Northern Ireland
Fire & Rescue Service

STANDARD OPERATING PROCEDURE NO 15A

Explosives

15 December 2010 (Version 1)

Prepared by: Operations Policy Unit

Protecting Our Community

INDEX

VERSION CONTROL

Version No	Page No	Issued (Date)	Amendment	Initiated By	Reason for Change
1	All	15/12/10	Initial Issue of Standard Operating Procedure (SOP)	Group Commander (Operations Policy)	New SOP

NORTHERN IRELAND FIRE & RESCUE SERVICE

STANDARD OPERATING PROCEDURE NO 15A

EXPLOSIVES

INTRODUCTION

This Standard Operating Procedure (SOP) has been developed by Operations Policy Unit in line with the current Northern Ireland Fire & Rescue Service (NIFRS) Corporate Plan and NIFRS Annual Business Plan. This SOP should be read in conjunction with SOP No 15 (*Improvised Explosive Devices*), in order to provide a comprehensive overview of the procedures to be adopted at incidents involving explosives that NIFRS resources are likely to attend.

SOP No 15A deals specifically with explosives that are categorised into Hazard Divisions (HDs). It is imperative that all personnel can identify each HD as this shall determine the operational tactics to be deployed and the distances of cordons to be established. **The primary aim of this SOP is to ensure that adequate pre-planning arrangements are made prior to an incident occurring, and to provide operational guidance for incidents involving explosives.**

This SOP has been developed to ensure that all personnel have received information on how to adopt safe systems of working by ensuring that personnel can identify significant hazards and ensure appropriate management of the risk posed.

Explosives may be developed with various materials and can be made in various forms. This SOP provides a generic operational framework, information on the most common types of explosives and what actions are to be taken by NIFRS personnel at incidents where explosives are involved.

SOP No 15A – "*Explosives"*, has been produced in the following format:

SECTION A

Safety-Critical Information

All personnel ***must*** have complete knowledge and understanding of this section to ensure maximum safety at incidents. Section A is designed to reflect the content in the relevant section of the Operational Aide-Mémoire.

SECTION B

Provides More Detailed Information on the Topics Covered in Section A

Personnel ***should*** have a good knowledge of information contained within this section. This includes:

- hazards and risks;
- operational pre-planning and information gathering.

SECTION C

Background and Reference Material

This section includes information which personnel ***could*** use for reference material.

It provides details of relevant legislation and reference material used during SOP development.

1 – SECTION A

1.1 OPERATIONAL CONSIDERATIONS

All explosives are classified into HDs 1.1 to 1.4. These classifications refer to the behaviour of explosives when burnt in their packaging in open air. The same explosive may behave entirely differently when stored in International Standards Organisation (ISO) transport containers, thick walled steel stores or process plant. In these circumstances, rapid pressure build-up can cause explosives to react more violently than their classifications would suggest.

1.1.1 EN ROUTE

- Access pre-planning information from all available sources, eg:
  - turn-out sheet premises information;
  - mobile data terminal.
- If possible, identify location, type and quantity of explosives stored.
- The Officer-in-Charge (OiC) is to consider approach and on-arrival tactics based on information available.
- The OiC is to brief crews on incident type/initial actions.

1.1.2 ON ARRIVAL

- If it is confirmed that explosives are involved in the fire then the IC must establish a cordon, having consideration for the minimum Hazard Zone.
- If there is any doubt about the nature or location of the explosives involved, the fire should not be fought; personnel should withdraw to a safe distance[(1)].
- Fires that have spread to buildings or areas holding HD 1.1, 1.2 or 1.3 explosives must not be fought [(1)].
- Gather the following information:
  - Are all persons accounted for?
  - What is on fire?
  - What is the location of the fire?
  - What is the quantity and type of explosives and if directly involved?
  - Details of other significant hazards present.
  - Is further information available via Site Plans?

[(1)] *Manufacture and Storage of Explosives Regulations (MSER) (Northern Ireland) 2006*

- If dealing with an incident at a fireworks site, all buildings should be treated as if they contain HD 1.1 explosives, unless there is reliable confirmation that they do not. Fireworks are normally classified as HD 1.4 explosives.

