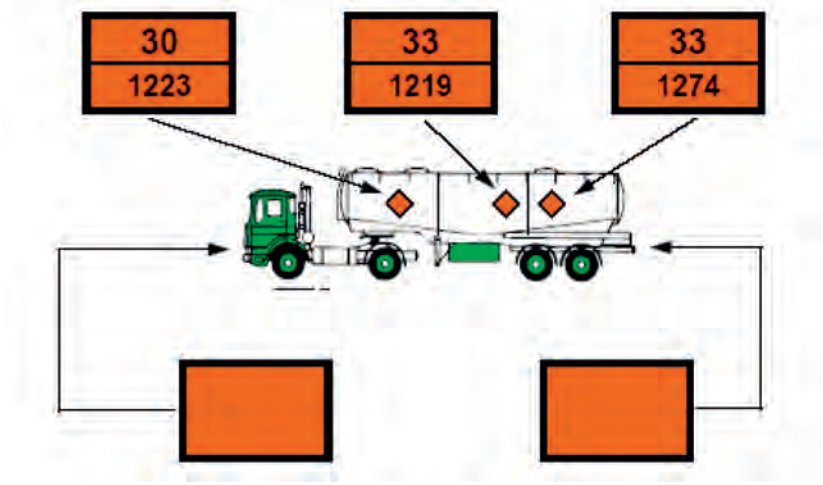
European ADR tanker or tank placarding

Single load tanker



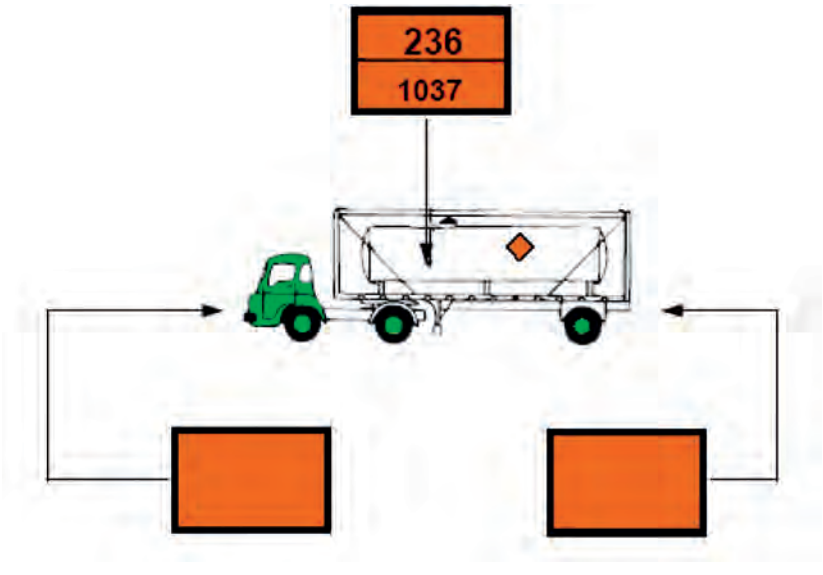
7C3.81 For tank vehicles carrying only one substance, as shown above the identification numbers can be shown on the orange plates at the front and rear of the vehicle. Hazard warning symbols are located on each side of the vehicle and at the rear (as indicated).

Bulk load tanker



7C3.82 Tank vehicles carrying a multi load will display signage as shown above.

Tank container



7C3.83 Vehicles carrying tank containers must display orange plates on each side of the tank, or tank compartments, giving hazard and substance identification numbers. A blank plate is displayed at the front and rear. Hazard warning symbols are located on each side of the compartment adjacent to each ADR placard.

7C3.84 Tank containers must have the identification numbers on the tank itself, to remain in sight when the tank is offloaded from the vehicle.

Elevated temperature marking

7C3.85 Tank-vehicles, tank-containers, portable tanks, special vehicles or containers or especially equipped vehicles or containers carrying elevated temperature substances are required under ADR to display an elevated temperature mark (shown below) on both sides and at the rear for vehicles, and on both sides and at each end for containers, tank-containers and portable tanks.

Mark for elevated temperature substances

Environmentally hazardous substances marking

7C3.86 When required to be displayed in accordance with the provisions of ADR – containers, tank-containers, portable tanks and vehicles containing environmentally hazardous substances meeting the specific criteria shall be marked with the environmentally hazardous substance mark shown below.

Mark for environmentally hazardous substances

Switch loading of petrol and distillate fuels

7C3.87 Switch loading is the terminology used to describe the practice of loading a distillate fuel eg diesel or gas oil, into a tank compartment which has previously contained petrol. Switch loading can also be practiced between petrol and kerosene but this practice is normally discouraged because of the risk of residual petrol (liquid or vapour) lowering the flash point of the kerosene.

7C3.88 In the UK the practice of switch loading road tankers is very common with perhaps as many as 95 per cent of petrol/distillate fuel tankers undertaking it in order to minimise unnecessary journeys eg by discharging one load and returning without another. Compartments of tankers which have been switch loaded will not only contain the liquid distillate product but also an amount of petrol vapour remaining from the previous load/loads.

7C3.89 Road tankers that transport petrol are designed and constructed for bottom loading with vapour recovery and in addition to the compartment ullage spaces, petrol vapour will be retained in the associated vapour manifold and pipework, together with small amounts of petrol in other associated pieces of equipment.

7C3.90 Distillate fuels have a greater density than petrol and in many cases a nominal 'full load' of distillate will require a tanker to run with an empty or partially filled compartment, to ensure that the vehicle does not exceed its maximum authorised mass on the road.

7C3.91 Large volumes of petrol vapour will be retained in the empty and/or partially filled compartments of a tanker carrying distillates in which petrol has been previously loaded. Even in compartments not previously loaded with petrol there is a risk that vapour will be present, due to the inter-compartment connection afforded by the vapour manifold and the vapour transfer valves, all of which are open during the bottom loading process. It is possible that a tanker may arrive at a site with a full load of diesel and leave with a full load of petrol vapour.

7C3.92 Where a mixed load of liquid products comprises petrol, diesel, kerosene or aviation fuels the tanker will be marked with the UN number of the product with the greatest hazard ie the lowest flashpoint. In the case of empty uncleaned tanks, the tanker is marked as if it still contained the original product. However, there are no specific provisions for marking where the transport of a single substance with the residual vapour of a product with a greater hazard (lower flashpoint) is undertaken even though this may present a similar hazard to that of an empty uncleaned tanker.

7C3.93 Under the current regulations, a compartment that was previously filled with petrol and then refilled with diesel and subsequently emptied of the diesel would have to be marked UN 1202 (diesel) to reflect the last load in the uncleaned tank, but in fact could be filled with petrol vapour.

7C3.94 These hazards are recognised by the petroleum industry and as a result it has become widespread practice in the UK for road tanker operators to retain the petrol marking (UN 1203) on tankers for a number of full loads of diesel or gas oil (UN 1202) after carrying petrol in order to reflect the presence of the retained petrol vapour and the greater danger this may pose.

7C3.95 Fire and Rescue Services should be aware that, when dealing with incidents involving petrol/distillate tankers, any of the tank compartments may contain mixtures of distillate and petrol vapour. Therefore, all the tanks should be treated as if they contained petrol vapour until information to the contrary is obtained.

7C3.96 This also means that tanks may contain diesel/gas oil as the main load but still marked as petrol to better reflect the greater danger from any residual petrol vapours.

7C3.97 The emergency action code for all such tankers should therefore be taken to be 3YE (indicating a possible public safety hazard beyond the immediate area of the incident) even though the emergency action code for the distillates will be 3Y and some tankers may still be marked as such.

7C3.98 As there are no movements of petrol/distillate tankers to and from Europe this will not be an issue for non UK registered tankers ie those marked with ADR hazard identification numbers.

Supply labelling of chemicals

7C3.99 *Chemicals (Hazard Information and Packaging for Supply) Regulations 2009* is the law that applies to suppliers of dangerous chemicals. Its purpose is to protect people and the environment from the effects of those chemicals by requiring suppliers to provide information about the dangers and to package them safely.

7C3.100 The *Chemicals (Hazard Information and Packaging for Supply) Regulations 2009* requires the supplier of a dangerous chemical to:

- identify the hazards (dangers) of the chemical. This is known as 'classification';
- give information about the hazards to their customers. Suppliers usually provide this information on the package itself (eg a label); and
- package the chemical safely.

7C3.101 **NOTE:** Safety data sheets are no longer covered by the *Chemicals (Hazard Information and Packaging for Supply) Regulations 2009*. The laws that require a Safety Data Sheet to be provided have been transferred to the European REACH Regulation.

7C3.102 'Supply' means making a chemical available to another person. Manufacturers, importers, distributors, wholesalers and retailers are all examples of suppliers.

7C3.103 The *Chemicals (Hazard Information and Packaging for Supply) Regulations 2009* applies to most chemicals but not all. The details of the scope are set out in the regulations. Some chemicals, such as cosmetics and medicines, are outside the scope and have their own specific laws.

7C3.104 The *Chemicals (Hazard Information and Packaging for Supply) Regulations 2009* will gradually be replaced by the *European Regulation on Classification, Labelling and Packaging of Substances and Mixtures*.

7C3.105 Supply labelling differs from transport labelling in that different danger symbols are used and different criteria are used to assign the risks. Therefore, something classified as 'toxic' (Class 6.1) for transport may only be classified as 'harmful' for supply. Equally, something classed as 'toxic' (skull and cross-bones) for supply, such as a carcinogenic substance, may not be classified as hazardous for

transport at all. Equally, a particular substance may have different classifications for each system. Solvents may be classed as 'flammable' (Class 3) for transport, but 'harmful' or 'toxic' (equating to class 6.1) for supply.

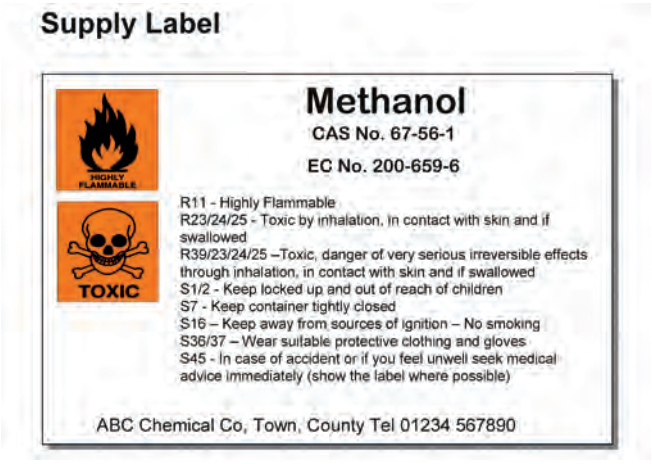
7C3.106 The reasons for this are the different types of risk exhibited in different situations. The end user, dealing with small quantities on a frequent basis over long time-periods, is at greater risk from any harmful/toxic effects due to contact with the product than from its flammable characteristics. The emergency services, however, will be dealing with a "one-off" situation which is not supposed to happen, potentially involving large quantities of the product, where the flammability hazard far outweighs the longer-term effects of contact with the product.

Supply labels

7C3.107 Supply labels may also provide advice for the consumer for the safe use of the product. Such information might include (UK/EU Example):

- Name, address and telephone number of person responsible for supplying the substance or preparation
- Name of the substance or preparation
- Indication(s) of danger and warning symbol(s)
- Risk and safety phrases
- EC number (for substances)
- Chemical Abstract Service number (for pure chemicals).

Typical package with transport labels



REACH – registration, evaluation, authorisation and restriction of chemicals regulations

7C3.108 The registration, evaluation, authorisation and restriction of chemicals regulations (REACH); an EU regulatory framework for chemicals came into force on 1 June 2007. The aim of REACH is to improve the protection of human health and the environment. REACH puts greater responsibility onto industry to manage the risks from chemicals and to provide safety information that will be passed down the supply chain.

7C3.109 REACH will require a registration, over a period of 11 years, of some 30,000 chemical substances. The registration process requires anyone manufacturing in, or importing into the EU, more than one tonne per year of these substances to generate data for all chemicals produced or imported, whether on their own or in one or more preparations. This information must be registered with the European Chemicals Agency. The registrants must also identify appropriate risk management measures and communicate them to the users.

7C3.110 In addition, REACH will allow the further evaluation of substances where there are grounds for concern and foresees an authorisation system for the use of substances of very high concern. This applies to substances that cause cancer, infertility, genetic mutations or birth defects, and to those which are persistent and accumulate in the environment. The authorisation system will require companies to switch progressively to safer alternatives where a suitable alternative exists. All applications for an authorisation need to include an analysis of alternatives and a substitution plan where a suitable alternative exists. Current use restrictions will remain under the REACH system.

Globally Harmonised System

7C3.111 The REACH Regulation is currently written around the current classification and labelling system which is set out in 67/548/EEC and implemented in the UK through the *Chemicals Hazard Information and Packaging for Supply Regulations 2009*. However, the EU is committed to introducing the Globally Harmonised System of classification and labelling of chemicals.

7C3.112 The Globally Harmonised System is being progressively implemented worldwide. In the EU, a timetable for implementation has been issued and the deadline for substance reclassification was 1 December 2010 and for mixtures 1 June 2015.

7C3.113 The Classification Labelling and Packaging Regulation No 1272/2008 that implements the Globally Harmonised System for classification in Europe will result in a major overhaul of hazard communication for safety data sheets and labelling for supply. Therefore, over the next few years, we will be faced with a dual system as some labels and safety data sheets change and others do not and the key message for this confusing transition period is that those supplying chemicals attempt to make the communication of hazards and risk management as clear as possible to users and to emergency responders.

7C3.114 To ensure that hazard classifications (and consequent labelling) of all substances manufactured in or imported into the EU are transparent, industry are required to submit a notification of the hazard classification to the European Chemicals Agency at the latest by 1 December 2010 unless already submitted as part of a registration. The Agency will then include this information in a classification and labelling inventory in the form of a database accessible via the internet.

7C3.115 The Globally Harmonised System introduces a set of harmonised criteria for the classification of chemicals. Many of these criteria are familiar to those working under the current EU system, although in many cases the actual values used to define the hazard category will differ. There are also a number of additional hazard categories for some criteria that indicate a lower degree of hazard. These may be implemented on an optional basis and it is expected that some countries will include them in their new regulations while others will not.

7C3.116 The system for classifying mixtures (preparations) will also change, and this is expected to result in a significant increase in the number of mixtures that are classified as hazardous.

7C3.117 The content of labels will also change significantly. Under the Globally Harmonised System, the familiar rectangular orange symbols are replaced by a set of pictograms which are diamond shaped like the transport symbols, but with the symbols in black on a white background with a red border. The EU Indications of Danger is replaced with signal words, while R & S phrases are replaced with hazard statements and precautionary statements.

7C3.118 The tables below compare the Globally Harmonised System and the existing labelling systems. Examples of Globally Harmonised System compliant labels are also given.

