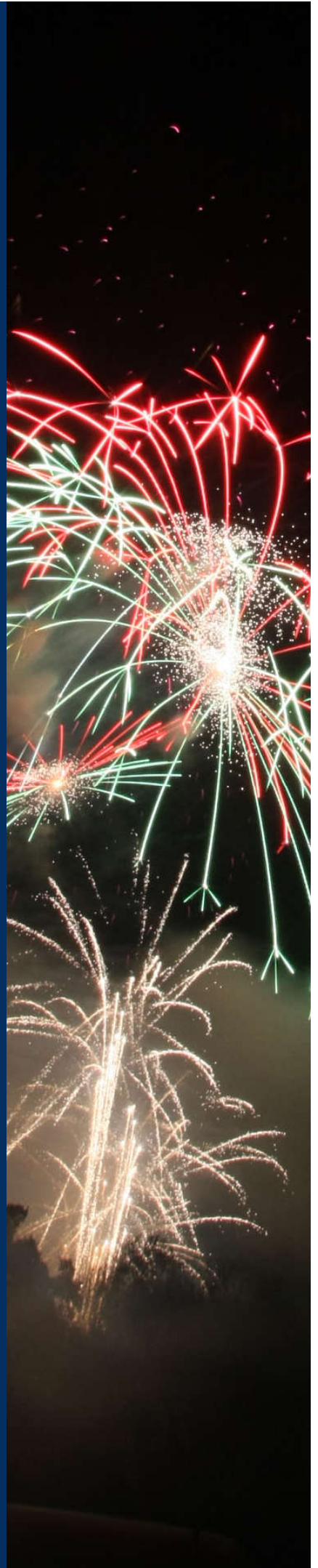


WORKING TOGETHER ON FIREWORK DISPLAYS

A guide to planning and safety at firework displays for
organisers and professional operators

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Working together on firework displays

A guide to safety for firework display organisers and operators

This book replaces the Health and Safety Executive guide HSG 123 and incorporates new features that have been introduced since the last revision of that guide.

The Explosives Industry Group of the CBI (EIG) has agreed to publish this guide and update it periodically. The assistance of HSE is acknowledged.

This guide is for competent display operators and organisers. It does not cover displays where the fireworks are to be fired by people without specialist knowledge or training – a separate guide has been prepared by EIG for those users.

This new edition has been updated to include the significant changes in the law relating to the supply, possession, transport, keeping and use of fireworks which may have an effect on the way you organise and the company fire your display



Acknowledgements

EIG gratefully acknowledge the assistance of the following organisations, companies and individuals in preparing and revising this guide

- The British Pyrotechnists Association (BPA)
- CarnDu Limited
- HSE Explosives Inspectorate

This Guide describes accepted practice within the explosives industry. Following it is not compulsory and persons are free to take other action in order to achieve equivalent levels of safety. By following the guidance, persons would normally be compliant with their legal duties.

Nothing in this Guide should be read as setting a higher standard than that required by legislation. Those persons involved in the explosives industry are responsible for taking their own legal and other advice as they see fit. Readers are strongly advised to check for any changes in legislation since the publication of this Guide.

Nor do the CBI, its servants and agents make any representation expressed or implied that the products and product ranges or the processes, equipment or materials referred to in this Guide are suitable, satisfactory or appropriate for the purpose or purported

purposes set out or referred to in this Guide and the CBI, its servants and agents accept no responsibility or liability therefore.

It is not the intention of this Guide to be used as a technical manual by those inexperienced in the design and execution of firework displays. Those not experienced in the field should seek expert assistance.

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Part 1- Introduction

This publication gives advice on safety for outdoor firework displays where the fireworks are to be fired by a competent display operator. This edition provides an update on relevant legislation, training, risk assessment and competence.

Who is this guide for, and who is it not for?

This guide is specifically intended for:-

- Organisers of firework displays, or events where fireworks are to be used, where the display is setup, fired and derigged by a professional display company
- Professional display companies – as the basic information to enable them to communicate effectively with an event organiser to achieve a safe and effective display

It is not intended for:-

- People using consumer fireworks
- The use of stage pyrotechnics



Professional display companies

Firework displays typically fired by professional display companies vary widely in their nature and scale, for example:

- displays held around 5 November attracting thousands of spectators, often run by local authorities;
- displays held by businesses, for example to celebrate a special event, an invited audience where the number of spectators may be no more than a hundred or so, or open to the public;
- displays for celebrations such as weddings and birthdays;
- Events of National and International importance

Glossary of terms

This is not exhaustive, but aims to provide a common glossary of terms used within the professional firework display industry to assist organisers of events. Because different companies operate in different ways there may be situations where their terminology differs from that given below.

Table 1- Glossary of common terms

Term	Meaning
Display site	The entire area of the display incorporating the Firing area, the Fallout area and the Spectator area.
Firing area	The area or areas where the fireworks are physically located prior to firing. This could include barges or structures
Fallout area	The area where debris and fallout land. It is extremely dependent on wind direction and strength and cannot be definitively determined prior to the display
Spectator area	The area or areas where spectators are located
Safety area	The area between the firing area and the spectator area
Safety distance	The minimum distance between the firing area and the spectator area
Display Manager	Usually the person within a company who organises displays, survey's sites, carries out risk assessments and plans the displays.
Senior Firer	The BPA qualification – the BPA aspires to have a Senior Firer on every display site. The Senior Firer is responsible for managing the display site and determining if a display should be curtailed or even cancelled.
Firer	The BPA qualification – the BPA aspires that all personnel on a display site should be qualified to this level or working towards this level of training.
Display company	The professional firework company that is procuring and setting up and firing the display. In most cases they will also be responsible for transporting the fireworks to the display site.
Event organiser	Usually the person who arranges the display, selects the venue and sources funding as well as overseeing the running of the entire event.
BPA	The British Pyrotechnists Association – for further details see the Further Information section. The BPA organises training for professional display operators.
EIG	The Explosives Industry Group of the Confederation of British Industry (CBI) – for further details see the Further Information section
Debris	For the purposes of this guide this is “abnormal” material landing on Earth - for instance a “blind” shell or unburnt stars
Fallout	For the purposes of this guide this is the “normal” material landing on Earth – for instance paper discs, plastic units, shell fragments or long burning stars

In addition there is a list of common firework types given later in this guide.

Part 2 – Planning the display

This part of the guide is primarily intended for organisers of events but should be part of the discussions with the companies tendering for the event, or firing the fireworks. We strongly believe that all parties having a common understanding of terminology and of potential pitfalls will lead to a safer, more enjoyable, display.

Organisation

Useful guidance on the organising of an outdoor event including those incorporating a fireworks display can be obtained from

The Event Safety Guide: A guide to health, safety and welfare at music and similar events.