- The Incident Commander (IC) should:

  - determine the level of resources required to resolve the incident;
  - consider access route(s) for on-coming resources;
  - implement an appropriate Incident Command System (ICS) to ensure adequate command and control;
  - establish NIFRS Control Point and Rendezvous Points (RVPs) and relay location to the Regional Control Centre (RCC).

RECOMMENDED MINIMUM HAZARD ZONES FOR EXPLOSIVE-RELATED INCIDENTS PREMISES

Table 1

Premises		**Storage**			
Type	**Location**	**Maximum Quantity and Type**			**Recommended Minimum Hazard Zone**
Registered for Retail Fireworks	Retail Outlet within Residential or Industrial Area	250 kg - HD 1.4			200 m
Other Registered Premises	Retail Outlet within Residential or Industrial Area	30 kg - HD 1.1	100 kg – HD 1.3	250 kg - HD 1.4	200 m
Licensed Storage of Fireworks	Not normally in Built-up Area	Up to 2, 000 kg - HD 1.1, HD 1.3 and/or HD 1.4			600 m
Licensed for Storage by PSNI	Generally remote, eg, Quarries	Up to 2,000 kg - Generally HD 1.1			600 m
Licensed Site by HSE	Not normally Built-up Area	Limited only by Separation Distances			Less than 2,000 kg - 600 m
					More than 2,000 kg - 1,000 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.1, HD 1.2			600 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.3			200 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.4			100 m

Where explosives of different HDs are stored together, they must be treated as if they are all of the highest HD present, ie, 100 kg of HD 1.1 and 1,000 kg of HD 1.4, will be treated as 1,100 kg of HD 1.1. In the event of HD 1.5 and 1.6 being involved in fire, they should be treated as HD 1.4.

For Transportation Incidents

Table 2

Minimum Hazard Zone	HD
600 m	Transportation of HD 1.1 or HD 1.2
200 m	Transportation of HD 1.3
100 m	Transportation of HD 1.4

For ISO Containers Storing Explosives

- If an ISO container, suspected or confirmed as containing explosives, is involved in fire:

  - do not approach;
  - establish a 600 m Inner Cordon;
  - allow ISO container to "burn out" due to mass explosion hazard.

  The container doors should not be opened for at least 24 hours and should be treated as a potential source of explosion until that time.

1.1.3 PLANNING AND IMPLEMENTING THE RESPONSE

- The IC shall carry out a Dynamic Risk Assessment (DRA) to assess the Hazard Zone.

- Should the IC's DRA recommend no operational activity, then:

  - Implement cordon;
  - withdraw to NIFRS Control Point;
  - forward Hazard update to the RCC – Defensive Mode;
  - remain in contact with on-site competent/responsible person;
  - control access to Inner Cordon.

- Should the IC's DRA require operational activity to be conducted:

  - Forward Hazard update to the RCC – Offensive Mode.

  - The IC is to prioritise operational objectives prior to implementing plan.

  - Assess effectiveness of Inner Cordon to control access to the scene.

- The IC must ensure that crews fully understand and comply with their operational brief.

- The minimum of personnel are to perform safety-critical tasks inside the Hazard Zone.

1.1.4 EVALUATING THE RESPONSE

- Re-assess operational objectives, ie,

  - no remaining life risk and fire involves HD 1.1 to 1.3 – withdraw;
  - no remaining life risk and fire involved HD 1.4 – consider firefighting.

- Continual evaluation of significant hazards and risk management.

- Evaluate effectiveness of the operational response.

- Use of DRA flowchart.

- Is appropriate ICS in place for the IC to retain command and control?

- It is imperative that the IC adjusts and communicates the Response Plan when the DRA determines that the risk posed is not in proportion to the operational benefits.

- If an explosion has occurred, secondary explosives 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.

1.1.5 CLOSING THE INCIDENT

- The IC should ensure the safe and effective end to NIFRS operations.

- Liaise with other agencies present and/or responsible on-site person(s), to ensure that an appropriate cordon is maintained to control access to the scene.

1.1.6 POST-INCIDENT

- The IC is to ensure crews receive an appropriate level of debrief.

- Any learning outcomes should be communicated to appropriate personnel via the chain of command.