Physio-chemical hazard markings under the Globally Harmonised System and the existing Chemicals Hazard Information and Packaging for Supply Regulations 2009 (CHIP) system

Globally Harmonised System symbol	Existing symbol	Hazards
		Explosive Self reactive Organic peroxide

Physio-chemical hazard markings under the Globally Harmonised System and the existing Chemicals Hazard Information and Packaging for Supply Regulations 2009 (CHIP) system		
Globally Harmonised System symbol	**Existing symbol**	**Hazards**
		Flammable gases self-reactive Flammable liquids pyrophoric Flammable solids self-heating Flammable aerosols Contact with water, emits organic peroxides flammable gas
		Oxidizing gases Oxidizing liquids Oxidizing solids
		Gases under pressure
		Corrosive to metals
		Acute toxicity Very toxic (fatal) Toxic
		Corrosive (causes severe skin burns and eye damage) Serious eye damage

Physio-chemical hazard markings under the Globally Harmonised System and the existing Chemicals Hazard Information and Packaging for Supply Regulations 2009 (CHIP) system		
Globally Harmonised System symbol	**Existing symbol**	**Hazards**
		Respiratory sensitiser Mutagen Carcinogen Reproductive toxicity Systemic target organ toxicity Aspiration hazard
		Acute toxicity Harmful Skin irritation, serious eye irritation, respiratory irritant Skin sensitiser Narcotic
		Acute / chronic environmental hazard

Comparison of Globally Harmonised System and Chemicals Hazard Information and Packaging for Supply Regulations 2009 (CHIP) labeling advice	
Existing Chemicals Hazard Information and Packaging for Supply Regulations 2009 (CHIP) labelling system	**Globally Harmonised System labelling**
Risk phrases Highly flammable Very toxic by inhalation Causes burns	**Hazard statements** Highly flammable liquid and vapour Fatal if inhaled Causes severe skin burns and eye damage
Safety phrases Keep container tightly closed Avoid contact with skin and eyes Wear suitable protective clothing	**Precautionary statements** Keep container tightly closed Do not get in eyes, on skin or on clothing Wear protective clothing [manufacturer/supplier to specify]

Example of Globally Harmonised System compliant supply labels on chemical products

Example of Globally Harmonised System compliant combined transport and supply label

Rail transportation

7C3.119 All of the classes of hazardous substances are carried on the UK rail network. The carriage of dangerous goods regulations apply to rail transport, with detailed guidance coming from *HS (G) 163 Guidance for Rail Operators and Others Involved in the Carriage of Dangerous Goods by Rail.*

7C3.120 The only exceptions to the application of the regulations are:

- all substances carried with the sole purpose of being used on or by the train, eg fuel
- radioactive materials; these have their own regulations, RAMRail.[1]

7C3.121 The regulations require that sufficient information is supplied with the load to ensure that all involved with the transportation process can:

- identify what is being carried
- be aware of the potential hazards
- in the case of the Fire and Rescue Service, respond quickly and efficiently.

7C3.122 The information is supplied to the train operator and the rail infrastructure controller, therefore if there is an incident and the information cannot be obtained from the train driver, it can be obtained from the operator. The information given includes:

1 Packaging Labelling and Carriage of Radioactive Material by Rail Regulations HSE.gov.uk

- designation and classification of the dangerous goods
- UN number
- packaging group
- compatibility and division for explosives
- consignor and consignee details
- specialist advice
- mass and volume for:
  - the package
  - the tank, tank container, or tank wagon
  - bulk load in container or wagon
  - the total consignment.

7C3.123 The containers, tank container tank wagons and wagons must display relevant signage as to its contents using the UK Hazchem system for UK only journeys or the RID marking provisions for international journeys (which mirror those of ADR for road vehicles), as shown above.

Total Operations Processing System

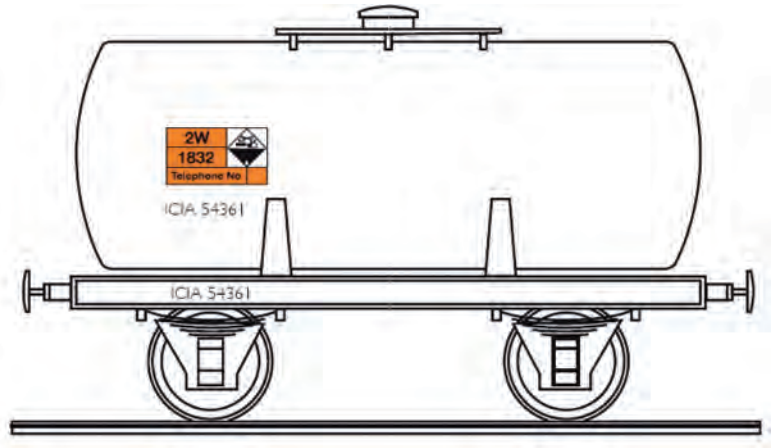
7C3.124 The Total Operations Processing System (TOPS) is a computerised system which enables Network Rail to keep a constant check on the position and availability of every rail vehicle on the Network Rail system and provide specific information of the various loads that are being hauled.

7C3.125 It consists of a central computer system connected to regional control offices, marshalling yards and depots throughout the country. The system is based on a main computer at Blandford House, Marylebone in London, which is linked to input points at area freight offices throughout Network Rail.

7C3.126 From these control centres, details are fed into the computer with all the wagon and freight details, loaded or unloaded, freight train movements and type of traffic conveyed. On request from an Incident Commander via Fire Service Control a Network Rail control office can obtain any specific information from the system, on any wagon or freight train and its cargo.

7C3.127 Each wagon is clearly marked with an individual identification number on the side of each wagon. This number will be recorded on the TOPS computer to enable information on the load to be readily made available for operational staff in the event of an incident.

Location of identification numbers and hazard warning plates on wagon



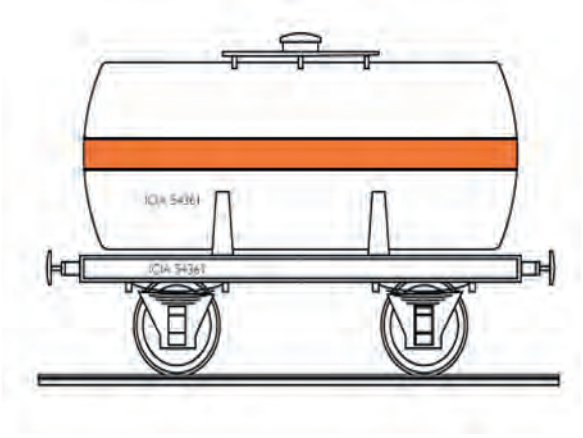
Additional tank wagon identification schemes

7C3.128 Tank wagons carrying certain classes of dangerous goods can be identified by specific colour schemes. For example, tank wagons carrying liquefied petroleum gas will have a white barrel with a horizontal orange stripe round the barrel at mid height. Tank wagons carrying flammable liquids are painted dove grey and the sole bars are painted signal red. (Sole bars are the two horizontal metal bars upon which the bottom of the tank rests.)

7C3.129 In addition to the labelling, all wagons containing dangerous goods will have a 'Network Rail Dangerous Wagon Label' displayed on each side of the wagon. This label indicates the class of substance being carried and the principal hazard encountered. Containers that are hauled by rail are exempt from being labelled in this manner.

7C3.130 The emergency code for the label consists of a six digit number. The first four numbers are the substance identification number for the substance carried or the class, division and compatibility group in the case of explosives. The remaining two letters are referred to as the 'Alpha Code'. This code has been allocated to firms and enables Network Rail to ascertain the telephone number from which specialist assistance can be requested in the event of an emergency.

Example of tank wagon designed to carry liquefied petroleum gas



Information available from the rail vehicle crew

7C3.131 Information on the specific details of each wagon and the details of their individual loads is held by the rail vehicle crew. This information sheet is known as the 'consist'. Information found on the 'consist' will contain the following information:

- position of every wagon from front to rear
- train identity number
- locomotive identity number
- wagon numbers
- dangerous goods emergency codes
- UN number plus specialist advice contact code.

7C3.132 It would be advisable for the Incident Commander, to obtain the consist as this will provide immediate information on the type of loads being carried and provide interim guidance on a course of action to follow until further information is secured either from TOPS or from a designated specialist advisor.

Guidance manual for accepted and regulated materials to be transported

7C3.133 Network Rail has established conditions under which they are prepared to accept dangerous goods detailed in their *List of Dangerous Goods and Conditions of Acceptance*. This is a working manual for all Network Rail staff commonly known as the 'pink pages' which sets out the specific instructions to staff on the handling of dangerous materials.

7C3.134 It contains guidance on the action necessary in emergencies, explains how to obtain specialist assistance, and requires staff to summon emergency assistance when an incident occurs. It also includes illustrations of the labels used on packages of dangerous substances and on the wagons containing them.

7C3.135 All train crews should be aware of all goods carried, especially those of a hazardous nature and should ensure that compliance with the regulations is made, in respect to the quantity, labelling and method of transportation and to initiate emergency measures if required.

Conveyance of explosives by rail

Wagon labelling

7C3.136 The wagon label for explosives (both commercially and military) replace the individual UN hazardous substance number with a set of four characters identifying the category of the explosive. Thus a wagon label whose emergency code begins with the characters 1.1D would indicate an explosive of Hazard Division 1.1, compatibility group D, (ie an explosive presenting a mass explosion hazard).

Wagon label – explosives

Weight limitations

7C3.137 Only commercial explosives are covered by GO/RT3422, (Railway Group Standard which identifies the requirements for the acceptance and carriage by rail of explosives on Network Rail) and the total amount to be conveyed on any one train is limited to 36.25 tonnes.

7C3.138 Military explosives are covered by the *Conveyance by Rail of Military Explosives Regulations 1977*. The weight limits for military explosives, and for mixed commercial and military loads are given in GO/RT3053.

7C3.139 To summarise no more than 20 tonnes of explosives per wagon or container can be carried with a net amount of the same explosives. It is permissible to convey several groups of explosives on the same train but subject to a separation distance of 80 metres and a limitation of 40 tonnes per group. This is applicable

to groups within Hazard Division 1.1 and combined with 1.3 and/or 1.5. For groups within 1.3 and 1.5 either separately or together the separation distance reduces to 40 metres and the limit per group increases to 120 tonnes.

Tank wagons held in sidings

7C3.140 Railway wagons laden with explosives in transit are occasionally parked overnight in railway sidings and to this effect the working manual for rail staff is quite specific in detailing the responsibilities to staff where explosives are concerned. The manual places personal responsibility upon the supervisor for ensuring that any wagon of explosives standing in the sidings, goods or marshalling yards are under surveillance by railway staff and for keeping a tally of each wagon with its location whilst in their responsibility.

7C3.141 If through exceptional circumstances it becomes necessary to hold explosives in an 'unsupervised location' the Chief Operating Officer of Network Rail has made arrangements to ensure that Network Rail staff responsible for the handling and conveyance of dangerous goods will inform the British Transport Police and the Fire and Rescue Service whenever it is known that wagons containing explosives are likely to be held in unsupervised goods yards or sidings.

7C3.142 On receipt of this information the Fire and Rescue Service concerned should instruct a Fire Safety Officer to visit the site and if conditions warrant it, arrange with their Service Control for an appropriate special attendance to be made to the sidings in the event of any fire or special service call being received.

Irradiated fuel flasks

Irradiated fuel flask

7C3.143 If an incident occurs involving an irradiated fuel flask, National Arrangements for Incidents involving Radioactivity (NAIR) will be activated immediately. However, there will be some operational priorities to be considered whilst the NAIR scheme is instigated.

7C3.144 If there is evidence of damage to an irradiated transport flask, all staff should keep at least 50m away upwind of the incident. If this area has to be entered for rescues, firefighters should wear breathing apparatus; protective clothing and dosimeters, and radiation procedures should be carried out.

7C3.145 Under severe damage to a flask there could be an immediate danger of a release of radioactivity and the approach to the incident and the immediate area around the incident should be treated with great caution and cordoned off to create safe areas.

7C3.146 If water leaks from the flask always treat as if radioactive and avoid if possible, especially any contact with the eyes or skin. In the event of the flask being involved in fire, it should be cooled by water spray. The nuclear physicist will monitor the run off and inform the local water authority of the slight chance of radioactive contamination in water courses.

7C3.147 The risk of contamination is not limited to water sources as there is a high possibility contamination can occur through airborne radioactive particles. Monitoring of the wind speed and direction is vital to continue to stay upwind and avoid further contamination risks.

Air transportation

Introduction

7C3.148 Unlike road and rail transportation of hazardous materials, air transport is international, and therefore is governed by international regulations and agreements.

7C3.149 The world-wide system used to control the transportation of dangerous goods by air is based on the same United Nation's 'Orange Book' requirements placed on all other modes of transport. International requirements for the safe air transportation of radioactive material also relate to UN standards. Because of the particular nature of air transportation, restrictions on the type and quantities of dangerous goods transported are strictly enforced.

Worldwide harmonization

7C3.150 Worldwide harmonization of the transportation of dangerous goods by air is overseen by an agency of the UN. The principles of the international requirements are detailed in the *International Civil Aviation Organisation Technical Instructions* and include:

- classification
- identification (marking, labelling and documentation)
- acceptability for air transport

- packaging and packing
- loading and stowage
- information
- training
- reporting of incidents and accidents
- inspection and investigation.

International agreement

7C3.151 The Convention on International Civil Aviation (Chicago convention) and its annexes set out the international standards and principles for air transportation throughout the world. Annex 18 to the convention contains the principles applied to dangerous goods. These principles include requirements that:

- states must ensure compliance with the technical instructions
- there must be inspection surveillance and enforcement procedures
- dangerous goods accidents and incidents must be reported
- dangerous goods accidents and incidents must be investigated.

International Civil Aviation Organisation Technical Instructions and International Aviation Transport Association dangerous goods regulations

7C3.152 The *International Civil Aviation Organisation (ICAO) Technical Instructions* are produced in English and are the source of the legal rules.

7C3.153 The International Aviation Transportation Association (IATA), the aviation trade organization, publishes a set of Dangerous Goods Regulations that incorporate the ICAO Technical Instructions. The only real difference between the two documents is the order of the information, although the IATA document is more restrictive than the Technical Instructions. The IATA document is a field document and is more commonly referred to in aviation circles.

UK law

7C3.154 The UK's legal obligations under the Chicago Convention are fulfilled by the following:

- *The Air Navigation Order 2005* – which permits the making of regulations to control the carriage of dangerous goods by air

- *The Air Navigation (Dangerous Goods) (Amended) Regulations 2006* – which contain detailed requirements and refer to the need for airlines to comply with the latest edition of the *ICAO Technical Instructions*.

7C3.155 The *Air Navigation (Dangerous Goods) Regulations* apply to the following:

- Shippers
- Freight agents
- Handling agents
- Couriers
- The Post Office
- Passengers
- Operators.

7C3.156 The regulations require compliance with the technical instructions and require that the operators listed above have permission to carry dangerous goods from the Civil Aviation Authority.

Cargo aircraft

7C3.157 These aircraft are designed or modified for the carriage of cargo only, both in the under-floor hold and on the main deck. Aircraft specifically designed to carry cargo may have nose-opening or tail-opening cargo doors to facilitate the loading of large or specialist cargoes. Other cargo aircraft have large main-cabin freight doors, usually positioned aft of the nose area on the port side.

7C3.158 Dangerous goods are carried on cargo aircraft either in the under-floor holds or on the main deck. Those in the under-floor holds will be in passenger aircraft quantities, whereas those on the main deck will usually be cargo aircraft only items.

Passenger aircraft with under-floor holds (only)

7C3.159 These aircraft are designed primarily for carrying passengers. Cargo (and baggage) will be carried in holds that are below the main deck (under-floor). Examples of this type of aircraft are Boeing 737, 747 and Airbus 3 series. The introduction of wide-bodied passenger-carrying aircraft has meant that there is a great deal of capacity in the under-floor holds for carrying cargo. Dangerous goods may be carried in the under-floor holds in passenger aircraft in limited quantities.

Passenger aircraft with holds on the same deck as passengers (combi-aircraft)

7C3.160 These aircraft have also been designed primarily for carrying passengers. There are two types:

1. The holds are on the same deck as the passengers.
2. The holds are on the same deck as the passengers and there are also under-floor holds.

7C3.161 In aircraft with holds on the same deck as the passengers, the holds may be little more than areas of the cabin separated from the passengers by curtaining. In others they may be surrounded by sealed bulkheads with access from outside the aircraft only or through doors in the cabin that are kept locked in flight. Aircraft with holds on the same deck as passengers have come to be known as combi-aircraft.

7C3.162 Dangerous goods in passenger aircraft quantities may be carried on combi-aircraft in under-floor holds and on the main deck holds. When dangerous goods are carried, the hold must be totally separated from passengers by a bulkhead. Some low hazard dangerous goods (ie those which would not lead to the occurrence of a serious safety or health problem in the event of a leakage) may be carried in the main deck cargo hold on other types of combi-aircraft with approval from the Civil Aviation Authority.