This publication, available online, is known colloquially as the “Purple Guide”.

General legal considerations

Most displays covered by this publication will involve a work activity (ie at least one person will be involved on a professional basis) and therefore be subject to the requirements of the Health and Safety at Work etc Act 1974 and subsidiary health and safety legislation. This legislation imposes duties in respect of the health and safety of everyone involved in arranging and giving the display, the display spectators, and other people in the neighbourhood of the display site.



You can only discharge these duties effectively if there is one person having overall responsibility for health and safety at the display. That person will usually be one of the organisers, and will be responsible for implementing a system for the management of health and safety to ensure the organisers, display operator and any other people working at the display, for example a catering firm, comply with their duties under health and safety legislation. In most cases, however, none of the organisers will be experts in setting up and firing fireworks and you are therefore advised to appoint a display operator to assist you with firework safety matters. Have a formal contract which defines the extent of responsibility of yourselves and the operator.

Procedures

Start organising the firework display as early as possible to ensure everything gets done. It is recommended that you form an organising team to share the workload, with one member in a co-ordinating role. For example, one person could be responsible for liaising with the display operator, local

authority, fire service etc, another person for site facilities and crowd safety, and so on.

Selecting a display operator to fire the display

Careful selection of a display operator is important for the safety of people at the display.

The following points will assist you in selecting a display operator:

- Can the operator provide evidence of competence?
- What training and experience does the operator have? Is there any evidence of formal training?
- Does the operator have insurance cover?
- Does the operator agree to observe the safety recommendations in this publication?
- Can the operator provide a list of displays he/she has fired in the past, together with the name of each display organiser?
- Can the organisers of these earlier displays confirm there were no safety problems involving fireworks?
- Is the source of supply or fireworks for the display a reputable company?
- Has the operator asked to see the proposed site, or asked for details of it, before giving a quotation?
- Has the operator taken the initiative in discussing responsibilities?

The answer to ALL of these questions should be “YES”!

A list of addresses where you can obtain advice on the selection of a display operator is given at the end of this guide.

Once you have selected a display operator, you and the operator are strongly advised to agree your respective areas of responsibility for health and safety. In some cases (usually small displays) the display company may take on overall responsibility for the entire event, whereas for the largest events there will be an established and possibly complex hierarchical structure involving:-

- The event organiser
- A production company
- A creative director or designer
- Landowners
- Companies involved in other aspects of the overall event (eg lighting, sound and communications companies)
- The emergency services

- Stewards

The majority of displays will fall somewhere between these two extremes – however demarcation of responsibilities is critical to the safe organisation and running of the event.

Types of fireworks and effects

The variety of types of fireworks available to the professional display operator has extended somewhat in recent years. The table at the end of this document illustrates the most common types of fireworks used currently, together with a brief description of the firework's effect and functioning, and any particular hazards that may be associated with the type. Please note that this list is not exhaustive.

The following are typical types of fireworks used in a display. The descriptions here are necessarily brief but are presented to highlight the potential hazards associated with each type.

Table 2- List of common firework types

Type	Function	Effect	Potential Hazards
Shells	Fired from mortars by a "lifting charge". After a delay the shell bursts to produce stars or effects high in the sky.	Varied - shells may contain stars, noise or other effects, parachutes or daylight smokes	Fallout from debris Projectile effect Unfired shells falling to ground (very infrequent)
Rockets	Usually fitted with a stick, the rocket motor propels the firework into the air with a distinct "tail". At the apex of its flight the rocket performs in a similar manner to a shell	Varied as above	Fallout from debris or from the stick falling to earth Projectile effect if launched at low angle
Mines	Fired from integral or separate mortars, mines produce a column of stars or effects	Varied - may contain stars, effects (eg noise units) or bombettes	Relatively low debris Projectile effect if launched at low angle
Roman Candles	Typically a long tube containing several "shots" which are fired sequentially	Varied - may contain stars (comets), mini-mines, effects (eg noise units) or bombettes	Internal components as debris Projectile effect if launched at low angle
Single shot devices	These can be considered as single shot Roman candles or mines	Varied - see above	Generally designed to produce very low debris.
Multishot batteries ("cakes")	A collection of single shot devices fired sequentially	Varied - see above	Debris Projectile effect if item is tipped over or launched at low angle Projectile effect if cake disrupted due to one malfunctioning item affecting integrity of the remaining tubes Spent carcasses catching fire on ground
Fountains and gerbs	Shower of sparks from single tube - often used on wheels as well as formal designs (Set Pieces)	Metallic or other sparks projected in the direction of firing	Local effect from sparks
Waterfalls	Usually a vertical curtain of sparks fired from many tubes fired simultaneously	Metallic sparks (usually bright silver) falling vertically downwards from tubes fired horizontally or vertically	Local effects below the waterfall from sparks which usually are designed to reach the ground
Lancework devices	Sculptures depicting messages, logos or animated scenes (eg battles or novelty effects) comprised from many small fountain like tubes arranged on a frame	May comprise many colours, and may incorporate other effects	Very low hazard from lancework itself



Communications

It is advisable to have a two-way radio link between the display operator and those with key responsibilities for emergency action. At large-scale events it is preferable to have several channels operating, eg control to stewards; control to firework crew; firework crew to musicians/producer etc. Have an agreed procedure on radio for dealing with emergencies.

Types of displays

Defining the main features of the display

One of the first things to be done is to decide on some basic details, for example:

- What is the expected size of the audience?
- Is there to be a bonfire? (It is preferable not to light the bonfire before the fireworks are fired as stray sparks may accidentally set off the fireworks.)
- Which display operator is to be contracted to fire the display?

We believe that it is possible to fire some sort of display at almost any site provided that a suitable site and product assessment of risks has been carried out paying particular attention to:-

- The location and dimensions of the display site including firing area(s), safety area(s) and fallout area(s)
- The effect of wind strength and direction on the fireworks chosen
- Curtailment and cancellation criteria

- The types of fireworks suitable, their performance and failure characteristics and rigging and firing methods

Selecting the display site

The selection of a suitable display site is critical to the management of a safe and spectacular display.