- Consider welfare issues of personnel where appropriate.

2 – SECTION B

2.1 SCOPE

- This SOP considers the hazards, risks, operational planning and information gathering for explosives.

- **It is imperative that "fireworks" are not considered as anything other than explosives.**

2.2 HISTORY

- Incidents involving explosives are fortunately rare, but when they do happen, there is potential for them to be catastrophic. An explosion at a fireworks manufacturing storage site in the Dutch city of Enschede, resulted in the death of 22 people, including 4 Firefighters.

- There have been a number of other serious incidents in Britain and abroad, including an explosion in Kolding, Denmark, when one Firefighter was killed and 3 Firefighters were seriously injured. The explosion at Marlie Farm in East Sussex in December 2006 resulted in the deaths of 2 Fire & Rescue Service personnel.

- Those 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 worst case scenarios.

2.3 HAZARDS AND RISKS

2.3.1 THE NATURE OF EXPLOSIVES

The United Nations Committee of Experts (UNCOE) on the Transport of Dangerous Goods 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 that could cause damage to surroundings. TNT 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.

Explosive Articles

An explosive article is one which contains one or more explosive substances; thus, all ammunition is classified as explosive articles.

2.3.2 HOW EXPLOSIVES REACT

Explosives are generally divided between those which:

- **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;

- **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.

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 under water. Once initiated, the application of water will not extinguish a fire involving explosives.

Explosives may be initiated by:

- impact/friction;
- fire/heat;
- fragment attack/over-pressure;
- electrostatic discharge;
- electromagnetic radiation (in the case of electro-explosive devises);
- chemical attack.

2.3.3 EXPLOSIVES – HAZARD DIVISION (HD)/HAZARD TYPE (HT)

For transport purposes, explosives (in their packaging) are classified into HDs, in accordance with the United Nations Recommendations on the Transport of Dangerous Goods ("Orange Book").

Both the United Nations Scheme of Classification and the Manufacture and Storage of Explosives Regulations (MSER) recognise that many substances and articles classified as explosives do not present the same degree of hazard and sub-divide them according to their potential for harm.

Licences issued under the MSER refer to "Hazard Type" and are used as an alternative to Hazard Division (HD).

HD 1.1/HT 1

Substances and articles which have a mass-explosion hazard (a mass-explosion is an explosion which affects almost the entire load virtually instantaneously).

HD 1.2/HT 2

Substances and articles which have a projection hazard but not a mass-explosion hazard.

HD 1.3 /HT 3

Substances and articles which have a fire hazard and either a minor blast hazard or, a minor projection hazard or both, but not a mass-explosion hazard, ie:

- combustion of which gives rise to considerable radiant heat;
- which burns one after another, producing minor blast or projection effects or both.

HD 1.4/HT 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.

Throughout the rest of this document, the term **HD** is used to mean all aspects of explosives, whether in manufacture, storage or transportation. It is important to remember that the United Nations (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 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.
Where explosives of different HDs are stored together, they are treated as if they are **all** of the highest risk HD, eg:

100 kg 1.3 and 1 tonne 1.4 is treated as 1,100 kg of 1.3.

The same principle applies for different HDs carried together on a vehicle which should be placarded according to the greatest risk. However, each HD is classified according to compatibility with other HDs for transportation purposes (see Appendix "2", which includes some common transport labels).

The UN has defined 2 further divisions based on risk rather than hazard – HD 1.5 and 1.6. No cases have been found of these classification being imported or exported through UK ports and they are included for information only.

HD 1.5/HT 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.

HD 1.6/HT 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.

2.3.4 BLAST EXPOSURE

Multi-level injury from blast exposure, referred to as "blast injury", may result in a group of impairments to 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 the positive phase of the blast wave.

The negative phase of the blast wave occurs later, because 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.

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 Nitro-glycerine, 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. These types of explosives 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 a "shattering" effect found in the "blast wave" of high-order explosives.

See Appendix "3" for a synopsis of the physical effects of explosives.

2.3.5 WHERE EXPLOSIVES MAY BE FOUND

The majority of locations holding civilian blasting explosives are quarries. These explosives are typically held in a steel store. For quarrying operations, most explosives are mixed on-site from non-explosive ingredients.