Convertible aircraft (quick-change)

7C3.163 A number of aircraft are designed to be converted quickly so that during the day they can carry passengers and at night carry cargo. Dangerous goods are carried on quick-change aircraft as permitted for passenger or cargo aircraft, depending on the configuration at the time.

Principles of safe transportation of dangerous goods by air

7C3.164 The principles applied for the safe transportation of dangerous goods by air are that according to the hazard posed by the substance, they can be:

- carried on passenger and or cargo aircraft
- restricted to cargo aircraft only
- forbidden on both passenger and cargo aircraft (but exemption to carry may be possible)
- totally forbidden in all circumstances
- packaged – no bulk transportation
- limited quantities per package for passengers and cargo.

Dangerous goods integral to the aircraft

7C3.165 There are many systems and items of equipment on board an aircraft that are deemed to be hazardous materials, these include:

- aircraft equipment:
  - life rafts, aerosols
  - fire extinguishers, dry ice
  - batteries, alcohol
  - oxygen generators, perfumes and colognes
  - fuel, matches and lighters.
- passenger's baggage.

Packaging for transport by air

7C3.166 The requirements for packaging are similar to those required by ADR and the *Chemicals Hazard Information and Packaging for Supply Regulations* (CHIP), **except** that packages must also take into account:

- temperature variations
- pressure differences
- vibration.

7C3.167 Packages are therefore required to undergo the following tests:

- drop test
- stacking test
- leak-proof test (drums only)
- hydraulic (pressure) test (drums only).

Marking and labelling

7C3.168 Packaged goods are marked and labelled in accordance with UN recommendations. Both primary and secondary hazard symbols are displayed if appropriate.

7C3.169 Where goods are designated as being excluded from passenger aircraft, an aircraft-specific 'cargo aircraft only' orange label must be displayed.

Cargo aircraft-only label

Shipper's declaration

7C3.170 All dangerous goods must be accompanied by a shipper's declaration. The shipper's declaration for dangerous goods can be distinguished from other flight documents by the red and white hatching on each side of the document. The declaration should contain the following information:

- Proper shipping name
- UN number
- UN class, division and subsidiary risk(s)
- Packing group (if applicable)
- Packing instructions and type of packaging
- Net quantity and number of packages.

7C3.171 For radioactive materials, additionally:

- name or symbol of radionuclide
- activity
- package category and transport index.

7C3.172 The 'shipper's declaration' is produced by the shipper. There should be one copy at the originating point with one other travelling with the dangerous goods.

Shipper's declaration

Notification to the commander

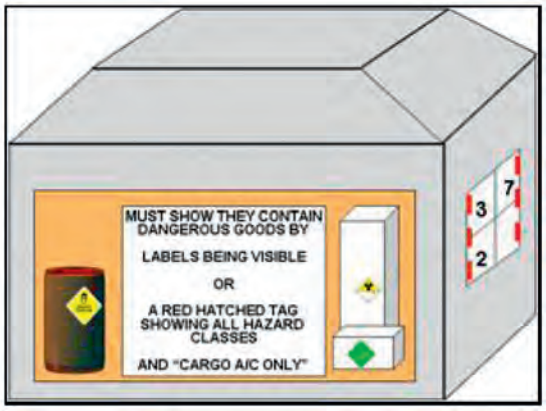
7C3.173 A 'special load form' must be given to the commander of the aircraft, identifying what dangerous goods have been placed on board in the cargo and where they have been loaded. This form is known as a 'notification to the commander' and must be **on the aircraft in the possession of the commander**. There should also be a copy of the notification to the commander at the airport of loading although, unlike the commander's copy, this is not a legal requirement.

Loading of dangerous goods

7C3.174 Packaged dangerous goods might be loaded into aircraft:

- as individual packages
- on pallets
- within transport loading units (known as 'unit load devices').

Unit load device



7C3.175 The above figure illustrates a typical unit load device. This refers to any type of container with an integral pallet, or aircraft pallet whether or not owned by an IATA member, and whether or not considered to be aircraft equipped. These units interface directly with an aircraft loading and restraint system. Such units become an integral part of the aircraft structure when loaded.

7C3.176 If the labels on packages are not visible when they are on pallets or in unit load devices, a red hatched tag showing which hazard classes are present must be displayed on the outside of the pallet or unit load device. The cargo aircraft only label must also be displayed or be visible where appropriate.

Loading restrictions

7C3.177 Packaged dangerous goods:

- **must not** be stowed in the passenger cabin or on the flight deck
- **must not** be on passenger aircraft if 'cargo aircraft only'
- 'cargo aircraft only' packages **must** be accessible in flight
- packages of liquids with orientation arrows **must** be upright
- packages **must** be secured to prevent movement
- damaged packages **must not** be loaded
- incompatible dangerous goods **must not** be stowed to allow interaction
- most explosives **must** be segregated from other dangerous goods
- some types of radioactive materials **must** be separated from persons
- magnetized material **must** be loaded so that the compass cannot be affected.

Incidents

7C3.178 Incidents can be categorized into those:

- on the ground
- occurring during flight.

7C3.179 During the flight, if an incident occurs involving dangerous goods, the commander of the aircraft will refer to an ICAO document known as the 'Red Book'. This publication provides emergency response details including an in-flight checklist for each dangerous substance category hazard. For incidents on the ground, the airport fire service will usually deal with the incident supported by the Fire and Rescue Service local to the airport.

7C3.180 All incidents must be investigated as this is a requirement of Annex 18 to the Chicago Convention.

Operational considerations

7C3.181 When dealing with an aircraft incident, the Incident Commander should take into consideration all of the hazards discussed previously (eg man made mineral fibres etc) as well as the biohazards from body fluids from casualties. The Incident Commander should also take into account the fact that until declared otherwise, the scene of an air crash is a crime scene.

Sea transportation

Introduction

7C3.182 Much of the cargo transported by sea may be classed as dangerous. Incidents involving dangerous substances at sea can be divided into two main areas:

- incidents offshore
- incidents in harbour.

7C3.183 The main difference between these two types of incident is that for an incident located in a harbour, the hazardous materials adviser must liaise with the Harbour Master when advising on the operational plan.

International Maritime Dangerous Goods code

7C3.184 By its very nature, transport of goods by sea is an international industry and as such is governed by an international standard, ie: The International Maritime Dangerous Goods code.

7C3.185 The International Maritime Dangerous Goods code is used by all areas of the shipping industry that carries dangerous goods, and covers all aspects of their transportation from the construction of the vessels to limiting quantities of substances carried.

7C3.186 The International Maritime Dangerous Goods code is in three volumes:

Volume 1: General provisions eg definitions, training requirements, etc

Volume 2: The dangerous goods list and limited quantities exceptions.

Supplement: The emergency schedules and medical first aid guidance.

7C3.187 The supplement also contains two sections that are of specific interest to the hazardous materials adviser.

Marine pollutants

7C3.188 A number of dangerous substances in the various classes have also been identified as substances harmful to the marine environment these are known as marine pollutants. Substances classified as such are carried in packages or transport containers identified with a 'marine pollutant' symbol. Amendment 23 of the International Maritime Dangerous Goods code introduced a new marine pollutant symbol of a dead fish and a tree that replaced the previous triangle containing a dead fish and crossed lines.

New (left) and previously used (right) marine pollutant symbols

Emergency schedule

7C3.189 This is the emergency schedule for dealing with incidents involving dangerous goods on fire or spilt.

Fire

A series of generic tables with the prefix 'F' providing guidance on specific hazards of a substance when involved in fire and the firefighting tactics to be employed in various locations on the ship.

Spillage
A series of generic tables with the prefix 'S' providing guidance on the hazards associated with various spills, personal protection, and tactics for different size packages and spills in various locations on the ship.

Medical First Aid Guidance

7C3.190 This section provides a flow chart to assist in the initial assessment of a casualty which refers the reader to generic numbered tables for specific conditions. In each case casualty signs and symptoms are described and detailed treatments given. In many cases the treatments are significantly more involved than for normal first aid and are designed to preserve life whilst at sea using the vessel's on board medical facilities. This information can prove to be of considerable value when attempting to assess the likelihood of the exposure of a casualty to a particular substance.

7C3.191 However, it must always be borne in mind that the guidance given under Emergency Schedule and Medical First Aid Guidance is designed for use when the vessel is at sea and to assist the survival of the ship and casualties whist awaiting help. As a result some of the tactics and procedures outlined, such as ditching the material overboard, may not be appropriate for when the ship is in port.

7C3.192 The emergency schedule is reproduced as a section in Chemdata. When accessing Chemdata for incidents involving ships the user should ensure that the sections on emergency schedules are referred to. This information is not only essential when formulating a plan but will give an understanding of the actions that may well have been taken by the ship's crew prior to the arrival of the Fire and Rescue Service.

7C3.193 The bulk storage of hazardous substances presents specific problems to Fire and Rescue Service personnel, which are:

- quantities of substances stored
- variety of substances being stored
- variety of storage media
- proximity of other bulk storage of hazardous substances (eg at Buncefield there were approximately 29 bulk storage tanks and three pipelines.)
- size of the consequence area in terms of the plume, firefighting media run off, the potential proximity of residential areas, etc.

7C3.194 The Health and Safety Executive have issued regulations and approved codes of practice for aspects of the storage of hazardous substances. The regulations and approved codes of practice require that the owner/occupier carry out a detailed risk assessment on the premises storing hazardous materials and

subsequent safety systems be implemented. It is recommended that the hazardous materials adviser refers to these documents for details on safety systems.

7C3.195 The basis of the safety systems is the assessment of the risks from:

- release of dangerous substances
- ignition sources
- separation of product
- elimination or reduction of risks from dangerous substances through:
  - ventilation
  - control of ignition
  - separation of product
  - fire resistance of the storage media
  - fire reaction.

Packaging

Pressure receptacles

7C3.196 Pressure receptacles and their closures shall be designed, calculated, manufactured, tested and equipped in such a way as to withstand all conditions, including fatigue, to which they will be subjected during their normal use and during normal conditions of carriage.

Intermediate bulk containers

7C3.197 An intermediate bulk container is a container constructed of moulded plastic, fibreglass, steel or plywood with steel reinforcing and is used for storage and transportation of goods. Intermediate bulk containers may range in size but are generally between 700 mm and 2000 mm in height. The length and width of an intermediate bulk container is usually dependent on the country's pallet dimension standard. They may have pallet-like bases so that they can be easily lifted using forklift trucks. Intermediate bulk containers can contain powdered or liquid chemicals.

Examples of intermediate bulk containers



Portable tanks, multi-element gas containers (ISO tanks)

7C3.198 Portable tank means a multimodal tank used for the carriage of explosives (UN Class 1) and other dangerous goods in UN Classes 3 to 9. The portable tank includes a shell fitted with service equipment and structural equipment necessary for the carriage of dangerous substances. The portable tank shall be capable of being filled and discharged without the removal of its structural equipment. It possesses stabilising members external to the shell, and is capable of being lifted when full. It is designed primarily to be loaded onto a transport vehicle or ship and is equipped with skids, mountings or accessories to facilitate mechanical handling. Tank-vehicles, tank-wagons, non-metallic tanks and intermediate bulk containers are not considered to fall within the definition for portable tanks.

Examples of portable tanks (ISO tanks)



Non-pressure transit tankers

7C3.199 Non-pressure tankers are used for the transportation of liquids and gases that do not need to be stored under pressure. There are various models ranging from the single load tanker to the multi load tanker. Tankers will not show any warning signage when empty.

Non- pressure tank – nitric acid

7C3.200 The photo above shows a non-pressure tank containing Nitric Acid>70 per cent. Note the added protection to prevent accidental damage to the structure of the tank, which is a good indication that the tanker carries a high consequence load.

Multi-compartment tanker

7C3.201 The photo above shows a 30,000 litre non-pressure, stainless steel, multi-compartment tanker that can carry a variety of substances at different times but only compatible loads during any single journey.

Vacuum-operated waste tanks

Vacuum-operated waste tank

7C3.202 The photo above shows a vacuum-operated tank; notice should be taken of the external strengthening ribs which are to prevent the tank collapsing when the vacuum is applied. Details of the specifications regarding vacuum operated waste tanks can be found in Chapter 6.10 of ADR Volume II.

Pressure tanks

Pressure tank

7C3.203 The above photo shows a typical pressure tank designed for carrying liquid petroleum gas.

Cryogenic liquid tanks

7C3.204 Cryogenic receptacle relates to transportable thermally insulated pressure receptacles for refrigerated liquefied gases of a water capacity of not more than 1000 litres.

Cryogenics liquid tanker

Cryogenics tanker

Valve groupings, note the frosting indicating recent use

Emergency stop button

Safety kit located in cab of vehicle; note the thermal protective gloves

Bags

7C3.205 These are a flexible packaging made of paper, plastics film, textiles, woven materials or other suitable materials.

7C3.206 The type of hazardous substances typically to be found in these bags include agrochemicals of a quantity of up to 1 tonne.

Carboys

7C3.207 These are large glass or plastic containers usually encased in a protective basket or crate and often used to hold corrosive liquids.

Bulk containers

7C3.208 Typically the term applies to containers designed for use on road vehicles and in shipping, such as ISO-containers. The term container does not cover conventional packaging, intermediate bulk containers, tank-containers or vehicles.

Bulk container

7C3.209 The photo above shows a shipping container stacked on the dockside. There can be issues with containers being used to transport dangerous goods that are not declared on the manifest, so care should be taken when opening containers.

Drums

7C3.210 A drum is a flat-ended or convex-ended cylindrical packaging made out of metal, fibreboard, plastics, plywood or other suitable materials. This definition also includes packaging of other shapes, eg, round, taper-necked packaging or pail-shaped packaging. Wooden barrels and jerry-cans are not covered by this definition.

Drums

7C3.211 One example of where non-UN approved packaging is used to transport dangerous goods is the use of oak barrels to transport alcoholic beverages such as Scotch whisky.

Bulk tanks

7C3.212 The various tanks in use are designed to store different types of substances. The list below shows the design criteria for hydrocarbon oils.

- Floating roof tanks; containing:
  - Class 'A' (flash point below 228°C) hydrocarbon fuels,
  - Class 'B' (flash point between 228 and 656°C)
- Non-pressure; containing:
  - Class 'A' (flash point below 228°C)
  - Class 'B' (flash point between 228 and 656°C)
  - Class 'C' (flash point above 656°C)
- Fixed roof tanks containing:
  - Class 'A' (flash point below 228°C)
  - Class 'B' (flash point between 228 and 656°C)
  - Class 'C' (flash point above 656°C)
- Pressure fixed roof tank
  - Class 'A' (flash point below 228°C) hydrocarbon fuels
- Spherical pressurised tank
  - Liquefied petroleum gas, liquefied natural gas
- Horizontal pressure tank
  - Liquefied petroleum gas, liquefied natural gas
- Refrigerated storage tank
  - Liquefied petroleum gas, ethylene, liquefied natural gas, similar hydrocarbons, and also ammonia.

7C3.213 Detailed information on the various methods of bulk storage in the petrochemical industry including bulk storage systems for liquefied petroleum gas and liquefied natural gas can be found in *Fire Service Manual (volume 2 Fire Service Operations) Petrochemical* Incidents.

Overview of tank farm

Labelling and signage

7C3.214 Storage facilities for hazardous materials will be required to apply signage to the premises in accordance with the *Notification and Marking of Sites Regulations 1990* (NAMOS) (7A.19).

Pipelines

Introduction

7C3.215 Onshore and offshore pipelines are an economic way of transporting large volumes of hazardous and non-hazardous substances across, into and out of the UK. Pipelines have long been used for transporting crude oil to refineries and to shipping terminals, and petroleum and its derivatives are still the main fluids moved by pipeline. Pipelines are being increasingly used for transporting various industrial materials and products, in particular those of the chemical industry. Progress has also been made with the transportation of solid materials as slurries in water or other fluids.