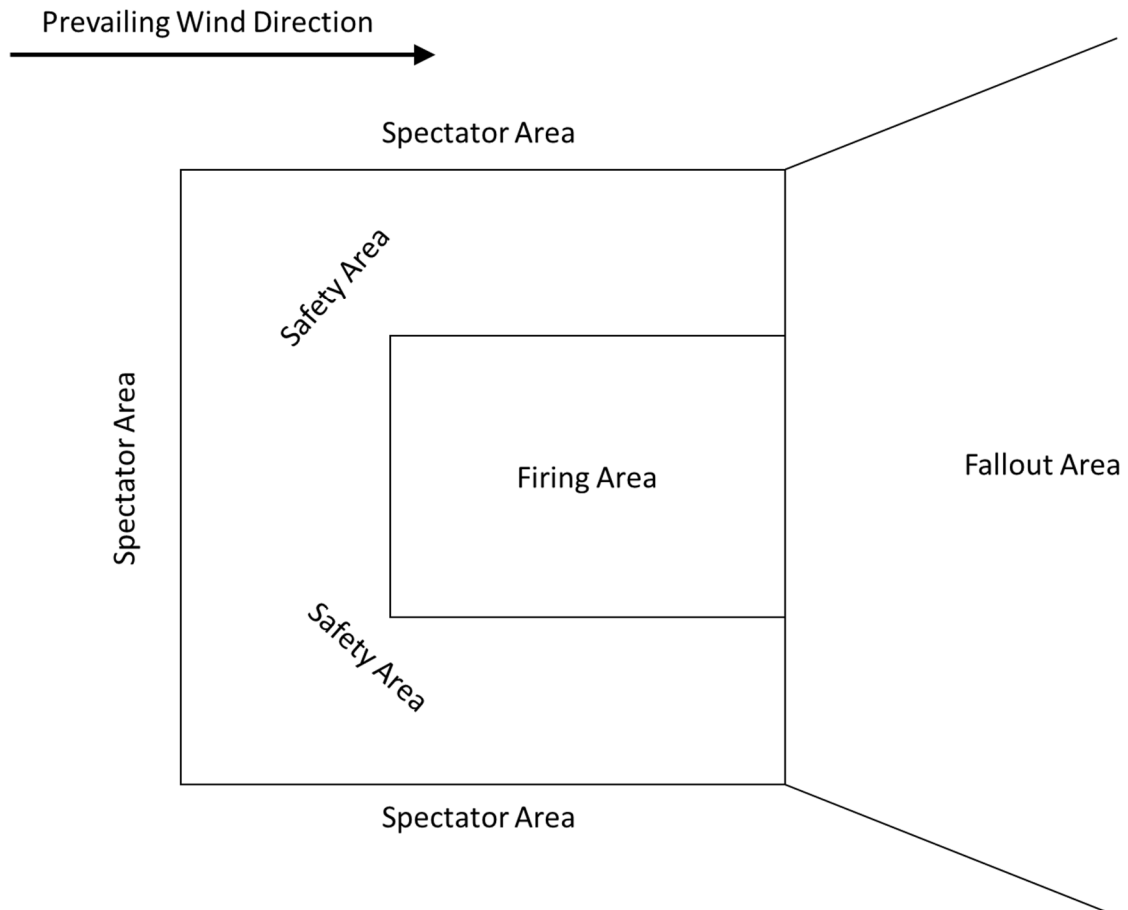
The display site is the whole site used for the display, and is made up of:

- the spectator area – from which the spectators watch the display;
- the safety area – a clear area between the spectators and the firing area to ensure that spectators are at a safe distance from the fireworks during the display;
- the firing area – from which the fireworks are set off;
- the fallout area (or dropping zone) – an area kept clear of people, where the debris from spent aerial fireworks lands; and
- the bonfire area – the area provided for the bonfire (if there is to be one).



The figure below shows how these areas should be located in relation to each other and the prevailing wind direction. However it is critical to appreciate that at the time of the display the weather conditions may vary considerable from these and it may be necessary to modify, curtail or even cancel the display as a result.

Figure 1- General display site layout



The display site needs to be large enough to ensure all the above areas can cope with:

- the types of fireworks to be used (this affects the size of the safety area and the fall-out area);
- a change in the direction or strength of the wind;
- the expected number of spectators.

The table below gives guidance on minimum dimensions of the display site. The distances given will be adequate in many cases, but the display operator may require greater distances for certain sizes or types of fireworks, for example crown wheels or flying saucers, or the larger sizes of shells. Allowance should be made for the burst diameter of shells when assessing safety distances. A 125 mm shell, for example, can project effects further than 50 metres and could

therefore endanger spectators if it malfunctioned at ground level without sufficiently extended safety distances.

In special circumstances the suggested safety distances given in the table may not always be appropriate, for example where displays are to be fired from unusual sites such as a barge on a river, the roof of a building, a bridge, or perhaps where only lancework or certain other non-aerial fireworks are to be used. In these cases it will be necessary for the operator to carefully assess the risks and decide on suitable spectator areas.

However, in some circumstances it may be possible to significantly reduce these distances if low hazard fireworks are used. We believe that it is possible to fire a display on almost any site by suitable choice of fireworks and by putting in place suitable precautions and procedures to reduce the risks to acceptable levels.

If the display company are using metallic mortar tubes you should take account of hard surfaces such as car parks, buildings and bridges near the firing site which could cause the ricochet of steel fragments if mortar tubes fail. Ricochets can increase the distance travelled by fragments by as much as 30%.

Table 3 - Suggested display site dimensions

Area	Dimensions
Firing area	30m x 10m is the ideal minimum – but larger sites offer more scope for creativity and firing from multiple locations simultaneously
Safety area	This is entirely dependent on the types of fireworks being used, but as a starting point we suggest a minimum of 25m for low hazard displays, and a minimum of 50-100m for displays containing arial fireworks. Very large displays will generally require even greater distance. However it is possible, by putting in place suitable risk-control measures to reduce these figures – it will depend on the scope and nature of the desired display and the site.
Fallout area	As large as practical – but note that fallout and debris typically travel downwind from the firing area and it is not possible to pre-determine the fallout area with certainty! The best sites allow flexibility to move the firing area so as to maximise the fallout area.
Display area	It will be seen from above that it is difficult to specify a total display area – but for medium sized displays a suggested area of 150m x 150m will allow all three of the above to be accommodated.

Ensure the site is free of dry, cut grass and other readily combustible materials.

Only make the final selection of a site after you (and preferably the display operator) have inspected it in daylight to check for obstructions, eg trees, adjoining buildings and overhead power lines.

Apart from obstructing the flight of aerial fireworks, overhead power lines pose other potential dangers, for example:

- scaffolding poles, metal ladders and similar items used in the construction of temporary staging, or long wires such as those sometimes used in firing circuits for electrically fired fireworks, can cause a dangerous discharge of electricity from overhead power lines if they touch, or even come near to them. This is known as a 'flashover';
- smoke or debris coming from fireworks or a bonfire burning under or near overhead power lines could also cause a flashover;
- overhead electric power lines near to firing wires for electrically fired fireworks can induce an electric current in the wires, causing the premature firing of the fireworks.

If you are in any doubt about overhead electric power lines, contact the local regional electricity company for advice. If it is impossible to arrange the site so the firing and bonfire areas are well away from obstructions, you may need to look for another site. In some cases the display operator may advise that certain types of fireworks you have requested cannot be fired safely at your chosen display site.