2.3.6 CONTROL OF MAJOR ACCIDENT HAZARDS (COMAH) SITES

The *Control of Major Accident Hazards Regulations 1999, Control of Major Accident hazards Regulations (NI) 2000 (SR 2000 No 23), Control of Major Accident Hazards (Amendment) Regulations (NI) 2005 (SR 2005 No 305) and Planning (Control of Major Accident Hazards Regulations (NI) 2000 (SR 2000 No 101),* 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, which are referred to in this document as COMAH, relate to the identification, prevention and mitigation of major accidents to people and the environment.

The definition of "installation" is broad. It includes storage and is not restricted to a processing or handling activity or to buildings or particular types of plant. Local authorities have duties in connection with the preparation, review, revision and testing of Off-site Emergency Plans and they are involved in the dissemination of operators' safety information to the public.

Employees and the emergency services identified as having a role to play in the emergency response must be consulted during preparation of the plan. There are 2 categories of COMAH sites:

Lower Tier Sites

Lower Tier sites are required to produce an On-site Emergency Plan, developed in consultation with the emergency services.

Top Tier Sites

Top Tier sites are required to have a safety case which will include the On-site Plan. In addition, an integrated Off-site Plan must also be prepared.

2.3.7 EXPLOSIVES MANUFACTURING

There are only a few locations in the United Kingdom (UK) where the manufacturing of high explosives or munitions using high explosives, is undertaken.

Other sites and companies are engaged in manufacturing small arms ammunition, munitions, pyrotechnics, detonators, oil well explosives, amongst others. Explosives manufacturing of this nature is not a seasonal activity.

2.3.8 STORAGE OF EXPLOSIVES

Where explosives are stored, the Net Explosive Content (NEC) is the licensable amount. The NEC is the amount of explosive in the article, not including the packaging. In the case of fireworks, the NEC can be 25% of the weight of the firework, therefore, eg, a store licensed for 2 tonnes NEC, may actually contain 8 tonnes gross weight including packaging. Licences for storage of less than 2 tonnes (NEC) are issued by the appropriate licensing authority.

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 HSE will issue a licence.

2.3.9 RETAIL PREMISES

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 ISO transport container in the Goods Yard. Typically, this will be up to 250 kg of HD 1.4, or smaller quantities of type 1.3, but may be more if separation distances permit.

NIFRS should also be mindful of transient locations where explosives may be encountered; operational crews should be made aware of this.

2.3.10 FIREWORKS

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. NIFRS could therefore encounter large stocks of fireworks at any time of the year.

Fireworks Safety material can be accessed via Community Development and Department of Health, Social Services and Public Safety website.

Fireworks importation varies according to the time of the year and the special event for which they have been imported, eg, in 2006 approx 1,180 containers were brought through the port of Felixstowe, equating to 15,559 tonnes of fireworks (gross weight); 57% of these were received in August and September.

2.3.11 FIREWORKS DISPLAY OPERATORS

Fireworks display operators are likely to be using HD 1.1 and 1.3 fireworks, in addition to HD 1.4. There are 2 main implications from this:

- HD 1.1 presents a mass-explosion hazard;
- when fireworks of HD 1.1 are present in a store together with HD 1.3 or 1.4 the whole quantity will behave as if it is HD 1.1.

HD 1.3 articles do not present a mass-explosion hazard. There is, nevertheless, a potential for them to explode and produce large fireballs.

2.3.12 EXPLOSIVES CARRIED IN VEHICLES

Vehicles carrying larger quantities of fireworks and other hazards should carry the appropriate UN HD orange diamonds. However, ICs 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. ICs should always consider the possibility of this arising if, for example, the driver of the vehicle involved cannot be easily identified at the incident.

2.3.13 INTERNATIONAL STANDARDS ORGANISATION (ISO) TRANSPORT CONTAINERS

ISO transport 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.

These containers 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 ISO transport container, should be treated with extreme caution if information about its contents cannot be determined.

In certain conditions, selected fireworks stored in ISO transport containers may be liable to simultaneous detonation; this could result in the fragmentation of the container.