7C3.216 The advantages of pipeline transport include the reduction of costs, the easing of congestion on roads, the maintenance of delivery 'round the clock' irrespective of season or weather conditions, the elimination of contamination during transport, the removal of dangerous fuels cargoes from the roads and the reduction of stocks being held in crowded areas. Pipelines are classified as 'cross-country' or 'local', and in law a cross-country pipeline is one whose length exceeds 16 km.

Safety considerations

7C3.217 The Gas and Pipelines Unit, part of the Health and Safety Executive, oversee the safety of pipelines. The unit is the enforcing authority for:

- upstream natural gas transmission and distribution networks
- gas storage facilities
- onshore major hazard pipelines
- offshore pipelines; and
- other associated high hazard sites.

7C3.218 The Health and Safety Executive have issued guidance on the safety of pipelines in the form of L82 *A Guide to the Pipelines Regulations*. These regulations cover all pipelines but in particular and of more interest to the firefighter, major accident hazard pipeline.

7C3.219 This is defined as a pipeline which conveys a dangerous fluid which has the potential to cause a major accident.

7C3.220 The regulations and guidance note give best practice advice on:

- the requirement for emergency shut-down valves
- the major accident prevention document
- arrangements for emergency plans.

7C3.221 It is advised that the fire officer contacts their local emergency planning officer for details of any emergency plan in operation within their area.

Marking of pipelines

7C3.222 Details of the types of markers used to indicate the location of pipelines can be found at:

www.linewatch.co.uk/pdf/A4_PplnMrkrs.pdf

Operational considerations for pipeline incidents

7C3.223 The Health and Safety Executive has issued a document that includes information on:

- hazards and effects of pipeline failures
- fire and explosion
- toxic effects
- blast effects and projectiles

- cryogenic effects
- asphyxiation
- noise.

7C3.224 The Incident Commander and hazardous materials adviser as a contributory part of the risk assessment process will consider all of the above.

PART C–4

UN Class 1 Explosives

General information

Introduction

7C4.1 Of all the commonly encountered hazardous materials which may be involved in fire, it is likely that explosives pose the greatest and most immediate danger to life and property.

7C4.2 The highest degree of care and precaution is exercised by those responsible for manufacturing, handling and transporting explosives and a very substantial and complex system of legal safeguards is in place to control them. For this reason, it is very rare for large fires to occur in explosives installations. It is important that Fire and Rescue Service staff seek guidance from those responsible at an explosives installation whenever they are engaged in firefighting at such premises in order to avoid being exposed to any unforeseen risk from the hazardous materials present. However, it is also essential to have a general understanding of explosives and the key operational principles for firefighting in the vicinity of explosives. This is because the 'responsible person' or 'duty-holder' may not always be available (eg transportation accidents etc) or may not share all of the safety-critical information with the Fire and Rescue Service (eg unlicensed storage site, criminal activity etc).

7C4.3 Duty-holders who are engaged in specific activities such as selling fireworks and other pyrotechnic articles, storing explosives, firework display operators and explosives manufacturers, are required to have in place robust systems to counter foreseeable eventualities in worse case scenarios.

7C4.4 It is important that 'fireworks' are not considered to be anything other than explosives. Important factors to be considered are the type and quantity of firework, this may not be initially determinable or known by the Fire and Rescue Service on-arrival at an emergency.

Characteristics and classification

7C4.5 Explosives are generally divided between those which:

Deflagrate

A technical term describing subsonic combustion that usually propagates through thermal conductivity (hot burning material heats the next layer of cold material and ignites it).

Deflagrations are usually less destructive than detonations; however, these events still present a serious risk as they will generate an overpressure which has the potential to harm individuals.

Detonate

A process of supersonic reaction in which a shock wave is propagated forward due to energy release in a reaction zone behind it. In a detonation, the shock compresses the material thus increasing the temperature to the point of ignition. The ignited material reacts behind the shock and releases energy that supports the shock propagation.

Because detonations generate high pressures, they are very destructive.

7C4.6 Explosives, irrespective of whether they deflagrate or detonate produce large quantities of hot gases and proceed without consuming oxygen from the surroundings. Ignited explosives can therefore function, for example, under water. Once initiated the application of water will not extinguish a fire involving explosives.

7C4.7 The types of energetic stimuli that can, in principle, bring about initiations of explosives are:

- impact / friction
- fire / heat
- fragment attack / overpressure
- electrostatic discharge
- electromagnetic radiation (in the case of electro-explosive devices)
- chemical attack.

7C4.8 The United Nations Committee of Experts on the Transport of Dangerous Goods (UNCOE) classifies dangerous goods in the form in which they are to be transported according to the hazard they present during transport, and defines explosives as follows:

Explosives substances

An explosives substance is a solid or liquid substance (or a mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as could cause damage to surroundings. Trinitrotoluene and dynamite are well-known examples of explosives substances.

Pyrotechnic substances

A pyrotechnic substance is a substance or a mixture of substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as a result of non-detonative self- sustaining exothermic chemical reactions. Pyrotechnic substances are commonly found in fireworks.

Explosives articles

An explosives article is an article containing one or more explosive substances. Thus, for example, all items of ammunition are classified as explosive articles.

7C4.9 In accordance with the UN *Recommendations on the Transport of Dangerous Goods* (Orange Book) for transport purposes, explosives (in their packaging) are classified into 'hazard divisions' (HD).

7C4.10 Licences issued under the regulations on the manufacture and storage of explosives refers to 'hazard type'(HT).[1]

7C4.11 With explosives that are packaged for transport, the hazard division and hazard type will be the same, however, in some cases (eg detonators) unpackaged explosives may present a higher hazard.

7C4.12 Both the UN scheme of classification and the *Manufacture and Storage of Explosives Regulations 2005* (MSER) recognise that many substances and articles classified as explosives do not present the same degree of hazard and subdivide them according to their potential for harm.

1 *Manufacture and Storage of Explosives Regulations 2005 (MSER)*

United Nations Committee of Experts on Transport of Dangerous Goods and Manufacture and Storage of Explosives Regulation 2005

HD 1.1 or Hazard Type 1
Substances and articles which have a mass explosion hazard. A mass explosion hazard is an explosion which affects almost the entire load virtually instantaneously. If involved in fire, major structural damage can be expected (eg high explosive shells, bombs etc).

HD 1.2 or Hazard Type 2
Substances and articles which have a projection hazard but not a mass explosion hazard. eg mortar bombs, rocket propelled grenades etc).

HD 1.3 or Hazard Type 3
Substances and articles which have a fire hazard and blast hazard or a minor projection hazard or both, but not a mass explosion hazard combustion of which gives rise to considerable radiant heat or which burn one after another, producing minor blast or projection effects or both (eg flares etc).

HD 1.4 or Hazard Type 4
Substances, and articles which present only a slight risk of explosion in the event of ignition, or initiation during carriage, storage or manufacture. The effects are local, largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package (eg small arms ammunition etc).

HD 1.5 (HD 1.5)
Very insensitive substances that have a mass explosion hazard. This division comprises substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of a transition from burning to detonation under conditions of normal transport (eg ammonium nitrate fuel oil – a preparation for blasting).

7C4.13 The UN has defined a further division based on risk rather than hazard, Division 1.6. However, it has not been possible to find evidence of articles of HD1.6 having been imported or exported through UK ports so they are included for information only:

Division 1.6 (HD 1.6)
Extremely insensitive articles which do not have a mass explosion hazard. This division comprises articles which contain only extremely insensitive detonating substances and that demonstrate a negligible probability of accidental initiation or propagation.

UNCOE classifications

7C4.14 Throughout the rest of this document the term *Hazard Division* (HD) is used, to mean all aspects of explosives, whether in manufacture, storage or transportation.

Hazards

Blast exposure

7C4.15 Multi-level injury from blast exposure, referred to as 'blast injury', may result in impairments to groups of body organs and systems. A phenomenon called "blast overpressure" forms from the compression of air in front of a blast wave which heats and accelerates the movement of air molecules. This overpressure phenomenon is considered to be the positive phase of the blast wave. The negative phase of the blast wave occurs later, as a result of sub-atmospheric pressure/under-pressurisation. The amount of damage from the pressure wave depends on the peak pressure, duration, medium in which the explosion occurs (open air, confined space, or water), and distance from the explosion.

7C4.16 The **type of explosive** will have an impact on the nature and severity of the resulting blast injury. Explosives are categorised as either "high-order" or "low-order."

- **High-order** explosives are chemicals which have a high rate of reaction-including nitroglycerine, dynamite, C-4, and a mixture of ammonium nitrate and fuel oil. When a high-order explosive detonates, the chemicals are converted into gas at a very high temperature and pressure. High-order explosives have the potential to generate a large volume of initial pressure, and a blast wave that may expand outwards in all directions.
- **Low-order** explosives are designed to burn and gradually release energy at a relatively slow rate. This type of explosive are referred to as 'propellants' because they propel an object such as a bullet through a barrel. Low-order explosives do not create the shock waves generated by high-order explosives. The 'blast wind' of low-order explosives is a 'pushing' rather than the 'shattering' effect found in the 'blast wave' of high-order explosives.

7C4.17 **Effects of exposure to explosive blast** – The effects of exposure to any explosive blast are broken down into three distinguishable areas, these are:

- **Primary blast injuries** – are caused by the direct action of a blast wave on the body. The two most common injuries are eardrum rupture and lung haemorrhage. Lung haemorrhage is in fact the most likely cause of death in cases where primary blast effects prove fatal.
- **Secondary blast injuries** – are defined as those, which occur as a direct consequence of blast damage to buildings and structures. These injuries include lacerations caused by flying glass, blunt trauma caused by crushing and impact of falling masonry, and suffocation caused by asphyxiating dust. Secondary blast injuries can occur at significantly greater distances from an

explosion than either primary or tertiary blast injuries, and indeed experience shows that structural collapse is the dominant mode of death and injury from explosions in built-up areas. Thus secondary blast injuries are normally related to degree of building damage.

- **Tertiary blast injuries** – are defined as those resulting from body movement induced by the blast wave. Two modes may be distinguished, injuries caused by differential displacement of internal body organs following high acceleration, and injuries caused by impact when the body is either blown over or picked up by the blast wave and thrown against an object.

7C4.18 The **constituents of explosives**, especially fireworks, varies significantly. Compounds such as metals, metal salts, chlorine donors, hydrocarbon fuels, and binders are incorporated into compositions, for colour or sound effects etc. Some of the constituents of fireworks are toxic. Unfortunately, literature relating to fireworks manufacture does not tend to cover this aspect in much detail. For example, most fireworks contain potassium perchlorate which in itself is an irritant to the mucous membrane, and can have adverse effects to blood and/or the thyroid gland.

Fireball

7C4.19 Severe burns may result even if no explosion takes place as the ignition of some types of Hazard Division 3 and Hazard Division 4 explosives can result in a significant fireball eg the burst diameter of an aerial firework shell can be in excess of 100m.

7C4.20 Respiratory injury may result if inhalation takes place.

Noise

7C4.21 Hearing damage, usually temporary loss or ringing in the ears.

7C4.22 Explosives generate considerable noise when they explode which can make communication difficult especially if this happens over a protracted time, for example with Hazard Division 4 fireworks.

Structural collapse

7C4.23 Entrapment following collapse of a structure.

Usage, transportation, packaging and storage

Usage

Quarries

7C4.24 The majority of locations holding civilian blasting explosives are quarries. These are typically held in a steel store. For quarrying operations most explosives are mixed on-site from non-explosive ingredients.

COMAH sites

7C4.25 The *Control of Major Accident Hazards Regulations 1999* (COMAH) apply mainly to the chemical manufacture and storage industry, but also to other industries such as explosives where threshold quantities of dangerous substances identified in the Regulations are kept or used. These Regulations relate to the identification, prevention and mitigation of major accidents to people and the environment and are detailed in 7A.41.

Explosives manufacturing

7C4.26 There are only a few locations in the UK where the manufacturing of high explosives or munitions using high explosives, is undertaken. The principal companies are:

1. Exchem
2. Orica
3. Chemring
4. Ulster Industrial Explosives, and
5. BAe Systems

7C4.27 Other sites and companies are engaged in manufacturing small arms ammunition, munitions, pyrotechnics, detonators, and oil well explosives, amongst others products. Explosives manufacturing of this nature is not a seasonal activity.

Retail premises

7C4.28 Shops, supermarkets etc usually only store small quantities of fireworks and then only during the peak firework season; either within the shop or in an IS0 container in the goods yard. Typically this will be up to 250 kg of Hazard Division 1.4, or smaller quantities of Hazard Division 1.3, but may be more if separation distances permit. Fire and Rescue Services should also be mindful of transient

locations where explosives may be encountered and that operational crews are apprised of these. This may necessitate the provision of temporary mobilising information.

Fireworks

7C4.29 The major proportion of fireworks are sold and used during the October/November firework season. However, professional fireworks displays take place at public and private events at other times of the year and there are a limited number of retailers selling fireworks all year round. Fire and Rescue Services could therefore encounter large stocks of fireworks at any time of the year. Fireworks importation varies according to the time of the year and the special event for which they have been imported. For example, in 2006 approx 1180 containers were brought through the port of Felixstowe. Equating to 15,559 Tonnes of fireworks (gross weight). Fifty-seven per cent of these were received in August and September.

Fireworks display operators

7C4.30 Fireworks display operators are likely to be using Hazard Division 1.1 and Hazard Division 1.3 fireworks in addition to Hazard Division 1.4. The main implications from this are:

1. Hazard Division 1.1 presents a mass explosion hazard

2. When fireworks of Hazard Division 1.1 are present in a store together with Hazard Division 1.3 or Hazard Division 1.4 the whole quantity will behave as if it is Hazard Division 1.1

3. Hazard Division 1.3 articles do not present a mass explosion hazard. There is nevertheless a potential for them to explode and produce large fireballs.

NOTE: Whilst the UN Hazard Division definition states that they have no mass detonation, this is based upon a test of the articles in the open within their correct transport or stowage packaging. Evidence from the Health and Safety Laboratory demonstrates that UN Hazard Division 1.3 fireworks will mass deflagrate (almost no perceptible difference to a detonation) when confined. In addition to this, containment also presents a different reaction to that of confinement (eg ISO containers).

Improvised or home-made explosive devices

7C4.31 Since the New York terrorist attacks of 9/11 awareness of terrorist activity has been heightened throughout the western world. A concerning development is the increased manufacture and use of improvised or home-made explosives and explosive devices. These have many forms but the most common group are peroxide explosives (eg triacetone triperoxide, hexamethylene triperoxide diamine etc).

Common explosives and their uses

Nitroglycerine

7C4.32 A very powerful and extremely sensitive liquid explosive which is usually mixed with other inert materials to form propellant, dynamites and blasting gelatines. The liquid is particularly sensitive to heat, flame, shock, oxygen or ultra violet light radiation and is not transported or used in its pure form as it is too dangerous to handle. Some types of explosives containing nitroglycerine, such as dynamite, release nitroglycerine liquid when in contact with water. This can present particular dangers during firefighting or where the explosives are involved in flooding. Nitroglycerine is also transported and used either as a dilute solution in alcohol or as a mixture with a solid dilutent for pharmaceutical purposes. Nitroglycerine-both the vapour and liquid (which is readily absorbed through the skin) are highly toxic.

T.N.T. (Trinitrotoluene)

7C4.33 A comparatively insensitive explosive mostly used for military purposes. It is a stable solid substance which is generally safe to handle. Small unconfined quantities may burn quietly but larger quantities, particularly under confinement, are likely to burn to detonation. On decomposition, toxic fumes are given off. It is moderately toxic by ingestion and can be absorbed through the skin.