Opportunities and constraints of different display sites

The table below illustrates some of the opportunities and constraints that a number of common display sites offer as compared to an open field site.

Table 4- Opportunities and constraints of display sites

Display site	Opportunities	Constraints
Open field site	Flexible positioning of effects to maximise fallout area in case of wind direction	
Restricted ground level site		Limited flexibility for moving effects to maximise fallout area
Rooftop display (eg a multi-storey car park)	Use of close proximity effects	Usually inflexible positioning of effects Potential for reduced "safety" distances Increased fallout area because of elevated launch position
Displays fired from structures	Enhancing the structure by use of "chases" and geometric elements	Limited choice of fireworks available Fallout and debris issues Rigging considerations
Barge displays	Potential for moving barges (if held rather than moored or anchored) to maximise fallout area	If moored or anchored then no potential for moving
Multiple firing points	Add variety by using "width" as well as height of effects	Larger fallout area

Complexity vs Scale

The extent of work that has to be done in planning and executing a display to minimise risks and to maximise the impact (which are not mutually exclusive) depends on many factors. However regardless of the complexity and scale the same basic principles apply.

The display should be designed and executed so as to minimise the risks to

- The display operators
- Other people in and around the firing area (eg lighting technicians)
- The public
- Others not involved in the display
- Buildings and other structures
- The display site, trees, rights of way, livestock

	Small scale	Medium scale	Large scale
Simple site	Plenty of space and extensive "safety" distances	Plenty of space and extensive "safety" distances	Multiple firing sites but each with extensive "safety" distances
Medium complexity	Simple contingency planning	Simple contingency planning	Simple contingency planning
Complex site	Tight sites potentially using a very limited range of fireworks	Significant contingency planning	Multiple firing sites, full risk based approach including extensive contingency planning

Various modelling tools have been developed in the UK and elsewhere to assist in carrying out determination of both fallout and debris distances. These range from simple "Safety distance tables" based on calibres, firing angles and wind effects, to quite complicated modelling programs such as ShellCalc© Pro.

Whatever tools are used they should be available in some form to the Senior Firer for use on the display site – so that they may make educated decisions that can be quantified and ultimately justified in case of an incident. The alternative of the mantra "the show must go on" is no longer acceptable!

Flexibility and design

In addition to the factors above, sites which allow some flexibility in maximising fallout areas (for instance when fired from a barge held by a tug as opposed to being moored) allow the display to be designed to increase the likelihood that the planned display can be fired without modification.

However on restricted sites where there is no such flexibility it may be necessary to plan to extensively modify the display, even at the point of firing, so as to minimise the risks of, for instance, normal fallout reaching the spectators.

Good display planning and design will maximise the display impact whilst maintaining enough flexibility to be able to fire the display under a variety of conditions.

For instance it may be desirable to fire a "wide" display rather than a "high" display so that the area subject to fallout from shells is restricted. Similarly it may be sensible to fire shells vertically from a

number of positions than to fire shells at extreme angles from a central point. In the case of a shell “blind” shells fired at angles can travel very significant distances horizontally, especially downwind.

An appreciation of this high hazard/low frequency event may ultimately over-ride the distances calculated for normal fallout – which can be considered a low hazard/high frequency event!

Fallout and debris from fireworks

There are three main types of fallout that must be considered:-

Fallout is material arising from the normal functioning of the fireworks, for instance pieces of display shells that are affected by the wind and travel downwind of the firing point.

Debris is material arising from the “normal” functioning of fireworks and pyrotechnics but where the item is firing in an unintentional and undesirable direction (eg when a device has fallen over). Debris is also material arising where, for instance, a display shell is fired normally, but the internal delay fuse fails to burst the shell at its design height and where the shell falls to the ground unfired, or bursts at a very low height.

Fallout and debris from fireworks must always be considered in any display, and the display design or any late modifications (to reflect weather on the display date for instance) should reflect the distances available where any potential fallout from the fireworks will land.

Where a display site is restricted, or where an adverse wind may mean that debris and fallout could potentially fall on the audience or in an uncontrolled area, the display company may be forced to choose the types of fireworks very conservatively - allowing for such a “worst case” scenario. In contrast, where the display site is unrestricted and the available fallout distances extensive irrespective of weather conditions - then the display designer may be able to use a wider range of fireworks.

However, it is important to understand that all displays present a potential risk from any fallout, and that, given the nature of fireworks themselves, that a risk free (or totally safe) display does not exist! The following section on risk assessments will consider this in more detail.

“Safety Distances”

There are no set “safety” distances for the use of professional fireworks in the UK, and the BPA have consistently argued strongly against their introduction. In some cases the demands of a particular site or a particular display design may mean that such distances do not provide an adequately low level of risk, and conversely, there are many occasions whereby careful choice of fireworks and specialist rigging techniques may allow extremely short safety distances to be considered. For example when firing off structures the distance to the structure itself is effectively zero!



Hence, the distances given in HSE's old guidance should be considered as indicative only. Professional operators may deviate from these distances, either upwards or downwards, dependent on their own site and product specific risk assessments for the event. The changes noted above to the types of fireworks available, and to modern rigging and

firing techniques mean that the HSE's guidelines are no longer relevant.

Other countries, notably the USA, have adopted a complex system of "safety" distances for each firework type and calibre, and the means of rigging and firing. The major problem with these tables is that they are not "safe" distances at all - in fact they are distances based on reduction of risks to a low (but not zero) level. They may provide useful baseline information but they are not "safe". Further details of these Standards is given in Part 4.

The UK prefers to assess risks on a case by case basis taking into consideration

- the nature of the site
- Particular conditions, such as the possibility of an adverse wind blowing debris towards a road or the audience.
- The fireworks chosen for the particular event and site (considering that some items may need to be removed or modified if conditions dictate)

Risk assessments

The Management of Health and Safety at Work Regulations 1999 require employers to make a suitable and sufficient assessment of the health and safety risks to which their employees are exposed while at work, and the health and safety risks to other people resulting from or in connection with the employers' work. Information on risk assessment is given below.

Regulation 3 of the Management of Health and Safety at Work Regulations 1992 requires employers to make a suitable and sufficient assessment of:

- the health and safety risks to which their employees are exposed while at work; and

- the health and safety risks to other people resulting from or in connection with the employers' work, to identify the measures needed to comply with health and safety legislation. The same duty is placed on self-employed people in respect of their own health and safety and that of other people.

Both the display operator and the display organiser should prepare a risk assessment. The display operator's assessment will form a part of the display organiser's overall risk assessment.

General guidance on risk assessment is given in the HSE leaflet Five steps to risk assessment. For a firework display you would need to do the following:

- identify the hazards;
- identify who might be harmed and how;
- evaluate the risks;
- identify appropriate and adequate precautions; and
- record the findings.