A 600 metre Hazard Zone should be put in place and the container allowed to burn out with the doors not being opened for 24 hours. 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.

2.3.14 LICENSING AND REGISTRATION

A licence is required for most manufacturing or storage activities. "Manufacturing" includes processes where explosive articles or substances are made/unmade or assembled/disassembled, repaired or modified. The HSE is the licensing authority for all manufacturing.

There are a number of licensing exemptions for the storage of small quantities and for temporary storage, eg, 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.

At present NIFRS has lists of all registered stores selling, storing or manufacturing fireworks and explosives in Northern Ireland; at the moment there are approximately 177 premises (as at September 2010). These lists (listed by Area Command) can be viewed in the public folders by the relevant authorised personnel.

Information on fireworks/explosives is provided by Department of Justice, Firearms and Explosives Branch; a sub-group of this branch is the Fireworks Enforcement Liaison Group (FELG) of which NIFRS are members.

Any renewed/updated information circulated by the Branch, is processed by Operations Policy Unit and shared with all Area Commands.

2.3.15 UNLICENSED STORAGE

During the fireworks season NIFRS personnel should be aware of the possibility that they may encounter illegally stored fireworks. Sites where this might occur would include:

- transport haulier's depots;
- shops on short lets;
- warehouses or lockup storage sites.

2.3.16 FIREWORKS DISPLAYS

As display technicians might use modern technology, such as radio frequency, as part of the display activation process, TETRA radios are not to be used within 25 m of a display location.

2.4 OPERATIONAL PRE-PLANNING AND INFORMATION GATHERING

2.4.1 PRE-PLANNING

Pre-planning will form the basis for strategic and tactical planning for incidents. Arrangements should be made under The Fire and Rescue Services (Northern Ireland) Order 2006, Section 5(2)(d), to gather relevant information pertaining to premises within NIFRS's area of responsibility where explosives are, manufactured, stored, sold or used.

Other information, which should be gathered, would include:

- location of the explosives;
- explosives HDs 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 firefighting 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;
  - high potential for structural collapse.

2.4.2 FIREFIGHTING/SEARCH AND RESCUE

Identify:

- access/egress safe routes within the establishment and boundary;
- the potential for the use of specialised vehicles, giving consideration to available head room, width, ground clearance, hard standing turning circles and load restrictions;
- travel distances from access points to various points in the building or around;
- 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;
- 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;
- any communication dead spots;
- water supplies, hydrants, open and tanked, including distances and available pressure;
- designated RVPs, primary and secondary for initial attendance - are these emergency services as a whole or NIFRS only? Consideration should be given to dependency on wind speed and direction.

2.4.3 FIREFIGHTING – TRANSPORT BY SEA

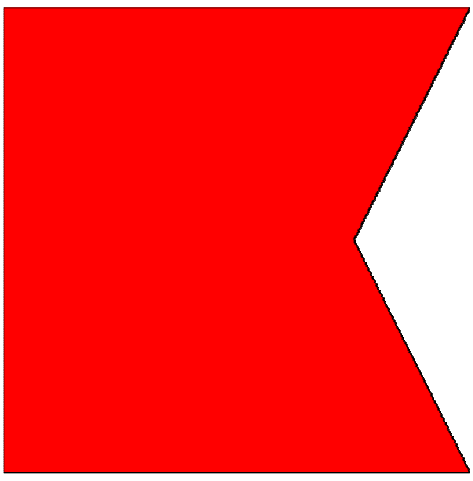
The strict and detailed control of the carriage of explosives in ships and in harbour areas under The Explosives in Harbour Area Regulations (Northern Ireland) 1995, makes it clear that the fire officer should always ascertain the quantity and location in the ship of explosives which may be threatened in a fire.

Both the classification of the explosives and the Emergency Plan/Procedure prepared as required under the Regulations will be available to the OiC. The correct firefighting techniques and safety measures to be adopted are therefore a question of adapting the instructions of the Emergency Plan to the particular circumstances of the fire.

2.4.4 VESSELS CARRYING EXPLOSIVES - FLAGS

A vessel carrying explosives will be indicated by a particular type and colour of flag.

The shape and colour of the flag, as shown below, is International Maritime Code Flag "B".