Nitrocellulose (guncotton, pyrocotton, nitrocotton)

7C4.34 Nitrocellulose is a white or cream coloured fibrous material produced in a range of forms. Its properties depend on the amount of nitrogen in it. Types with a nitrogen level above 12.6 per cent nitrogen are generally used in explosives manufacture. Those below that are used for other purposes. Nitrocellulose is sensitive to impact and friction and easy to ignite by flame when dry and is therefore normally transported either wetted with water or alcohol or plasticised. Explosives grade nitrocellulose can present a fire or explosion hazard depending on its level of dryness and whether it is confined. Non-explosives grade nitrocellulose will normally burn and is often classified as a Class 4.1 flammable solid. Its principal uses are as an ingredient in propellant mixtures for ammunition and rocket motors, and in nitroglycerine explosives. Non-explosive grades of cellulose nitrate are used with other substances in the manufacture of paints and lacquers. Small arms propellant powders. These materials are usually made from nitrocellulose (single base) or nitro-cellulose with nitroglycerine (double base) and are usually in the form of a free flowing granular material. For the most part they burn fiercely but many types can, under confinement, burn to detonation. As a consequence the hazard can be either a fireball or a mass explosion.

Primary explosives such as fulminates, azides, and styphnates

7C4.35 These are initiating explosives which are highly sensitive and dangerous particularly when they contain heavy metals such as lead, silver or mercury. They explode violently and are commonly used in initiators such as detonators and cap compositions. These types of explosive are infrequently transported and are only carried when wetted with water or other suitable liquid to minimise their sensitivity to impact and friction. Transport packages are carefully designed to minimise the risk of leakage of wetting agents and the consequent drying of the explosive. Some forms of these substances, such as styphnic acid or potassium azide, have low explosive properties. These substances can, however, react with other substances such as copper or lead salts to form the highly dangerous forms. This can be a serious problem where these substances have been spilled and allowed to get in contact with copper, lead or other reactive species. Because the sensitive forms tend not to dissolve in water, a hazard could rapidly develop.

Gunpowder/black powder/black blasting powder

7C4.36 These are generally made from a mixture of charcoal, sulphur and potassium nitrate and are frequently described as 'low explosives'. They are very sensitive to ignition from sparks, heat and friction. They burn violently even when loose and uncompressed and when confined may explode. They also release volumes of smoke on burning or exploding. Black powder is used as a blasting explosive as well as an ingredient in some types of sporting cartridges, fireworks and pyrotechnics.

Oxidisers

7C4.37 These substances are not explosives in their own right but can, under certain conditions in a fire, explode. Two types commonly used in explosives are worthy of comment.

Nitrates

Nitrates are used in explosives such as gunpowder, emulsion and slurry blasting explosives and pyrotechnic substances. The most common are potassium, sodium, barium and ammonium nitrates. If mixed with a fuel these compounds can burn fiercely or explode.

Wood, if impregnated with oxidisers, can burn fiercely and this can be a potential problem on vehicles with wooden floors or in wooden storage buildings where oxidisers have been transported or stored. Care must be taken in warehouses to ensure that oxidisers are segregated from other dangerous goods.

Ammonium nitrate is used as a fertiliser and is commonly found in farming areas. It is usually supplied as a porous prill[2] which can readily absorb liquids. It forms the basis of ammonium nitrate and fuel oil explosives much used by terrorist organisations.

It is possible that other fuels such as saw dust and metal powders could also form explosive mixtures with ammonium nitrate. There have been a small number of reports throughout the world of nitrates exploding without other chemicals being present when confined or subject to severe heat. In recognition of this danger, the size of stacks of ammonium nitrate in storage is normally carefully controlled.

Chlorates

These substances, typically in the form of potassium chlorate, are mostly used in pyrotechnic compositions. As with nitrates, chlorates can decompose violently in a fire, particularly if mixed with fuels. As a general rule, chlorates are more aggressive and less stable in a fire than nitrates.

Emulsion and slurry explosives

7C4.38 Emulsion and slurry explosives are relatively new types of explosives which are mixtures of nitrates and other substances often in a water-based system. They are now replacing nitroglycerine based explosives for many uses, particularly in quarrying. A small proportion of emulsion and slurry explosives are produced as pre-packed, ready to use, products. The majority of this type of explosives, however, is manufactured at the shot hole, immediately prior to use. This mixing is carried out on a specially designed mixer truck that carries the necessary ingredients for producing a fully active explosive.

Peroxide explosives (improvised or home-made explosives)

7C4.39 Peroxide explosives are extremely dangerous because:

- only small quantities are needed to cause serious injury or explosions
- the constituents are readily available from almost any high street
- they are easy to make, instructions for their manufacture are easily available on the internet
- the emergency services may encounter them at many routine incidents (eg domestic property fires).

7C4.40 The main constituents are:

- hydrogen peroxide (eg hair dye etc)
- acid (eg battery acid, brick cleaner, citric acid used in brewing etc)

2 A prill is a small aggregate of a material, most often a dry sphere, formed from a melted liquid.

- acetone (eg nail varnish remover etc)
- hexamine (eg camping stove fuel tablets etc).

7C4.41 It is important for Fire and Rescue Service responders to know and remember these constituents because early recognition of the possibility that home-made explosives are present at an apparently routine incident (eg fire and explosion at a domestic property etc) can save lives.

7C4.42 Peroxide explosives can vary greatly in appearance. Pure substances form a white powder, but they may also be granular in texture like sugar, or even form a sticky 'goo'. Due to this, responders should not rely on physical appearance alone to identify this hazardous material. It is more important to recognise the raw constituents along with other indicators such as mixing jars and containers, a fridge or freezer to keep the substance cool.

7C4.43 Common types of peroxide explosives are:

- **Triacetone triperoxide**
  A terrorist explosive which has appeared as a weapon in the Middle East. Triacetone triperoxide has been used by suicide bombers in Israel, and was chosen as a detonator in 2001 by the thwarted 'shoe bomber' Richard Reid. It is one of the most sensitive explosives known, being extremely sensitive to impact, temperature change and friction.
- **Hexamethylene triperoxide diamine**
  Another peroxide-type explosive which is less sensitive than triacetone triperoxide but still dangerous.

Transportation and packaging

7C4.44 UK regulations implement the EU directive on transportation by road (ADR), rail (RID) and in respect of training, examination for safety advisers only for inland waterways (ADN). Further guidance is contained in Section 7,C-12 Transportation, packaging and storage of hazardous materials and in Part C-4,4.66 Legal framework.

7C4.45 Certain explosives have to be segregated during storage and transport for safety. To facilitate this, each explosive is assigned to one of 13 'compatibility groups'. Explosives can be segregated by compatibility into a group according to well established mixing rules to avoid increasing the probability or magnitude of an accidental initiation.

7C4.46 Descriptions of the explosives which make up the various compatibility groups, and their subsequent classification codes are given below.

Description of substance or article to be classified		
	Compatibility group	Classification code
Primary explosive substance.	A	1.1A
Article containing a primary explosive substance and not containing two or more protective features.	B	1.1B 1.2B 1.4B
Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance.	C	1.1C 1.2C 1.3C 1.4C
Secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features.	D	1.1D 1.2D 1.4D 1.5D
Article containing a secondary detonating explosive substance without means of initiation, with propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids).	E	1.1E 1.2E 1.4E
Article containing a secondary detonating explosive substance with means of initiation, with a propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids) or without a propelling charge.	F	1.1F 1.2F 1.3F 1.4F
Pyrotechnic substance or article containing a pyrotechnic substance, or article containing both an explosive substance and an illuminating, incendiary, tear or smoke producing substance (other than a water activated article or one containing white phosphorous phosphides, a pyrophoric substance, a flammable liquid or gel, or hypergolic liquids).	G	1.1G 1.2G 1.3G 1.4G
Article containing both an explosive substance and white phosphorous.	H	1.2H 1.3H
Article containing both an explosive substance and a flammable liquid or gel.	J	1.1J 1.2J 1.3J
Article containing both an explosive substance and a toxic chemical agent.	K	1.2K 1.3K

Explosive substance or article containing an explosive substance and presenting a special risk (eg due to water activation or presence of hypergolic liquids, phosphides or a pyrophoric substance) and needing isolation of each type.	L	1.1L 1.2L 1.3L
Articles containing only extremely insensitive detonating substances.	N	1.6N
Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit firefighting or other emergency response efforts in the immediate vicinity of the package.	S	1.4S

Operational key principle

Explosive decomposition

It is important to remember that the UN classifications are based on the behaviour of the explosive when burnt in their packaging in the open air on a fire. However, the same explosive may behave very differently when under the sort of pressure that might be encountered in International Standards Organisation (ISO) transport containers, thick walled steel stores or some process plant.

In such circumstances, the very rapid build-up of pressure can cause the explosives to react more violently than the classification would suggest and therefore present a much greater hazard.

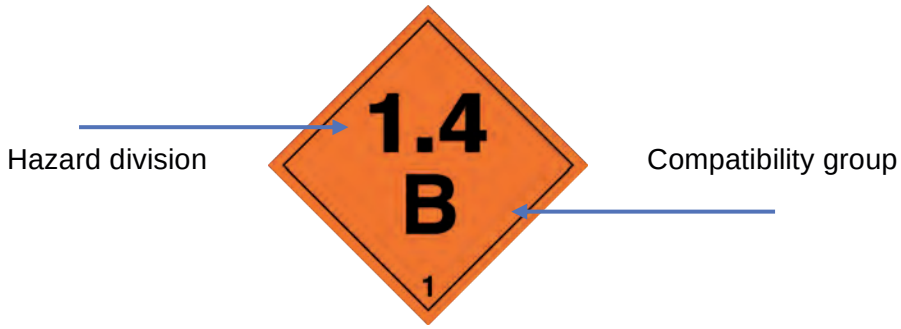
7C4.47 Where explosives of different hazard divisions are stored together, they are treated as if they are all of the highest hazard division (eg 100 kg Hazard Division 1.3 and 1000 kg Hazard Division 1.4 are treated as 1,100 kg of Hazard Division 1.3). For transportation purposes the same principle applies for different Hazard Divisions carried together and the vehicle should be placarded accordingly.

Road

7C4.48 ADR requires that, subject to some exceptions, vehicles carrying explosives should be marked with placards in accordance with the Regulations.

Warning Placard Hazard Division 1.1 to 1.3 and compatibility group

Warning Placard Hazard Division 1.4 to 1.6 and compatibility group (Note bomb blas pictogram deleted)



- Vehicles carrying larger quantities of fireworks and other hazards should carry the appropriate UN hazard division orange diamonds. However, Fire and Rescue Services should be aware of the possibility of smaller loads of explosives being carried in un-placarded vehicles. Potential exists for the illegal carriage of explosives. Incident Commanders should always consider the possibility of this arising, if for example the driver of the vehicle involved cannot be easily identified at the incident.
- Vehicles carrying more than 5 tonnes of Hazard Division 1.1 explosives must have a driver and attendant (less than 5 tonnes and other Hazard Divisions no attendant is required) both of who will have received specific training to the ADR standard that enables them to take measures for their own safety, that of the public and the environment. The vehicle crew should therefore always be consulted.

- If the crew are injured and unable to be consulted, instructions in writing, to a standard format and in a language that the driver understands, outlining the load and any special actions required can found, if it is safe to retrieve, in the driver's cab.
- All packages and the vehicle must be correctly identified as per *The Carriage Regulations*. The package labels and vehicle placards provide safety information for those involved in transportation and the emergency services and must be displayed at all times.
- On those occasions when Her Majesty's Forces in the interest of national security do not comply with the carriage regulations, liaison with the crew of the vehicle is paramount.
- Although small quantities of explosives may be carried in private vehicles without having to comply with *The Carriage Regulations*, the carrier still has a responsibility to move them safely and securely.
- Even though up to 2kg of one or more specific item may be carried on public transport, they must however remain with the person carrying them, be properly packaged and reasonable precautions taken to prevent accidents.

Rail

- Transport of explosives is strictly controlled under railway transport legislation.
- Explosives are clearly marked and packed in specific wagons or containers. Placards similar to those required for road transport are displayed on both sides of the wagon and on all four sides of containers.
- Information in writing is carried by the crew detailing the explosive carried and any special action required. The crew will also have received specific training similar to that of road vehicle crews but to the *European Agreement on Carriage of Dangerous Goods by Rail* (RID) standard and if uninjured, crews should always be consulted.
- The incident should be managed in a similar manner to that involving road transport but modified as necessary to ensure the safety of personnel working on the rail infrastructure.

Sea and inland waterways

- Legislation prohibits, with certain exceptions, unless a licence has been granted:
  - explosives being brought into or handled in a harbour
  - the loading/unloading of explosives on a vessel.

  When this occurs on any part of the coast or in the tidal waters or within the territorial waters of Great Britain.

- The licence specifies any conditions or restrictions, including limits on the type and quantities of explosive handled and where in the harbour area the handling may take place.
- Once the loading/unloading of a vessel or a vehicle is completed, the master of the vessel or the operator of the vehicle shall ensure that the vessel or vehicle is taken out of the harbour or harbour area as soon as is reasonably practicable unless the harbour master and if berthed, the berth operator agree.
- Vessels carrying dangerous goods will, between sunrise and sunset, display a red warning flag and when moored or anchored between sunset and sunrise and during the day in restricted visibility, display an all-round, uniform and unbroken red light visible in good night time conditions for at least 2 nautical miles.
- The operator of any berth where explosives are being loaded/unloaded or stored before being loaded/unloaded, shall ensure that their emergency plan is made available to the Fire and Rescue Service.
- **ROYAL NAVY VESSELS**
  All Royal Navy vessels have a liaison officer who will inform the Fire and Rescue Service whenever the vessel is in port. Courtesy visits should be arranged on a regular basis especially if different types of vessels visit. If a vessel is in port for any length of time consideration should be given to holding a firefighting or rescue exercise. In the event of a fire onboard a navy vessel the Incident Commander must ensure that they clearly establish and understand the Royal Navy's priorities. On a warship, protection of the ship's magazine will often be the top priority and the action taken to achieve this may appear to be contrary to the priorities that are the norm to Fire and Rescue Services.
- **INLAND WATERWAYS**
  Fire and Rescue Services should contact the appropriate controlling authority for their area, which is usually but not always, the British Waterways Board for information in respect of:
  - types of vessel eg barges, small craft
  - mooring
  - storage areas
  - emergency access points to canals and rivers.

7C4.49 Visits should be made to the wharves and vessels to liaise with the owners, masters, wharfing and berthing agents etc. and a response plan drawn up. Although the UK has only adopted part of and, craft on inland waterways may well display warning signs in line with British Waterways Board guidance and these will be similar to those for road and rail. In addition, packages, unless carried for their entire journey on inland waterways must comply with the carriage regulations for that part of their journey by road or rail. On canals and

many rivers it will often be possible to deal with the incident from on land and similar methods as those for dealing with road and rail transport can often be used.

Air

- **CIVIL AVIATION**
  International Air Transport Association Dangerous Goods Regulations and International Civil Aviation Organisation Technical Instructions detail classifications which follow the UN system. Hazard Division 1.1, Hazard Division 1.2, Hazard Division 1.3 and Hazard Division 1.5 are normally forbidden.
- In the event of an incident occurring, eg aircraft overshooting the runway, the operator must inform the emergency services of any dangerous goods being carried. The airport fire service will usually be the first to be informed. In addition, the aircraft operator is required to ensure that a copy of the dangerous goods documentation, or the information contained in it that had been provided to the aircraft captain is readily available at the points of departure and intended arrival.
- **MILITARY**
  If military aircraft are involved in any incident guidance should always be sought from the Ministry of Defence or armed services personnel as the munitions carried will present a wide variety of hazards eg high explosives, sub-munitions that arm on ejection, incendiaries and possible radiation hazards form depleted uranium ammunition.

International Standards Organisation Transport Containers (ISO)

- International Standards Organisation (IS0) containers are used for the transportation of fireworks from the port of origin to the port of disembarkation; they are also used for storage of fireworks. They can be found in a number of locations, varying from designated container yards, private properties to derelict sites. A fire involving, or in near proximity to an IS0 container should be treated with extreme caution if information about its contents cannot be determined.
- In certain conditions selected fireworks stored in IS0 containers may be liable to simultaneous detonation. This could result in the fragmentation of the container. Therefore, if there is a window of opportunity to prevent direct burning or thermal radiation affecting the container, then every effort should be made to provide complete cooling to the container, if the container is at any risk of heating then firefighting actions should not be undertaken.
- If this is not possible a 600m minimum hazard zone should be put in place. (**NOTE:** This distance should be extended depending on the quantity of storage on-site.) This situation may arise when fireworks that contain flash powder are stored. If only one of the large fireworks detonates, due to

localised heating through the container, a shock wave could be produced that provides sufficient energy to detonate all/the majority of this grade of firework at the same time. This will generate high pressure that will likely destroy the container.