Risk assessments – specific aspects relevant to displays

Risk assessments are used to assess the RISKS arising from any operation, in this case the risks from firing particular fireworks, rigged in a particular manner, at a particular site. Risk assessment initially considers two factors

- The hazard of an occurrence (ie the intrinsic hazard - what is the consequence of a particular sequence of events, to whom and of what severity)
- The frequency of such an occurrence.

For the display operator the risk assessment need only cover the display itself and anything that might affect it. The display organiser needs to take account of every aspect of the event including any additional activities, such as the sale of refreshments, crowd control, access for the emergency services etc.

It is particularly important to consider the following:

Display site location and layout:

- Is the layout and size of the firing area adequate, bearing in mind the risk of the burning debris from one firework accidentally setting off another firework and endangering people and property, prevailing weather conditions, and the need for firers to be able to move safely out of the area etc?
- Are the safety distances adequate for the fireworks to be fired, taking into account the risks from the malfunction of those fireworks and other eventualities?

- Are the precautions to be taken while setting up the fireworks adequate, taking into account risks to those doing the work and other people, including the general public?
- Have the risks to people from the possible problems arising with shells and other fireworks which can explode violently, or which project debris, been fully considered, and adequate precautions taken?
- Have the risks to animals in the display vicinity been considered, and are there control measures that can be introduced to mitigate any adverse effects of the display?
- Have the risks to structures (either the place where the fireworks are being setup and fired from) or ones adjacent to the display site been considered?
- Have the risks associated with these operations for your display been fully considered and adequate precautions taken?

The UK display industry has promoted a semi-quantified approach to risk assessments, in order to be able to adequately assess which risks need particular attention and mitigation, and to develop displays which present a very low overall risk to operators, other performers, vulnerable structures and the audience alike. It is important to note that such an approach: -

- Does not mean that there is NO risk from the use of fireworks - as noted above this is an impossibility
- Attempts to identify situations where the reduction in risk to one particular sector does not inadvertently lead to an unacceptable increase in risk to another sector, or identifies means by which such an additional risk may be adequately controlled.
- Allows displays to be selectively modified according to the conditions prevailing when the display is fired.

Individual and Societal Risk

HSE's guidance on risk assessments considers two particular types of risk.

- Individual risk - the risk to a specified individual (for instance a display firer, or a member of the audience in a particular spot)
- Societal risk - the risk to society as a whole.

In general it is much easier to quantify the former, and HSE's guidelines suggest that an individual risk of fatality of about 1×10^{-6} (ie one in a million) is considered "broadly acceptable". Levels of risk above this (1×10^{-5} to 1×10^{-4}) are in the so called "ALARP" region - As Low As Reasonably Practical - and may still be considered acceptable provided that they have been properly assessed, and that additional control measures are cost effective.

Societal risk is more difficult to quantify - for firework displays the societal risk should consider the risk to all people involved in or watching displays throughout the UK in any particular year. Fortunately, for firework displays, individual risk is an adequate measure of overall risk because the total aggregate amount of time that displays are fired and the number of people who are at potential risk is very small.

Rating both hazards and frequency, and applying the simple formula

RISK = HAZARD x FREQUENCY

allows risks to be ranked for further consideration (see below) or determined as being "broadly acceptable. It does not matter particularly what system is used, and whether it is qualitative (eg High, Low, Medium), semi-quantitative (using simple numbers to represent frequencies of levels of hazard) or fully quantitative (which produce risk levels relating, say, to the risk to an individual in terms on probabilities), the important thing is to be able to

- Determine if risks are "broadly acceptable", unacceptable, or whether they are in the "ALARP" region where additional control measures may reduce them to an acceptable level
- Rank the risks to be able to address the highest risks first
- Measure whether risk control measures actually reduce the risk to all those who may be affected
- To form a basis for consideration whether control measures are cost effective (by cost/benefit analysis)
- To provide a basic operating procedure - ie those things as identified as reducing the risk
- To monitor whether changes in rigging or firing techniques, or changes in the types of fireworks used, have adverse consequences for risk control

The BPA favours a semi-quantified risk assessment methodology where hazards are rated according to severity from 0 - 10, and frequencies similarly rated from impossible to absolute again on a range from 0 - 10.

Thus, risks can be rated from 0 - 100, and high risk operations could arise from either low frequency/high hazard events, or high frequency/low hazard events. Very high (and generally unacceptable) risks arise from high hazard/high frequency events.

Two particular types of risks are common at firework displays, and which dictate whether the display on a particular site, using particular fireworks and rigged and fired in a particular manner is as low as possible.

High frequency/low hazard operations - for instance fallout from shells. All shells produce fallout, and that fallout will travel downwind from the firing site and land on the ground. If the debris falls on the audience it could cause minor eye injuries, or minor burns to people or property. Reduction of this risk may be achieved by maintenance of adequate fallout distances downwind of the firing site. If the display has been planned only considering the prevailing wind, and the wind at display time is from another direction or is particularly strong - then the display may have to be curtailed or abandoned.

Low frequency/high hazard operations - for instance where a shell fails to burst and lands in the audience and subsequently explodes. In such cases there could potentially be several fatalities, but the risk can be reduced to acceptable levels by, for instance, angling mortars away from the audience (so that if a shell fails in this manner it does not fall towards the crowd), or in certain cases, by providing a barrier between the firing site and the audience to "catch" low trajectory shells.

It is important to realise that any particular risk reduction method will affect EITHER the frequency of the event OR the hazard of the event. It is rare, if not impossible, to have risk reduction methods that affect both. In general it will be the frequency which is easier to address.

In general it is PHYSICAL things that affect HAZARDS (eg reducing the calibre of a shell, or changing a long duration star shell for a short duration one) whereas ACTIONS affect LIKLIHOODS (FREQUENCIES).

In the first case above it is not possible to reduce the frequency of debris being produced and falling to the ground - "what goes up must come down", but it may be possible to reduce the frequency of debris falling on the audience by ensuring that the audience are further away. Similarly if lit debris DOES fall on a member of the audience it is not possible to reduce the hazard to them.



In the second case, again, it is only possible to reduce the frequency of the event (the probability) of a shell falling unfired into the audience. In addition to the methods outlined above, it would be possible to reduce the frequency of a shell failing to burst by fitting, for example, two independent internal delay fuses. However - fitting two internal delay fuses increases the risk (by increasing the frequency) of a shell bursting in the mortar because of a failure of the delay fuse in which it fires instantaneously once the lifting charge of a shell is ignited.

All these factors (and many others) have to be taken into account in determining the suitability of a site itself and the suitability of certain fireworks to be fired from that site

under a variety of conditions. The risks from a professional firework display are generally very low when adequate assessment and precautions have been taken - but they are never zero!