2.4.5 OTHER HAZARDS

Consider:

- large above or below ground oil or gas pipelines serving the establishment, or supplying products for storage or process;
- compressed gas storage, electrical transformers, sub-stations, etc.

2.4.6 PERSON IN CONTROL OF THE SITE/RESPONSIBLE PERSON - INFORMATION

- Who is the responsible person for the site and contact details for normal and out-of-hours?
- Gain access to a current copy of the "On-site Plan".
- Are explosives transported around the site and, if so, how is this achieved?
- Assess security regimes employed by a responsible person, 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.

2.4.7 HAZARD ZONES

Consider:

- Hazard Zones to establish safe distances associated with quantity, division, etc (see Appendix "4");
- anything that has a projectile hazard in the event of an explosion, eg, walls;
- evacuation distances;
- environmental consequences - watercourses, interceptors, plant, drainage systems, etc;
- equipment required to mitigate an environmental impact;
- using GIS mapping to overlay Hazard Zones, based on risk information;
- any other information which may be considered to be useful.

NB - This list is not exhaustive.

Pre-planning should make provision for a Pre-determined Attendance (PDA) that reflects the access and facilities provided for NIFRS and the type of incident likely to be encountered.

Pre-planning should take into account the size of the building, the time required to gain access, the time to assemble sufficient resources to undertake firefighting and search and rescue operations and the PDA should ensure that adequate resources of personnel and equipment are provided to undertake initial assessment and effect an early response to the incident safely.

2.4.8 FAMILIARISATION AND EXERCISING

It is imperative that personnel required to attend specific explosives manufacturing and/or storage locations, 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.

2.4.9 MINISTRY OF DEFENCE (MoD) ESTABLISHMENTS

The safety of explosives at any MoD site or whilst being transported, together with firefighting recommendations, is determined by the Explosives, Storage and Transport Committee of the MoD. NIFRS must ensure that effective and regular liaison is maintained with MoD establishments and that they are fully aware of the emergency procedures for the establishment.

2.4.10 POST-INCIDENT

At incidents involving explosives, it is possible for explosive material to remain live post-incident when buried under ash, even if they have been involved in a very intense fire. Unexploded material 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.

NIFRS personnel should not enter into an explosives storage structure until it can be confirmed by the person in control of the site/responsible person that sufficient steps have been taken to identify and remove any live explosives.

2.4.11 MOBILISATION

The standard PDA for a site known to store explosives of any type has been set to a minimum of 2 WrLs, nearest Flexi Duty Officer, Hazmat attributed vehicle and a Hazmat Officer.

This PDA has been applied to all known premises held at the RCC. Additional resources may be added if the quantity and type of explosives stored requires greater management at the scene of operations, ie, dealing with an incident where a 1,000 m Hazard Zone is required, as opposed to a 200 m Hazard Zone.

3 – SECTION C

3.1 REFERENCES

Quantification and Control of the Hazards Associated with the Transport and Bulk Storage of Fireworks (CHAF), EC Contract EVG1-CT 2002-00074
A von Oertzen (BAM), S Myatt (HSL), D.Chapman (HSL), R Webb (TNO), M P van Rooijen (TNO), W Colpa (TNO), E G de Jong (TNO), J de Ruiter (TNO) *Literature Review of Fireworks Compositions, Propagation Mechanisms, Storage Legislation and Environmental Effects, CHAF, Work Package 4 Report, June 2003;*

Enschede Final Report;

R Merrifield - *Report on the Peterborough Explosion, Peterborough, UK 1989: Blast Damage and Injuries* - Health and Safety Executive;

Fireworks Accident, Kolding, 2004 - Operational Incident Response Report - Danish Emergency Management Agency, December 2006;

HSE Explosives Group - explosives@webcommunities.hse.gov.uk - *Manufacture and Storage of Explosives Regulations 2005* (MSER) and ACoP L139;

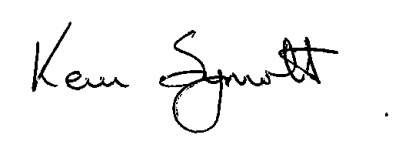
Control of Major Accident Hazards (COMAH) Regulations 1999;

Fire and Rescue Services Act 2004.