- Where only Hazard Division 1.4 fireworks are stored, the containers should be suitably marked, but only when the container is in use. An example of such storage arrangements would be a supermarket prior to bonfire night.
- Any fire involving an ISO container at any location, not just explosives sites, should be treated with caution until information on its contents is known.
- At manufacturing and storage sites a large number of ISO containers may be found in close proximity (within 1m) of each other. In these circumstances it is possible for a fire involving one container to affect another.
- Under no circumstances should the doors of an ISO container doors be opened, even if the fire appears to be out. The doors should not be opened for at least 24 hours and the container treated as a potential source of explosion until that time.

Unsafe explosives

7C4.50 The following list has been compiled from available accident records and safety reports. It is not necessarily exhaustive. Safety flaws in the design, manufacture, processing, keeping, packaging and conveyance of explosives sometimes only come to light after accidents have occurred.

UNSAFE PACKAGING OF IMPACT-SENSITIVE ITEMS

Badly packaged impact-sensitive explosives items could be initiated by the knocks and jolts cargoes typically receive in transit. Such an accident occurred on a road vehicle in the UK as recently as 1989. The explosion caused one fatality and widespread damage.

EXUDATION OF EXPLOSIVES MATERIAL

This is a problem mainly associated with nitroglycerine-based blasting explosives, which may, under certain conditions, exude free nitroglycerine, a substance sensitive to impact and friction. Possible causes of exudation include poor quality control during manufacture, exposure to water, prolonged storage, storage at incorrect temperature and pressure on explosives cartridges. Nitroglycerine-stained packages have been found on a number of occasions within magazines in the UK, and there has been one incident in the last 25 years in which exuding explosives were found on board a ship – the ship was scuttled to avoid the risk of unloading the material. Nitroglycerine-based blasting explosives are currently being phased out and replaced with inherently safer types of explosives.

POOR INTEGRITY OF PACKAGING

Poor integrity of packaging may result in spillage of explosives substances. This in turn may result in the ignition of fire in the event that the spillage is subjected to impact or friction, or the spillage falls through cracks in the floorboards of a vehicle and lands on a hot surface, such as an exhaust manifold. One or two minor explosives events have occurred within UK manufacturing sites in recent times, caused by vehicles running over spilt explosives material, but no such events have occurred during transport of packaged explosives goods.

PROPELLANT WITH DEPLETED STABILISER CONTENT

Nitrate-ester based propellants with depleted stabiliser content may ignite spontaneously through the process of autocatalytic decomposition. Within the last 25 years there have been several fires in UK storehouses caused by this process. Within the last 10 years there has been one incident of fire on a rail wagon caused by spontaneous ignition of nitrocellulose, a raw material used in the manufacture of propellants.

LEAKS FROM MUNITIONS CONTAINING WHITE PHOSPHORUS

Certain types of munitions contain white phosphorus, a substance that can spontaneously ignite on exposure to air. There have been at least two instances in the UK during the last 45 years when leaks from these munitions have resulted in ignition of fire during rail transport.

MUNITIONS WITH CONTAMINATED COMPONENTS

Physical or chemical reactions between contaminants and explosive fillings may lead to the formation of heat-and impact-sensitive explosives crystals or compounds within munitions. These munitions may then become more susceptible to accidental initiation. Migration of sensitive compounds into screw threads and non-continuous welds may further increase the susceptibility of the munitions to accidental initiation by impact. There was a major explosion in a UK military port in 1950 caused by impact-induced ignition of a depth charge that had been sensitised by the presence of impurities in the main explosives filling. A similar accident occurred in Gibraltar a year later.

MUNITIONS WITH CRACKED WARHEADS

The explosives fillings of certain types of munitions are prone to cracking. Cracking may result in migration of explosives dust into screw threads and non-continuous welds within munitions, and this may increase the susceptibility of the munitions to accidental initiation in two ways:

- impact accidents may result in nipping of dust between metal surfaces and the presence of bare explosives crystals in the cracked surface may increase the chance of an initiation proceeding to full detonation
- the dangers posed by munitions with cracked warhead fillings are well recognised; such munitions are normally subject to Ordnance Board constraints, which would include restrictions on the height to which such munitions can be lifted.

MUNITIONS WITH DEFECTIVE ELECTRICAL COMPONENTS

Certain types of munitions, such as torpedoes, are equipped with power supplies. There is a possibility that electrical short circuits within these types of munitions may ignite fires which may in turn initiate explosives material. So far as is known, no such accidents have occurred in the UK in post-war times.

SPONTANEOUS MOVEMENT OF SENSITIVE ITEMS WITHIN MUNITIONS

Stresses are created when components are installed into certain types of munitions. An explosives event may occur if these stresses relieve spontaneously on some subsequent occasion. There have been a number of such accidents within UK storehouses, though, so far as is known, no such accidents have occurred in ports or during transport.

DEFECTIVE ELECTRO EXPLOSIVES DEVICES

Electro explosives devices that have been badly designed, manufactured or packaged, may be susceptible to initiation by radio frequency radiation. There have been a number of such accidents involving unpackaged items on firing ranges, though so far as is known, no such accidents have occurred in ports or during transport.

FUSE DEFECTS

Munitions fitted with defective fuses may be vulnerable to the sorts of knocks and jolts that cargoes typically receive while in transit. There are three ways in which the safety of a fuse may be compromised:

- mis-assembly in which the fuse is assembled in a manner which “short circuits” the intended safety features
- severe metal corrosion affecting components such as springs, shutters etc, making inoperative the safety features that rely on the correct functioning of these components
- chemical reaction in which the chemical composition of some of the explosives compounds are changed, making them more sensitive to external stimuli.

ENERGETIC ACCIDENTS

Explosives cargoes, which contain unsafe items, may initiate spontaneously, ie without involvement of the cargoes in external accidents, such as lorry crashes and falls of loads from cranes. Explosives cargoes that do not contain unsafe items may initiate in the event that they become involved in accidents, such that sufficient energy is imparted to explosives material in the cargo to bring about an explosion or fire.

Storage

General storage

7C4.51 Where explosives are stored, it is the 'net explosive content' or 'net explosive quantity' that is the licensable amount. The net explosive content is the amount of explosive in the article, not including the packaging. In the case of fireworks the net explosive content is assumed to be 25 per cent of the weight of the firework but can be as high as 70 per cent, so a store licensed for 2 tonnes net explosive content, may actually contain 8 tonnes gross weight including packaging. Licences for storage of less than 2 tonnes net explosive content are issued by the appropriate licensing authority that, depending on the quantity stored and the location in the UK can be the police, the Metropolitan Fire and Rescue Authority, local authority or, in harbour areas and mines, the Health and Safety Executive. Where lower quantities are stored then the appropriate licensing authority may issue a registration rather than a licence. For stores involving more than 2 tonnes the Health and Safety Executive will issue a licence.

Licensing and registration

7C4.52 A licence is required for most manufacturing or storage activities. 'Manufacturing' includes processes where explosive articles or substances are made or assembled/disassembled, repaired or modified. The Health and Safety Executive is the licensing authority for all manufacturing. Depending on the quantity and type of explosives, the licensing authority for storage could be the local authority, Metropolitan Fire and Rescue Service, police or the Health and Safety Executive. There are a number of licensing exemptions for the storage of small quantities and for temporary storage. For example there are allowances for storing limited quantities of shooters' powders, certain lower-risk pyrotechnics and articles such as flares, fog signals, car airbags and seatbelt pre-tensioners.

Unlicensed storage

7C4.53 During the fireworks season Fire and Rescue Services should be aware of the possibility that they may encounter illegally-stored fireworks. Situations where this might occur would include:

- transport haulier's depots
- shops on short lets
- warehouse or lockup storage.

Operational considerations

Pre-planning

7C4.54 It is estimated that there are between 20 and 30 thousand premises licensed or registered to store explosives. The vast majority of these are shops and supermarkets registered for storing fireworks during the firework season. These premises are licensed or registered either by the Fire and Rescue Service (in the metropolitan counties) or by the local authority trading standards department.

7C4.55 The sites storing the largest quantities of explosives are licensed by the Health and Safety Executive, who licence about 230 sites in the UK. These sites range from manufacturers of blasting explosives and munitions, through to firework importers and firework display operators

7C4.56 Sites holding smaller quantities of high explosives are licensed by the police. These sites are mainly at quarries. The police also grant explosives certificates to private individuals holding black powder ('gunpowder'). This can be up to 5kg of black powder.

7C4.57 Fire and Rescue Services should contact the Health and Safety Executive and other licensing authorities with a view to identifying the Health and Safety Executive – licensed sites in their areas, so that they can undertake 7(2)(d) information-gathering visits. This will give them the information on the most hazardous sites in their area. A close and effective working relationship with the police, Health and Safety Executive, Customs and Excise, the Local Authority Planning and Trading Standards should be adopted to ensure that information about the movement, storage and use of explosives is made available to all partner organisations.

7C4.58 Sites owned and/or used by firework display operators should be treated as falling into the priority group for *Fire and Rescue Services Act 2004* section 7(2)(d) inspections. Fire and Rescue Services should also ensure that operational crews are reminded that explosives will be encountered at domestic homes and many retail businesses (eg flares stored at retail chandlers or Royal National Lifeboat Institution (RNLI) property; shot gun cartridges in homes etc.).

7C4.59 Effective formalised systems for liaison must be in place to identify what information Fire and Rescue Services require and arrangements for updating that information at regular intervals.

7C4.60 Information which should be gathered would include:

Manufacturers and storage

- location of the explosives
- explosives hazard divisions that may be present

- maximum quantities of each held on site and in each location. This information is readily available from the site licence
- construction type of manufacturing and storage buildings; features or structural hazards which may have a profound effect on fire fighting or rescue operations, including:
  - potential for rapid fire spread or production of large columns of smoke and toxic products
  - lack of compartmentation
  - unprotected shafts or openings
  - substantial basement areas; and
  - high potential for structural collapse.

Fire fighting/search and rescue

- Access/egress safe routes within the establishment and boundary, in particular for aerial appliances and other specialised vehicles, giving consideration to available headroom, width, ground clearance, hard standing turning circles and load restrictions
- Travel distances from access points to various points in the building or around the grounds
- Details of fixed fire protection installations eg ventilators, sprinklers, drenchers, fire shutters, any back-up installations etc
- Safe areas where firefighting operations can be undertaken
- Identify the best locations in which to site command and control units, Breathing Apparatus control and special appliances, in order to maximise the overall control of the incident
- Communication dead spots
- Water supplies, hydrants, open and tanked
- Distances from water source and pressure calculations
- Establish designated rendezvous points for initial attendance; are these for emergency services as a whole or for Fire and Rescue Service use only? Consideration should be given to dependency on wind speed and direction, and giving alternatives.

Hazard zones and evacuation distances

- identify safe distances to establish notional hazard zones associated with the permitted quantity, hazard division etc
- anything that has projectile hazard in the event of an explosion eg walls
- evacuation distances for when explosives are involved in fire.

Other hazards

- large above or below ground oil or gas pipelines serving the establishment, or supplying products for storage or process
- compressed gases
- electrical transformers, sub-stations etc
- environmental consequences – identify watercourses, interceptors and plant drainage systems etc
- equipment required to mitigate environmental impact.

Duty holder information

- Who is the responsible person for the site and contact details for normal and out of hours?
- Access to a current copy of the 'on site plan'
- Are explosives transported around the site and if so, how is this achieved?
- Security regimes employed by duty holder eg electrified fences, guard dogs etc which might impact upon operational tactics
- Would the use of mobile communication equipment create a hazard?
- Gather any technical data that gives general information on the properties and physical nature of substances.

7C4.61 Pre-planning arrangements should also include the development of contingency plans for a range of reasonably foreseeable events. The plans should also make provision for a pre-determined attendance that reflects the access and facilities provided for the Fire and Rescue Service and the type of incident likely to be encountered. Taking into account the size of the building, the time required to gain access, should this be necessary, to assemble sufficient resources to undertake firefighting and search and rescue operations from the pre-determined attendance and the effect that this will have on the anticipated mode of operations. The pre-determined attendance should ensure that adequate resources of staff and equipment are provided to undertake initial assessment and effect an early response to the incident safely.

FIRE SAFETY INSPECTIONS

7C4.62 The Fire and Rescue Service is responsible for the general fire precautions on all (except military) sites. Process fire safety is the responsibility of the licensing authority. Therefore, due to this dual enforcement position fire safety inspections should wherever possible be joint inspections (ie Fire and Rescue Service and the licensing authority). Under the Regulatory Reform (Fire Safety) Order, before a licence can be granted, the licensing authority have a duty to consult with the Fire and Rescue Service.

7C4.63 Information contained in the Fire and Rescue Service's fire safety file should therefore also be considered when producing operational site specific plans. If as a result of any 7(2)(d) visit it is identified that a premises does not have a fire safety file, then the Fire and Rescue Service's normal process for information exchange should be followed.

MINISTRY OF DEFENCE (MOD) ESTABLISHMENTS

7C4.64 The safety of explosives at any Ministry of Defence site or whilst being transported, together with fire fighting recommendations is determined by the Explosives, Storage and Transport Committee of the Minstry. Fire and Rescue Services should ensure that:

- effective and regular liaison is maintained with Ministry of Defence establishments
- they are fully aware of the emergency procedures for the establishment
- they make themselves aware of these procedures via good liaison with the sites to ensure that co-ordination with Ministry of Defence personnel is arranged during pre-planning and before firefighting.

Familiarisation and exercising

7C4.65 It is imperative that personnel required to attend specific explosives manufacturing and/ or storage location's, are fully conversant with the layout of the site and all facets of fire prevention contained therein. Moreover, personnel should, on a regular basis, undertake exercises with other emergency services responders and site personnel to ensure that 'response plans' are fully understood. Training and exercising should not be constrained by time; the safe and effective outcomes are the crucial factors. To that end, training and exercising should be as realistic as possible, giving due cognisance to the tasks to be undertaken and the levels of command that may be implemented. Consideration should be given to the requirements of specialised equipment that may assist in an incident eg high volume pumps could prove to be a valuable asset in the drawing and delivery of large quantities of open water.

7C4.66 The above principles would apply to sites that have been identified as being of high risk, but the level of detail needed will depend on the complexity of each site. Where a Fire and Rescue Service has a *Fire and Rescue Service's Act Section 13* arrangement in place with a neighbouring Fire and Rescue Service, it is essential that that Fire and Rescue Service is also involved in any training and exercises that may arise and pertinent to the overall planning and response.

7C4.67 All personnel who may be expected to attend incidents at identified risk sites should also undertake technical training. This is particularly important for any operational/tactical managers who may have to take command at an incident. This should include an understanding of the hazards and risks associated with explosives and operational procedures.

Generic standard operating procedure

Phase 1: Mobilising and en-route

Considerations:

- Pre-planning information should be readily available en-route in an easy to read and understandable format (eg explosives key actions aide memoir, contingency plans, response plans, risk cards, site specific risk plans etc)
- Collate information available from the Fire and Rescue Service Control
- Consider on-arrival and approach tactics (eg slow approach, look for visual/audible incident indicators etc)
- Identify type and quantity of explosives
- Consider if fire fighting media may have adverse reaction
- Assess proximity to neighbouring habitable properties
- Assess if there is likely to be an immediate life risk
- Identify water supplies (open and hydrants)
- Identify boundary protection
- Take account of any local features that could exacerbate the incident (eg industrial premises or an increase in the number of persons that could be affected ie time of day, public attractions etc)
- Obtain contact details of competent person for the site
- Assess if resources are sufficient or if there is a need for more
- Commence risk assessment on information available (eg caller information, visual/audible indicators etc).