Environmental effects of fireworks

Environmental concerns over the use of fireworks have increased in recent years. Basically, the concerns are in four main areas:-

The environmental impact of noise from the display

The Fireworks Act and subsequent regulations has limited the hours in which fireworks may be fired, however, unless the design requirements for the display, or particular local features dictate, noise is an important feature of any firework display, and is an inevitable consequence of fireworks functioning. For instance the bursting of a display shell must produce some noise - reducing the burst charge could actually increase the risks from the use of such devices. Deliberately noisy displays may be inappropriate in certain circumstances - but this is a matter for the early planning stages of an event where such things may be considered.

Physical fallout and debris from displays

Over recent years the design of fireworks and the types available has changed and most fireworks now do not include plastic and metal components where it is possible to replace them with biodegradable alternatives such as card or compressed paper. However, there are components which cannot, at present, be replaced in this manner and will continue to be present as fallout. Display companies are mindful of these concerns and can adapt displays to minimise the use of such materials - but this may also restrict severely the types of fireworks available to them.



Chemical debris from the display

The functioning of fireworks inevitably produces some smoke - and this smoke contains the combustion products from the burning of the firework compositions. The combustion products include the gasses nitrogen oxides, carbon dioxide and sulphur dioxide, as well as solid combustion products dependent on the particular effect.

Research by the Disney corporation has shown that the effects of such combustion products on the environment and on structures is very limited. Disney investigated the effects of firing over 2000 displays over a body of water on the same site (a rate much higher than any UK display site) and concluded that although the deposition of metal salts in the

lake was considerable, the majority of the deposition was found in the mud in the bottom of the lake rather than in the water mass above it, and that there were no measurable biological effects on the flora or fauna of the lake. A recent study in London has shown that the levels of atmospheric pollution are also very low - for instance for the New Year's Eve celebrations the amount of the atmospheric pollutants Nitrogen Dioxide and Sulphur Dioxide were approximately one 300th of the amount of the same gasses arising as a consequence of people travelling by car, bus and train to watch the display.

Use of perchlorates in fireworks

Potassium perchlorate is an important constituent chemical of many fireworks, but the levels of this particular chemical released to the environment after the functioning of a firework are extremely low (it is usually consumed completely during the functioning of the firework). American studies have shown enhanced levels of perchlorate in ground water and soil samples around sites where a large number of displays have been fired over an extended period. However the increases in levels is extremely low and does not pose an environmental or human health concern.



Provision of site facilities

Prevent spectator access to the safety, fall-out, bonfire and display areas, by a suitable form of physical barrier.

Check that fire-fighting facilities at the site are adequate and consider asking the fire service or a fire-fighting specialist for advice. The following provisions are advised as a minimum:

- equipment for putting out small fires (eg fire extinguishers, buckets of water, fire blankets) available throughout the display site; and
- an adequate number of stewards instructed in how to use this equipment. Tell the stewards not to attempt to fight major fires.

Provide at least two spectator exits from the site which are large enough, spaced well apart, clearly marked, kept free from obstructions and well lit.

Keep the agreed emergency service routes clear of obstruction and readily accessible at all times.

A small public address system or loudspeaker will ensure that announcements and instructions can be clearly heard by all spectators at larger displays.

Provide at least one suitably equipped first-aid point, manned by a qualified first-aider. Signpost it clearly and make it easily accessible to an ambulance.

Provide suitable litter receptacles throughout the spectator area.

Any car-parking area should preferably be well away from the display site and upwind of it (ie with the wind blowing from the car park towards the site). Do not allow parking anywhere else. The parking area needs to be clearly signposted, with vehicle and pedestrian routes to and from the parking area totally segregated from each other. Where appropriate, supervise parking to prevent obstruction of emergency access routes.

Locate any bar selling alcohol well away from the display site and do not allow alcohol to be taken away from the bar area. No one involved in running the display should be under the influence of intoxicating substances.

Looking after the fireworks before the display

It is advisable for the display operator to be responsible for keeping the fireworks at all times, because the operator will:

- already have a safe and suitable place of storage; and
- know how to transport the fireworks by road from the storage place to the display site in accordance with the relevant legislation listed in Part 4.

Provide a safe place at the display site to store fireworks immediately before use, for example a building or a closed metal or wooden container located in an area of the site not accessible to the public. Alternatively, they can be kept in the display operator's vehicle parked in an area not accessible to the public, provided they are kept safely.

Once fireworks have been set up, ensure the firing area is supervised.

Selecting a professional display company

There are a wide variety of display companies operating in the UK and it is important to select one that:-

- has sufficient resources to be able to carry out the display on day in question
- understands the principles of carrying out a risk assessment
- understands the requirements of health and safety legislation which apply to the activities of a firework display operator and firework displays;
- ensure that people forming part of a firing team who do not have knowledge, training or experience are directly supervised by an experienced team member.

What is meant by a 'competent display operator'?

A competent display operator should have sufficient knowledge, training and experience to set up and fire the fireworks and clear them up after firing in a way that ensures the health and safety of the operator, the operator's employees and other people at, or affected by, the display. Competence will normally be achieved through a combination of theoretical training (for example a 'classroom'-based training course), and practical 'on the job' training gained from planning, setting up and firing displays. It is not expected that satisfactory competence could be obtained without this practical training. The typical areas expected to be included in any training course are given below.

A competent display operator will:



- understand the characteristics and proper use of the various types of fireworks, including debris patterns and fall-out distances;
- understand the principles and practice of ignition systems;
- understand the principles of adhering to a risk assessment;
- understand the principles of setting up, firing and clearing up the fireworks both in relation to operator safety and the safety of others;
- be trained in setting up, firing and clearing up fireworks, either by a competent display operator or as part of a training course;
- have practical experience in rigging, firing and disposing of the types of fireworks selected for the display:

Display Operator training

The BPA organises a training and registration scheme for professional firers in the UK, which is accredited by City & Guilds. BPA members arrange training for firers from both BPA member companies, and other professional operators culminating in an examination which is set and marked independently.

Candidates, who are required to have completed a number of displays prior to sitting the examination and to maintain a log book of displays fired, are examined at 2 levels and successful candidates awarded a certificate and firer's ID card. A publicly available database of all firers is maintained at the BPA website.



Firers will usually be assistants at displays and it is intention of the BPA that all professional firers should be aspiring to a "Firer" qualification. The BPA recommends that the lead firer on a display site will be qualified to "Senior Firer" level.

It is planned in the future to extend the BPA training scheme to display managers within companies, and also to make awareness training available to event organisers and enforcers.

Who should be informed about the display

It is advisable to contact the following well before the display and keep in touch as your plans proceed. Reconfirm your arrangements on the day of the display:



Police

Contact the police as soon as possible, informing them of the location of the site and its layout, including all entrances and exits.