CONCLUSION

There are many references and pieces of legislation associated with the professional use of explosives. In producing this SOP it became very evident that including all 39 pieces (some containing over 200 pages) would have been extremely onerous. Therefore, this SOP contains the key information to prepare and assist personnel for incidents involving explosive materials.

Reference material relating to explosives will be made available in the Public folders, additionally you can contact Operations Policy Unit at Fire & Rescue Service Headquarters.



Kevin Synnott
Group Commander (Operations Policy)

MB/RS

15 December 2010

APPENDIX "1"

SOME COMMON EXAMPLES OF EXPLOSIVES, THEIR USES AND DEFECTS

PRIMARY EXPLOSIVES SUCH AS FULMINATES, AZIDES AND STYPHNATES

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, 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 reaction can be a serious problem where these substances have been spilled and allowed to get into contact with copper, lead or other reactive species. Because the sensitive forms tend not to dissolve in water, a hazard could rapidly develop.

GUN POWDER/BLACK POWDER/BLACK BLASTING POWDER

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 and 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

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 gun powder, 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, is commonly found in farming areas and is usually supplied as a porous pill, 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 sawdust 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, mostly 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 rule, chlorates are more aggressive and less stable in a fire than nitrates.

EMULSION AND SLURRY EXPLOSIVES

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 Nitro-glycerine-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 these 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, which carries the necessary ingredients for producing a fully active explosive. Apart from the oxidisers mentioned above, some organic peroxides have explosion subsidiary risks. In addition, Ammonium Nitrate can give off large quantities of toxic fumes (mainly oxides of nitrogen) in a fire.

NITROGLYCERINE

Nitro-glycerine is 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 radiation and is not transported or used in its pure form, as it is too dangerous to handle. Some types of explosives containing Nitro-glycerine, such as dynamite, release Nitro-glycerine liquid when in contact with water. This mixture can present particular dangers during firefighting or where the explosives are involved in flooding. Nitro-glycerine is also transported and used either as a dilute solution in alcohol or as a mixture with a solid dilutent for pharmaceutical purposes.

Nitro-glycerine - both the vapour and liquid (which is readily absorbed through the skin) are highly toxic.

TNT (Trinitrotoluene)

TNT is 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 (Gun Cotton, Pyro Cotton, Nitro Cotton)

Nitrocellulose is a white or cream coloured fibrous material produced in a range of forms. Its properties depend on the amount of Nitrogen content. Types with a Nitrogen level above 12.6% 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.

Nitrocellulose's principal uses are as an ingredient in propellant mixtures for ammunition and rocket motors, in addition, in Nitro-glycerine 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 Nitrocellulose with Nitro-glycerine (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. Therefore, the hazard can be either a fireball or a mass-explosion.

UNSAFE EXPLOSIVES

UNSAFE PACKAGING OF IMPACT-SENSITIVE ITEMS

Badly packaged impact-sensitive explosives items could be initiated by the knocks and jolts that 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

Exudation is a problem mainly associated with Nitro-glycerine-based blasting explosives, which may, under certain conditions, exude free Nitro-glycerine, 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.

Nitro-glycerine-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. Nitro-glycerine-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 2 minor explosive events have occurred within UK manufacturing sites in recent times, caused by vehicles running over spilt explosive material, but no such events have occurred during transport of packaged explosive 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 2 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 explosives 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 explosive filling of certain types of munitions are prone to cracking. Cracking may result in migration of explosive dust into screw threads and non-continuous welds within munitions, and this may increase the susceptibility of the munitions to accidental initiation in 2 ways:

- impact accidents may result in nipping of dust between metal surfaces and the presence of bare explosive 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 (EEDs)

EEDs 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 types of knocks and jolts that cargoes typically receive while in transit. The safety of a fuse may be compromised in 3 ways:

- 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.

The above list has been compiled from available accident records and safety reports. It is not necessarily exhaustive. Safety flaws in the design, manufacture, processing, storing, packaging and conveyance of explosives sometimes only become known after accidents have occurred; future accidents may reveal further types of unsafe explosives material.