Phase 2: Arriving and gathering information

Considerations:

- Assess any immediate crew and public life risks from a safe location
- Consult with the on-site competent/responsible person and other responders to ascertain:
  - actual type/class and quantity of explosives involved
  - location of explosives
  - life risk
  - other hazards.
- Consider whether action already taken is adequate/appropriate

- **SHIPPING CONTAINERS**

As a general rule, shipping containers should be treated with suspicion as they have become a convenient storage facility for all kinds of materials and are often unmarked. Incident Commanders must be cognisant that the external heating of a container could have adverse effects on the contents. Under no circumstances should the container doors be opened during firefighting, even if the fire appears to be out. The container doors should not be opened for at least 24 hours and the container treated as a potential source of explosion until that time. When dealing with an incident at a firework display operator's site all structures, including ISO containers, should be treated as if they contain Hazard Division 1.1 explosives, unless there is reliable confirmation that they contain no explosives

- Notify mobilising control of the best approach route for other responding vehicles to follow to the marshalling area. Any designated rendezvous point should be a safe distance from the incident
- Implement an initial cordon around the suspected hazard zone and strictly control access into it. The table below gives recommended initial cordon distances for explosives related incidents based on the quantities of explosives that might be stored within certain premises
- As it may not always be possible to determine quantity at the early stage of the incident, decision-making should always default to these distances. As with any hazard zone, it can be increased or decreased once information has been gathered and a risk assessment carried out. All non-essential staff should be excluded from the hazard zone.
- **NOTE:** If it is confirmed that explosives are involved in fire then a risk assessed exclusion zone must be set-up and everyone, including Fire and Rescue Service, staff must withdraw from it.

Recommended minimum hazard zones for explosive related incidents			
Premises		**Storage**	Recommended minimum hazard zone (radius in metres)
Type	Location	Maximum quantity and type	
Registered for retail fireworks	Retail outlet within residential or industrial area	250 kg HD1.4	100m
Other registered premises	Retail outlet within residential or industrial area	30kg HD1.1 100 kg HD1.3 250 kg HD1.4	200m
Licensed storage of fireworks	Not normally in built up area	Up to 2000kg HD1.1, HD1.3 and/ or HD1.4	600m

Licensed for storage by the police	Generally remote eg quarries	Up to 2000kg Generally HD1.1	600m
Licensed site by the Health and Safety Executive	Not normally built up area	Limited only by separation distances	Less than 2000kg 600m
			More than 2000kg 1000m
Transportation incident	Public roads, rail undertaking	HD 1.1 HD 1.2	600m
Transportation incident	Public roads, rail undertaking	HD 1.3	200m
Transportation incident	Public roads, rail undertaking	HD 1.3	200m
Transportation incident	Public roads, rail undertaking	HD 1.4	100m
CBRN(E)*	Any	Suitcase size	100m
CBRN(E)*	Any	Car size	200m
CBRN(E)*	Any	Lorry or when the size of device is unknown	400m
* To be used in the absence of any reliable information/intelligence regarding the nature of the substance involved. Consideration should always be given to being out of line of sight of the device and behind substantial cover, if available.			

- Estimate and request any additional resources
- Determine operational mode and ensure all staff are aware of it
- Implement any immediate life-saving rescues required following a risk assessment
- Consider evacuation at any early stage (this may be time consuming)
- Ensure robust incident command procedures are implemented in accordance with the incident command system
- Request police for cordon control
- Implement or initiate contingency plans (eg major incident plan etc) as appropriate
- Consider if there are other significant hazards present (eg pressurized gases, electrical sub-stations etc)
- Decide whether there is a risk of several simultaneous incidents

- Be aware that an unpredictable, dynamic sequence of damage can be expected.

NOTE: Improvised or home-made peroxide explosives can be encountered at the most routine incidents (eg house fires, car fires etc). They are detonated easily by shock, impact, flame impingement, sparks and even static electricity. As soon as responders believe that home-made explosives may be involved they should consider the following:

  - Don't touch anything suspicious especially white powders in unmarked jars
  - Don't tread on anything, peroxide explosives can explode when stepped on especially granulated forms
  - Consider defensive tactics if no life is at risk
  - Carefully retrace your route away from the scene
  - Preserve the scene and any potential evidence
  - Establish cordons and secure the site
  - Inform the police and the Explosive Ordnance Disposal Service.

Phase 3: Planning the response

Considerations:

- The Incident Commander must ensure that a risk assessment is carried out in order to develop the response plan including appropriate and relevant control measures
- Identify the objectives - the prime objectives when dealing with any incident that could result in the involvement of explosives are to:
  - save life; and
  - prevent the fire spreading to the explosives.
- The Incident Commander's priority must be the evacuation of everybody in the hazard zone at which point all emergency service personnel can withdraw
- Once explosives are involved in the fire, the application of water will not extinguish them
- If explosives are involved in fire then a risk assessed exclusion zone must be set-up and everyone, including Fire and Rescue Service, staff must withdraw from it
- If explosives are not involved in fire, firefighting should be limited to preventing the fire spreading to structures or other areas containing explosives
- Ensure adequate protection is available, from which to undertake firefighting operations
- Identify exposure hazards and provide protective spray

- Consider environmental impacts as smoke plumes and water run off may contain high concentrations of chemicals
- Develop the response plan with the site operators, other emergency services and hazardous materials advisers
- Consider whether action already taken is adequate / appropriate.

Phase 4: Implementing the response

Considerations as the incident develops and the response plan is implemented:

- Ensure all personnel including other emergency services are aware of and understand the evacuation signal
- Be aware of any vehicles in the area of Fire and Rescue Service operations and determine contents if safe to do so
- If an explosion has occurred, secondary explosions can take place for some considerable time afterwards
- Fighting of secondary fires after an initial explosion should not take place until there is confirmation that no more explosives remain on site
- Where it is considered safe to do so, firefighting jets should be positioned to prevent fire spread utilising branch holders and ground monitors
- Use appropriate number of personnel, in proportion to the tasks to be undertaken
- Liaise with site management or competent person
- Small buildings or vehicles offer little protection and sheltering behind walls can be dangerous because they will only stop small projectiles and any blast wave may overturn vehicles, demolish walls and in doing so create more projectiles
- **NOTE:** Fireworks are routinely stored in ISO containers (See Phase 2 guidance above for shipping containers)
- Be aware of any explosives that may have been subjected to the blast wave but have remained intact
- If dealing with an incident at a firework display operator's site all buildings should be treated as if they potentially contain Hazard Division 1.1 explosives unless there is reliable confirmation that they either contain no explosives or they only contain Hazard Division 1.4 explosives.
- Fires that have spread to buildings or areas holding Hazard Division 1, 2 or 3 explosives must not be fought:
  - Hazard Division 1.1 explosives stored or transported in ISO containers may mass explode if the container is heated or involved in a fire

  - Hazard Division 1.2 fragments are mainly munitions. If a container of Hazard Division 1.2 explosives were involved in a fire they would be likely to produce potentially lethal flying fragments (either from the munitions themselves or from the container)
  - Hazard Division 1.3 explosives may produce a significant explosion, or the doors may burst open under pressure from the build-up of gases and a large fireball produced. It is possible that in extreme circumstances the container may mass explode
  - Hazard Division1.4 – The effects of a fire involving Hazard Division 1.4 explosives should normally be contained within the container. However, it may not always be possible to determine type and quantity; therefore, it would be prudent to treat the load as a higher class of explosives ie Hazard Division 1.3.
- If there is any doubt whatsoever about the nature or location of the explosives involved, the fire should not be fought and personnel should withdraw to a safe distance
- As stated above, the priority is to save life. This is best achieved by evacuating all those in the immediate vicinity. In exceptional circumstances, this could involve placing firefighters at a higher risk than would normally be considered acceptable
- Incident ground communications – No radio frequency transmission is to be allowed within a radius of 10 metres from the electro explosive device. Emergency services using vehicle borne sets with an effective radiated power greater than 5 watts should not transmit within 50 metres of the damaged equipment. All non-essential transmitters should be either switched off or removed to a distance greater than 50 metres.
- Consider the impact of noise on any evacuation signal.
- Key considerations for all Fire and Rescue Service staff:
  - ensure effective communications are established and maintained throughout the incident
  - ensure that crews operate at a minimum of two persons in the hazard zone
  - do not enter the hazard zone unless instructed to undertake operational tasks
  - remember that vehicles, brick or block structures may afford little protection; use earth embankments or similar substantial cover for protection
  - be aware of smoke plumes and avoid where possible.
- Hazardous materials advisers, after liaison with the Incident Commander and site specialist, should, in line with the generic standard operating procedure, complete a hazardous materials risk assessment including the:

- explosive type and quantity
- life safety
- provisions for cover or protection
- business continuity for the wider community.

This approach should be used to establish suitable and sufficient hazard zones. This will enable hazardous materials advisers to advise Incident Commanders that cordons can be downsized. For example, fire in a town centre shop registered to store 250kg of Hazard Division 1.4, the initial cordon table says 100m cordon. The hazardous materials adviser may advise a reduction of the hazard zone to 15 metres and out of direct line of sight. This would enable perimeter cooling until such time that the explosives have all detonated or remote monitors have controlled the fire.

Phase 5: Evaluating the response

Incident Commanders should constantly evaluate the risk posed by explosives at the incident and the effectiveness of specific operational procedures and advice. Evaluation is not a one-off process but should be continual throughout the incident as circumstances change or new information is gathered. After evaluation, if necessary, the Incident Commander should adjust the response plan, amend/implement control measures and communicate the changes to all staff.

Phase 6: Closing the incident

At the end of any incident involving explosives, further control measures should include:

- **RESIDUAL HAZARDS**
  It is possible for explosives to remain live after the fire has been extinguished when buried under ash, even if they have been involved in a very intense fire. Unexploded parts may also have been projected some considerable distance. Simply stepping on these explosives, particularly detonators, can generate sufficient friction to set them off potentially causing severe injury. Entry into an explosives storage structure should not be undertaken until it can be confirmed by the duty holder that sufficient steps have been taken to identify and remove any live explosives.

- **LIAISON BETWEEN THE INCIDENT COMMANDER AND THE FIRE INVESTIGATION OFFICER**
  The Fire Investigation Officer must be briefed regarding the location, condition, type and actual involvement of any explosives at the incident. Any fire investigation may be subject to the higher requirements of the Health and Safety Executive, police, coroner's or public enquiry investigations. In such circumstances the Fire and Rescue Service's strategic management should be consulted for further guidance.

- **HAND-OVER OF THE INCIDENT TO THE APPROPRIATE AUTHORITY**
  This will be the duty holder, owner or occupier in most instances. The outcomes of the analytical risk assessment should form part of the incident hand-over.
- **HEALTH AND SAFETY EXECUTIVE**
  The Health and Safety Executive should be informed whenever explosives are involved fire.

PART C–5

UN Class 2 Gases (including acetylene)

General information

Introduction

7C5.1 This section offers Fire and Rescue Service staff technical operational guidance to assist them in carrying out operational risk assessments to safely resolve emergency incidents involving gases. It does not cover the basic scientific principles applicable to gases, such as the gas laws, as these are contained in *Fire Service Manual (volume 1 Fire Service Technology, Equipment and Media) Physics and Chemistry for Firefighters*.

Characteristics and classification

What are gases?

7C5.2 Gas is one of three states of matter. Dependant on pressure, most substances can be cooled to form a solid. As heat is added to the solid it turns into a liquid at its melting point, and then changes into a gas at its boiling point.

7C5.3 A pure gas may be made up of individual atoms (eg a noble gas or atomic gas like neon), elemental molecules made from one type of atom (eg oxygen), or compound molecules made from a variety of atoms (eg carbon dioxide). A gas mixture would contain a variety of pure gases much like air.

7C5.4 Vapour refers to a gas phase at a temperature where the same substance can also exist in the liquid or solid state, below the critical temperature of the substance.

7C5.5 Gases and vapours have no size or volume; they expand to fill their container or in the open spread out until they are equally distributed throughout the space available to them. The physical behaviour of gases is described by the gas laws. Properties, notable for those who have to manage incidents, include:

- gases and vapours exert an increasing pressure on their containers as they are heated
- when a gas or vapour expands, perhaps as it escapes its container, its temperature falls.

UN Class 2 – classification

7C5.6 Gases are recognised by their containers, warning symbols and their behaviour.

7C5.7 In the system of hazard classification devised by the United Nations Sub-Committee of Experts on the Transport of Dangerous Goods (UNSCETDG) the following classes are directly associated with gases:

- Class 2.1 – Flammable gases
- Class 2.2 – Non-flammable, non-toxic gases
- Class 2.3 – Toxic gases
- Class 4.3 – Substances which in contact with water emit flammable gases

CLASS 2 – Gases

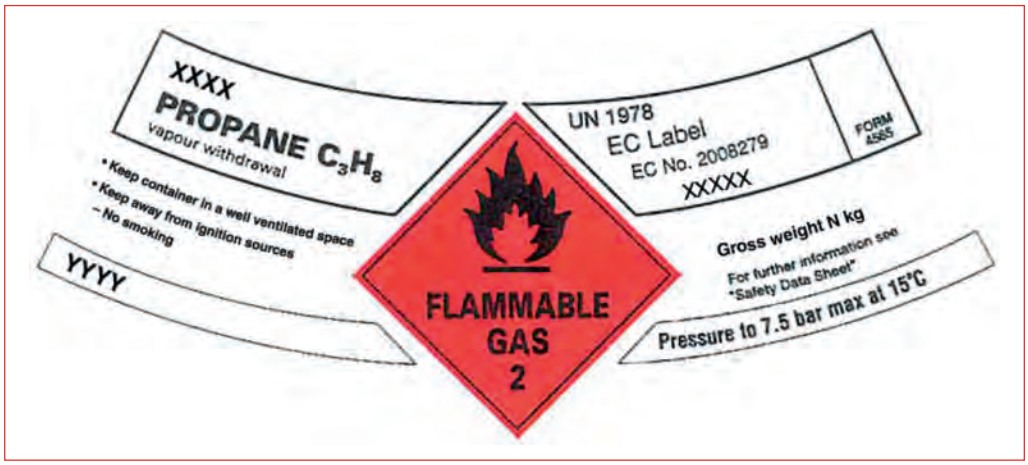
Flammable gases

Non-flammable, non-toxic gases

Toxic gases

CLASS 4.3 – Substances which, in contact with water, emit flammable gases

7C5.8 With regard to compressed gases, primary identification is by means of the shoulder label with the name and chemical formula, an example of which is shown below.



7C5.9 Secondary identification is by cylinder shoulder colour. Unless otherwise specified, gas and gas mixtures can be identified by a colour classification indicating gas properties in accordance with the risk diamond on the cylinder label, for example:

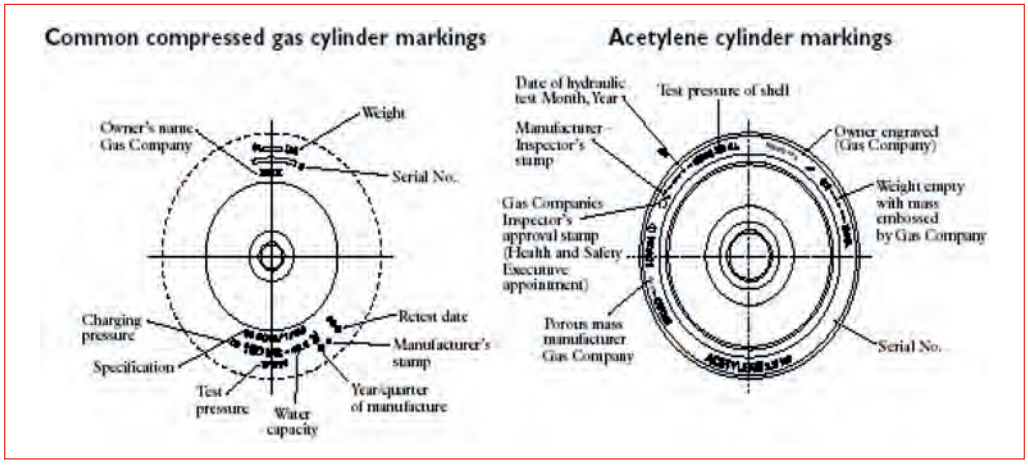
Gas Type	New Colours
Inert	 Bright Green
Oxidising	 Light Blue
Flammable	 Red
Toxic and / or corrosive	 Yellow

7C5.10 A number of the most common gases have been assigned a specific colour. The specific colours assigned to the common gases are shown below. The full scheme is contained in BS EN 1089-3: 1997, which although not mandatory by law is being adopted by British Compressed Gas Association member companies. Fire and Rescue Service responders should be aware that body colours below the shoulder of a cylinder are not specified and may vary according to the gas company. The adoption of BS EN 1089-3: 1997 has been agreed by the British Compressed Gas Association and the Health and Safety Executive and is expected to be in adopted in 2015.