The police's main interests are crowd control, public order, emergency access, and local traffic management and parking. It is advisable to act on any recommendations they make.

Fire service

Contact the fire service at least 28 days before the event. They will mainly be interested in:

- how the emergency services will be called;
- access for emergency vehicles;
- marshalling crowds and traffic in emergency conditions;
- arrangement of spectators' enclosures;
- local fire-fighting arrangements; and
- buildings and other features nearby which could be affected by a fire.

Local authority

You may need to contact the local authority under entertainments and related legislation (see Appendix 3). In any case think about contacting:

- local authority enforcement officers, for advice on complying with health and safety legislation and other matters such as minimising noise nuisance, avoiding any problems that may have occurred in the past, and complying with local by-laws;
- the trading standards/environmental health departments, or in some areas the fire service, if you are in any doubt about arrangements for storing fireworks before the display. The

place of keeping may need to be licensed or registered under the Explosives Regulations 2014.

Local institutions

It is wise, in the interests of good public relations, to inform any local hospitals, old people's homes etc of the event.

Neighbouring landowners or users

Advance warning to neighbouring landowners or users at an early stage will enable them to move livestock (cattle, horses etc) where necessary.

Local people likely to be affected by the display may not be aware of it through local advertising. Contacting them via a leaflet drop, for example, would be preferable to leaving them unaware of the nature, scale, timing and duration of the event.

Coastguard

If the display is to be held near the sea it is important to inform the local coastguard in advance. Aerial fireworks could be mistaken for distress signals.

Harbour authority

Inform the harbour authority as soon as possible, and at least 24 hours in advance, if the display is to be anywhere in a harbour area, or if the fireworks have to be taken through a harbour area to reach the display site. Under the Dangerous Substances in Harbour Areas Regulations 1987,¹² there is a duty to give advance notice of the entry of dangerous goods into a harbour area.

Aerodromes

If the display is to be held near an aerodrome, inform the airport authority at least seven days in advance. Alternatively, contact the Civil Aviation Authority (CAA),

Safety Regulation Group, Aviation House, Gatwick Airport South, West Sussex RH6 0YR Tel: 01293 567171, particularly if you are unsure whether there are aerodromes near the display site. Adhere to height restrictions for aerial fireworks stipulated by the airport authority or CAA. The Civil Aviation Authority has issued detailed guidance on the operation of lasers, searchlight and fireworks in UK Airspace¹³ (CAP 736). This document can be downloaded from the CAA web site (www.caa.co.uk) or requested from the address given above.

If you are unsure whether or not to get in touch with anyone – do so.

Crowd safety

The safety of the crowd is an essential part of the planning of the display. There are a number of foreseeable situations which will require adequate planning before the display commences.

Spectators in the safety, firing or fallout areas

If spectators break through the barrier into the safety, firing or fall-out areas, ensure that firing of fireworks stops as soon as is practicable.

Disorderly behaviour by spectators

If trouble seems to be developing, call the police before attempting to deal with the matter yourselves.

Announcements to spectators

Prepare announcements in advance which can be made to the spectators in the event of an emergency, telling them what has happened and what they are required to do.

Provide an adequate number of stewards responsible solely for crowd safety.

- Ensure stewards receive adequate briefing, and a clear chain of command exists.
- Make them easily identifiable, for example they could all wear fluorescent jackets
- Instruct them to be on constant watch for emergencies.

Pay particular attention to keeping spectators out of the safety, firing and fallout areas. Control entry to the spectator area to avoid overcrowding.

Do not admit spectators to the display with their own fireworks. Publish proper notice of this in advance and post notices at all the entrances. No fireworks should be on sale at the site.

Make every effort to start the display on time as crowd control becomes more difficult, the longer people are kept waiting. If a delay is unavoidable, tell the spectators and ask for their co-operation at an early stage.

Some important points on crowd safety can be found in the leaflet *Managing crowds safely: A guide for organisers at events and venues*.



Firing methods

There are a variety of firing methods available to the professional display operator which range from simple hand firing" where individual fireworks are lit manually with a portfire, to complex computer controlled systems which allow simultaneous firing from a number of locations.

The way a display is designed and fired is dependent on a number of factors including:-

- The scale of the event
- The budget
- The types of fireworks used
- The layout of the firing site
- The complexity of the display design
- The synchronisation to music

Computerised firing systems can offer a number of advantages in creativity and control but the use of such a sophisticated approach should not over-ride good

display design principles nor the fundamental need to use appropriate fireworks for the site and to fire the display so as to present as low a risk as possible. A suitable and sufficient risk assessment will highlight where, for instance, moving from a manually fired display to an electronically fired display may, in the case for instance of mortar rack failure, potentially increase the risks to spectators while reducing risks to operators.

What happens if something goes wrong?

Plan in advance!

Well before the day of the display, you will need to consider what could go wrong on the day. Draw up a plan to deal with each emergency or contingency, answering the questions 'What action will be taken?' and 'Who will take that action?' Involve the display operator in this exercise where necessary.

The paragraphs below highlight some of the problems which could arise, and actions which could be taken. The list is not exhaustive, but should help you plan ahead for emergencies.

Stopping the display early or cancelling it due to adverse wind conditions



You will have based the layout of the display site on the prevailing wind direction (see Figure 1). If the wind direction is different on the day of the display, the display operator may suggest modifying the layout to ensure people's safety. If this is impossible or inadvisable for other reasons, for example because this would interfere with exits, consider the actions described for high winds below.

In high winds it may be necessary to modify the display (eg eliminate aerial fireworks) or, in extreme conditions, cancel it or finish early. Involve the display operator in these decisions; do not continue if the operator advises cancelling or stopping the display.

Accident to someone from a firework or incident involving a firework

Have a procedure to ensure that first-aiders have clear access to the injured person as soon as possible. In the case of serious injury, have an ambulance called immediately by a designated organiser and suspend firing of the display.

Where an accident or incident is reportable under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), the enforcing authority should be contacted as soon as possible and not later than legally required. Ensure the scene of the accident or incident is preserved and the remains of any fireworks involved and other debris are left undisturbed, unless this would pose an immediate threat to safety. The enforcing authority will tell you when you may start clearing up.

Pyromusicals

Pyromusical events, where fireworks are fired accompanied by, or synchronised to music - be it live or recorded - form an extensive and increasing part of the professional display company's repertoire. As above, there is often little impact on the safe rigging or firing of a fireworks display, except where theatrical pyrotechnics are to be used in close proximity to staging, the performers or the audience. In such cases the use of such pyrotechnics should be subject to both recommendations from the suppliers (eg manufacturer's safety distances) and site and product specific risk assessment which takes into account the proximity of any features (such as elements of the set design such as curtains and screens) and their potential flammability. In many cases it will be appropriate to treat such items with a flame retardant to further minimise risks arising from the use of proximate pyrotechnics.