APPENDIX "2"

CLASSIFICATION CODES

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 2 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 2 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 a 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 without 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

Description of Substance or Article to be Classified	Compatibility Group	Classification Code
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

SOME EXAMPLES OF DANGER LABELS

1.4 – 1.6 HD have no Bomb Burst Pictogram

1.1 – 1.3 HD will have Bomb Burst Pictogram

These are 2 examples of the required placarding which you may find on vehicles carrying explosives.

Heating may cause an explosion!

New pictogram, in accordance with the Globally Harmonised System.

EFFECTS OF EXPOSURE TO EXPLOSIVE BLAST

The effects of exposure to any explosive blast are defined as "modes". The degree of injury is broken down into 3 distinguishable areas, these are:

PRIMARY BLAST INJURIES

Primary blast injuries are caused by the direct action of a blast wave on the body. The 2 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

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 a degree of building damage.

TERTIARY BLAST INJURIES

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;

- injuries caused by impact when the body is either blown over or picked up by the blast-wave and thrown against an object.

The second of these effects is sometimes called "whole body translation" or "whole body displacement". The extent of injuries caused by this effect is dependent on a number of factors, including the velocity to which the body is accelerated, the part of the body which impacts the ground or object, the hardness of the ground or impacted object, and whether flailing of the limbs occurs as the body tumbles over the ground. The constituents of explosives, especially fireworks, significantly varies; 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, eg, 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. There is insufficient information available as to the exposure quantities required, before ill health effects set in.

EFFECTS OF SMALL EXPLOSIONS

Quantity of Explosive Initiated (g)	Effect of Initiation
1	Any person holding the explosives could receive serious injury.
10	Any person close to this quantity of explosives at the time of the initiation would receive very serious injuries.
100	Any person standing approximately 1.5 m away would be liable to a 1% chance of eardrum rupture. 50% of windows in a room (size 6 m x 6 m) are likely to be blown out. There is approximately a 1% chance of eardrum rupture at a distance of 3.5 m and approximately 50% chance of eardrum rupture at 1.5 m. Persons in very close proximity to the explosion (eg, holding the explosives) will almost certainly be killed.
500	Inside a 6 m x 6 m brick building, structural collapse is mostly likely; considerable damage to panels between steel or concrete frames in other structures. Persons very close to the blast will almost certainly be killed. Persons close to the blast will sustain lung and hearing damage and injuries from fragmentation effects and being thrown bodily. Almost all persons in the room will sustain perforated eardrums.

APPENDIX "4"

HAZARD ZONES

The table below gives recommended minimum Hazard Zones for explosives-related incidents based on the quantities of explosives that might be stored there. As it may not always be possible to determine quantity at the early stage of the incident, decision-making should always default to the minimum distance. As with any Hazard Zone, it can be increased or decreased once information or operational intervention dictates, otherwise it should be noted that all non-essential personnel should be excluded from the Hazard Zone and all other NIFRS personnel withdrawing thereafter.

The term "Hazard Zone" has been used instead of "evacuation distance". Hazard Zone is a term which is common to NIFRS operations and should therefore ensure consistency of approach.

RECOMMENDED MINIMUM HAZARD ZONES FOR EXPLOSIVE-RELATED INCIDENTS PREMISES

Premises		**Storage**			
Type	**Location**	**Maximum Quantity and Type**			**Recommended Minimum Hazard Zone**
Registered for Retail Fireworks	Retail Outlet within Residential or Industrial Area	250 kg - HD 1.4			200 m
Other Registered Premises	Retail Outlet within Residential or Industrial Area	30 kg - HD 1.1	100 kg – HD 1.3	250 kg - HD 1.4	200 m
Licensed Storage of Fireworks	Not normally in Built-up Area	Up to 2, 000 kg - HD 1.1, HD 1.3 and/or HD 1.4			600 m
Licensed for Storage by PSNI	Generally remote, eg, Quarries	Up to 2,000 kg - Generally HD 1.1			600 m
Licensed Site by HSE	Not normally Built-up Area	Limited only by Separation Distances			Less than 2,000 kg - 600 m
					More than 2,000 kg - 1,000 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.1, HD 1.2			600 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.3			200 m
Transport Incident	Public Roads, Rail Undertaking	HD 1.4			100 m