Gas Type	Chemical Symbol	New Colours
Acetylene	C_2H_2	Maroon
Oxygen	O_2	White
Nitrous Oxide	N_2O	Blue
Argon	Ar	Dark green
Nitrogen	N_2	Black
Carbon Dioxide	CO_2	Grey
Helium	He	Brown
Air or Synthetic Air	O_2 < or = 23.5%	Bright green

Cylinder identification marks

7C5.11 There are stamp markings on the cylinder shoulder, which may also help to identify the contents of a cylinder and the owner. Typical markings on cylinder necks are shown below. The name of the industrial gas company will be stamped on the cylinder. This will allow identification of the cylinder owner is. For acetylene cylinders, the word acetylene is stamped onto the neck.



Hazards

Compressed gases

7C5.12 Compressed gases pose different hazards to chemical liquids or solids and can often be more dangerous due to the following hazards:

- potential source of high energy, particularly in high pressure cylinders
- cylinders containing compressed gases may fail if over-pressurised or weakened by the application of heat
- low boiling point of some liquid contents resulting in the potential for 'vapour flashing'
- ease of diffusion of escaping gas
- leakage of flammable and/or toxic gases can cause dangerous conditions especially if they are confined
- low flashpoint of some highly flammable liquids
- absence of visual and/or odour detection of some leaking materials
- heavy and bulky containers, unless cylinders are secured they may topple over, cause injuries, become damaged themselves and cause contents to leak
- if the regulator and valve assembly shears off, the cylinder may 'rocket', like a projectile or 'torpedo', dangerously around the workplace
- liquefied gases (eg butane, propane etc) respond more rapidly to heat than the permanent gases such as nitrogen or oxygen
- low boiling point materials can cause frostbite on contact with human tissue
- some cylinders are protected by pressure relief valves, fusible plugs or bursting discs, however, these may not work correctly in a fire situation, or if damaged
- other physical hazards stem from the high pressure of a cylinder's contents (eg accidental application of a compressed gas or jet into eyes or onto an open wound, whereby the gas can enter the tissue or bloodstream, is particularly dangerous).

7C5.13 To prevent the interchange of fittings between gases, cylinder valve outlets are left hand threaded on flammable gas cylinders and right hand on other gases.

Cylinders in fires

7C5.14 All cylinders represent a potential hazard if directly involved in a fire. Cylinders are pressure vessels, designed to withstand high internal pressure but if that pressure increases with heat they may fail. This is particularly important if

cylinders are directly impinged with flame as, in addition to the increase in internal pressure, the cylinder shell itself starts to lose its strength as a result of excessive heat.

7C5.15 The nature of the failure and its consequences depends on the combination of cylinder design and gas type. Flammable gases clearly represent a greater risk but all failures will have significant consequences.

Flammable gases

7C5.16 Failure of flammable gas cylinders result in the release of combustion energy if they burst in a fire. Hazards from this include:

- a blast pressure wave
- fireball
- cylinder fragments may be thrown considerable distances
- flying fragments may travel up to 200 metres and have high looping trajectories
- flying glass and other structural material
- structural damage to buildings in the vicinity.

7C5.17 Flammable gases ignite or burn producing heat and light, and in certain conditions explosions. The following terms should be understood in order to assess the risk posed by this hazard:

- **Lower explosive, or flammable, limit** – lowest concentration of vapour/gas in air at a given pressure and temperature that will propagate a flame when exposed to an ignition source
- **Upper explosive, or flammable, limit** – maximum concentration of vapour/gas in air at a given pressure and temperature in which a flame can be propagated
- **Flammable range** – concentrations of flammable gas/vapour between the lower and upper explosive, or flammable, limit at a given temperature
- **Flash point** – lowest temperature required to raise the vapour pressure of a liquid such that vapour concentration in air near the surface of the liquid is within the flammable range, and as such the air/vapour mixture will ignite in the presence of a suitable ignition source, usually a flame
- **Fire point** – minimum temperature at which a mixture of gas/vapour and air continues to burn in an open container when ignited
- **Auto-Ignition temperature** – minimum temperature required to initiate or cause self-sustained combustion of material in the absence of any external source of ignition

- **Critical temperature** – that temperature above which no amount of pressure can liquefy a gas. It does not relate to flammability or likelihood of explosion.

7C5.18 Most gases are denser than air, although common exceptions include acetylene, ammonia, helium, hydrogen and methane. Even these may, on escape, be cooler than ambient air and therefore slump initially, but eventually the gas will rise. Gases that are lighter than air may accumulate under structures at high levels unless ventilated. Hydrogen and acetylene, which have very wide flammable limits, can form explosive atmospheres in this way. More dense gases will on discharge accumulate at low levels and may, if flammable, travel a considerable distance to a remote ignition source.

Toxic gases

7C5.19 Toxic or poisonous gases cause harm when we are exposed to them. Generally exposure occurs through inhalation but gases may also be absorbed through the skin. Further information on toxicity is contained in Section 7 Part C-9 – Toxic and infectious substances.

Cryogenics (extreme cold)

7C5.20 Cryogenic liquids present a cold burn hazard when they are released quickly, 7C5.124 – Cryogenics for further information.

Usage, transportation, packaging and storage

Usage

7C5.21 Most industrial gases are naturally occurring and are extracted from the atmosphere. It is not possible or necessary to describe the usage of gases further in this chapter, however, the following chapters contain information on the hazardous materials gases most frequently encountered by firefighters at emergency incidents.

Transportation and packaging

General

7C5.22 The transportation of gases as gases at ordinary temperatures and pressures is not a practical or economically viable option for the chemical industry due to the size of containers that would be required. Viable storage and transport options

rely on cooling, the application of pressure and dissolving gases. The favoured option is to use pressure to liquefy a gas but for every gas there is a critical temperature above which it cannot be liquefied by the application of pressure.

7C5.23 Gases below their critical temperatures are often called vapours and can be liquefied by the application of pressure so as to be transported or stored as liquids at ambient temperature. Above this critical temperature gases can not be liquefied by the application of pressure alone. When a pressurised liquid is warmed it will exert the critical pressure on its container at the critical temperature.

Critical temperatures of common gases

Name	Critical temperature (°C)	Critical pressure (bar)	Boiling point (°C)
Ammonia	132	112.8	-33
Butane	152	38	-1
Chlorine	144	77	-34
Propane	97	97	-42
Sulphur dioxide	158	79	-10
Argon	-122	49	-186
Oxygen	-119	49.6	-183
Nitrogen	-147	34	-196
Hydrogen	-240	13	-252
Helium	-268	2.3	-269

7C5.24 Gases which have a critical temperature below ambient temperature can be stored or transported in small quantities as compressed gases at ambient temperatures but when bulk quantities are required they are usually cooled to just above their boiling point and transported as a refrigerated or cryogenic liquid.

NOTE:

- **Carbon dioxide** – can be encountered as solid, liquid or gas. The critical temperature of CO_2 is a little over 31°C so for most of the year when encountered in small quantities (as in the case of fire extinguishers) it will be a pressurised liquid but on a hot day it will be a gas. Small quantities of carbon dioxide can also be encountered as a solid used as a refrigerant called 'dry ice', which does not melt but turns into a gas as it warms up. This process by which a solid does not melt but turns directly into a gas as it warms is known as 'sublimation'. Bulk carbon dioxide is transported as a refrigerated pressurised liquid.

- **Acetylene** – is different from other gases in that it can decompose in the absence of air into its constituent elements, carbon and hydrogen. This is an exothermic reaction, that is, it gives off heat and is more generally known as decomposition. Exothermic decomposition does not produce as much heat as acetylene burning in air. Decomposition requires a significant input of energy from direct flame contact on a cylinder to initiate it. Mechanical shock alone to a cold cylinder cannot initiate decomposition.

Road

7C5.25 Appropriate options for storing and transporting gases are detailed in the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), which is enacted into UK law by the carriage of dangerous goods regulations.

7C5.26 In this system a hazard identification number consists of two or three figures, where '2', for example, indicates a hazard of emissions of gas due to pressure or to chemical reaction.

Examples of hazard warning numbers associated with a gas hazard

Hazard warning number	Hazard description
20	Asphyxiant gas or gas with no subsidiary risk
22	Refrigerated liquefied gas, asphyxiant
223	Refrigerated liquefied gas, flammable
225	Refrigerated liquefied gas, oxidising (fire intensifying)
238	Gas, flammable corrosive
239	Flammable gas, which can spontaneously lead to violent reaction
25	Oxidising (fire-intensifying) gas
268	Toxic gas, corrosive
X323	Flammable liquid which reacts dangerously with water, emitting flammable gases
323	Flammable liquid which reacts with water, emitting flammable gases
362	Flammable liquid, toxic, which reacts dangerously with water, emitting flammable gases
X362	Flammable liquid, toxic, which reacts dangerously with water, emitting flammable gases
382	Flammable liquid, corrosive, which reacts with water, emitting flammable gases

Examples of hazard warning numbers associated with a gas hazard	
Hazard warning number	**Hazard description**
X382	Flammable liquid, corrosive, which reacts dangerously with water, emitting flammable gases
423	Solid which reacts with water, emitting flammable gases
X423	Flammable solid which reacts dangerously with water, emitting flammable gases
462	Toxic solid which reacts with water, emitting flammable gases
X462	Solid which reacts dangerously with water, emitting toxic gases
482	Corrosive solid which reacts with water, emitting corrosive gases
X482	Solid which reacts dangerously with water, emitting corrosive gases

7C5.27 Further information on the transportation of gases is contained in Section 7 Part C-3, Transportation, packaging and storage of hazardous materials.

Storage

7C5.28 Gases are stored in cylinders, cryogenic vessels or tanks. On-site generation of gas is also an option.

Cylinders

7C5.29 Gases are stored in cylinders either as a compressed or liquefied gas, or dissolved in a solvent (eg acetylene dissolved in acetone). Cylinders are subject to rigorous type testing to ensure that they are fit for purpose, and are tested to 1½ times their working pressure. Some cylinders are equipped with safety devices, which are designed to relieve pressure by venting gas as the cylinder heats up.

7C5.30 Serious accidents can result from ignorance of the properties of the gases, or from misuse or abuse. Great care is needed during the transportation, handling, storage and disposal of such cylinders.

7C5.31 Cylinders exist in the following types of construction:

- Welded cylinders – two steel halves welded together around the centre
- Drawn steel – a single steel skin containing no weld

- Aluminium cylinders – lighter in weight than steel cylinders and are used to contain specialist gases
- Composite cylinders – a woven jacket impregnated with resin and protected by a hardened plastic outer cage. This type of cylinder is mainly used for liquefied petroleum gas but can be found with various contents. Occasionally these cylinders can have an aluminium lining.

7C5.32 The cylinder construction provides little to no indication as to the contents of the cylinder, but may alter the actions required to deal with them when involved in fire, in particular composite cylinders.

7C5.33 All cylinders may fail in a fire situation and the effect of the consequent explosion will depend upon the nature of the gas contained. Acetylene is a special case because it can undergo a self-sustaining internal decomposition reaction, producing heat, which may continue after the fire has been extinguished.

7C5.34 Liquefied gases are generally of two types:

- high pressure (eg carbon dioxide, ethane)
- low pressure (eg liquefied petroleum gas).

7C5.35 As the cylinder heats up in the fire, the liquefied gas absorbs some of the heat and boils, increasing the pressure in the cylinder. This will normally result in the operation of a safety relief device, fitted to the cylinder valve, which relieves the excess gas pressure. If the cylinder wall becomes excessively heated, the effective maximum working pressure of it is reduced and the cylinder may fail catastrophically.

7C5.36 Liquefied petroleum gas cylinders failing under heat may result in a boiling liquid expanding vapour explosion. This is where the boiling liquid in the cylinder rapidly vaporises and expands explosively bursting the cylinder. If the gas released contacts a source of ignition this could result in a fireball. Further information is contained later in this Part at 7C5.116, Liquefied petroleum gas.

Operational key principle

Cylinder Failure – All pressurised cylinders, regardless of their contents are at the greatest risk of failure whilst being subjected to direct flame contact.

As a metal cylinder is heated the shell will begin to lose its tensile strength, in composite cylinders heating will also break down the resin. (**NOTE:** Although steel loses approximately 50 per cent of its strength at about 550°C, rising gas pressure may overcome reducing steel tensile strength at about 300°C)

All cylinders ultimately fail because the shell reaches a point where its tensile strength weakens to such a degree (or in the case of composite cylinders the resin breaks down) that it can no longer contain the internal pressure being exerted by the gas.

Operational considerations (compressed gas cylinder incidents)

Pre-planning

7C5.37 Fire and Rescue Services should ensure that they:

- proactively collect information on the location and type of hazardous gases in their turn-out area
- make significant information available to mobilising controls and operational staff
- have liaison and contact arrangements in place to deal with emergencies involving gas cylinders via the British Compressed Gas Association Competent Person Scheme
- have operational plans, which include safe rendezvous points, for significant site-specific risks
- review and update any information held.

Phase 1: Mobilising and en-route

7C5.38 Consideration:

- Pre-planning information should be readily available en-route in an easy to read and understandable format (eg gas cylinders involved in fire – key actions aide memoir, contingency plans, response plans, risk cards, site specific risk plans etc).

Phase 2: Arriving and gathering information

7C5.39 Considerations:

- Response vehicles must be parked outside any potential blast zone whenever cylinders are suspected of being involved in fire
- The Incident Commander should assess any immediate crew and public life risks, then gather information to establish an initial cordon around the potential hazard zone. Consideration should be given to evacuation of the public and non-essential responders. Liaison with the police will be necessary if evacuation is required. Where evacuation is not possible, or is considered inappropriate, all those remaining in the hazard zone should be warned of the risks and, if necessary, advised to stay away from openings especially windows and occupy rooms furthest away from the risk
- Staff required to carry out tasks within the initial cordon should make use of all available substantial shielding. Personal protective equipment (personal protective equipment) appropriate to the immediate hazard should be worn, such structural firefighting kit including gloves, flash/fire hoods and eye protection. Staff who are tasked to work behind shielding within the area of the hazard zone likely to be affected by a fireball (ie approximately 25m for a single cylinder) should wear breathing apparatus in addition to the above personal protective equipment
- The key information required is:
  - Are there cylinders at the incident? and if there are
  - Are the cylinders involved in fire? (ie direct flame contact, fire damage or radiated heat damage from the fire)
  - Are any cylinders leaking, venting, bulging or steaming?
  - What gases are involved?

NOTE: If acetylene cylinders are involved and are suspected of having been affected by heat they can pose significant additional risks, these are detailed in 7C5.48.

- Other considerations when designating the initial cordon include:
  - size of cylinder(s)
  - number of cylinders
  - shielding provided by any buildings or structures
  - type and extent of adjacent structures
  - local topography (eg protection provided by slopes and gradients of ground levels etc)
  - affect of the potential blast pressure wave