Non-firework elements in displays

Many displays now incorporate other elements in addition to the fireworks themselves. Traditional Guy Fawkes night firework displays, in which a bonfire is also part of the celebrations, now form only a relatively small proportion of all displays fired in the UK. In addition to pyromusical displays (see later) many events now incorporate lasers or other lighting effects. Although such elements rarely increase risks arising from the rigging or firing of fireworks, they may introduce considerable problems when planning how all the various elements of the event may be arranged on the display site whilst maintaining adequate safety distances for each. The desire of clients, organisers and producers to incorporate these additional elements should never mean that safety distances for fireworks are compromised.



Bonfires

Make one person responsible for the bonfire, and allow only that person and designated helpers into the bonfire area. Do not use petrol or paraffin to light the fire. A safer way to light is to use paper and solid firelighters in two or three places to ensure an even burn. Do not burn dangerous rubbish such as foam filled furniture, rubber, aerosols, tins of paint, pressurised gas cylinders, tyres and bottles. Materials producing light ash which could blow about, such as corrugated cardboard, are undesirable for burning.

Before lighting the fire, check its construction carefully to make sure it is stable, and that there are no children or animals inside.

The people looking after the bonfire are advised not to wear lightweight clothing which could ignite easily. They are recommended to wear a substantial outer garment of wool or other material of low flammability and strong boots or shoes. They need to know what to do in the event of a burn injury or a person's

clothing catching fire, and also have a fire blanket ready in the bonfire area.

If you cannot deal with the fire immediately, using available fire-fighting equipment, call the fire service without delay. Instruct the display operator to suspend firing of the display until the fire is extinguished or the fire service advises it is under control. You may need to move spectators to a safe place away from the site of the fire, but ensure that a clear access route for the fire appliance is maintained at all times.

Other issues

Drones

The use of drones to film displays from a high level position is increasing – but there are important safety considerations that need to be considered:-

- Is the drone being operated by a professional company, or by an enthusiastic amateur?
- Where will the drone be launched and controlled from?
- Is there adequate communication between the display company and the drone operator in case of issues during the display?
- Is the drone to be flown in amongst the fireworks and risk being damaged or disrupted?
- If control is lost where will the drone fall?

Flying a drone at night without clear visual contact and adequate control may contravene legislation and careful consideration must be given to their use by event organisers.

Amateur users who fly drones independently may also contravene regulations. Further information is available from the CAA.

<https://www.caa.co.uk/drones/>

Terrorist threats

In times of heightened awareness of terrorist threats and the potential for members of the public to assume that any loud bang as indicative of a “bomb” it is vital that relevant authorities are notified of the display in advance and their assistance sought in planning the event.

Part 3 - Rigging and firing the display

This part of the guide is predominantly aimed at the display company. However, again, it is essential to liaise with the event organisers



Display design

There have been significant advances in display design in recent years, primarily through the development of computerised firing systems which allow the display designer to develop a variety of new effects. As a consequence, the means of rigging displays and the types of fireworks used have changed. For instance, there has been developed a range of “single shot” Roman candles and mines which allow “chases” such as those seen on the Sydney harbour bridge and the Eiffel Tower in which a large number of such items are fired in extremely quick succession along the structure.

This in turn has led to the development, in some case, of modular firing systems which can be attached to these structures but which maintain a low level of risk.

Traditional safety distances are not particularly relevant to the firing of such items - in general the fireworks are designed to present the minimum of debris, and the modular firing systems which fix them to the structures adequately contain the fireworks and ensure that they are only able to be rigged and fired in the design direction.

Furthermore, the effects used are relatively low powered devices designed to produce a rhythmic or “wide” effect rather than one in which height (and therefore power) is paramount.

In addition there has been developed a vast range of multishot devices, colloquially known as “cakes” which have become a common feature of many displays. These devices produce a number (typically ranging from 25 to 1000) of “shots” each shot coming from a separate tube. The mass of tubes, usually in a rectangular or round design, is relatively wide compared to its height (cf a traditional Roman candle) and the appearance of which gives it its common name. These fireworks produce a continuous effect, often lasting up to 2 minutes, and are available in a very large variety. They produce relatively low debris, in the same way that the “single shot” devices described above do, however they do require careful handling and setting up by the display operator to prevent misfires.

Responsibilities at displays

Increasingly events involving fireworks are organised by local committees, with the professional display company providing a display as part of a larger overall event. It is important for the event organiser, the venue and the display company to agree at an early stage where their respective responsibilities in staging the event lie, and to have a clear communication path for decisions prior to and during the event itself. For instance

Who is responsible for ensuring the display area and fallout area are clear (usually the event organisers - the firework company will be firing the display)

How can the public be informed if the display is curtailed or cancelled - and what means are in place to ensure safe egress from the display site in these circumstances.

Display operator training

This list is not exhaustive but simply provides an indication of what a training course will typically include:

- The various types of fireworks available to professional firework operators, their effects (including duration, burst height etc), debris pattern and potential risks;
- Basic risk assessment including assessment and mitigation of risks;
- Site planning including layout, effects of wind and weather, special requirements of unusual sites etc;
- The nature of firing areas, safety area and fall-out area in relation to the overall display site, together with constraints or opportunities that might present themselves;

- Methods of modifying show content at the display site to reduce risk, eg repositioning aerial items, removing items, cancelling the display;
- Firing area layout;
- Fusing methods;
- Ignition systems – advantages and disadvantages;
- 'Rigging' – including aspects of unusual sites;
- General legal aspects including duties under the HSW Act etc;
- Specific legal duties including those involved with manufacture, storage, transport and disposal of fireworks;
- Basic display design;
- Basic first aid;
- Basic communication principles and protocols;
- Clearing up after the display.

The BPA organises training courses for firers and senior firers at displays. These courses are endorsed by EIG.

Setting up the display

What type of fireworks will the display operator use?

Fireworks used by display operators usually include category 4 fireworks. These typically have minimal labelling on them. They often do not have complete fuse systems and are often used by display operators as components linked together by fusing to create larger fireworks. Because of this it is not practicable for manufacturers or suppliers to provide detailed instructions on setting up and firing these fireworks. Some category 4 fireworks are much larger and more powerful than those available to the general public, and are potentially more hazardous.

This is in contrast to displays fired by amateurs using UK/European Standard compliant fireworks. In such cases the firer is not a professional and does not have, and should not have, access to product specific performance criteria nor to deviate from the rigging and firing instructions presented on the firework itself.

General precautions

Display operators are advised to take the following general precautions.

- Do not smoke when handling fireworks, or in the firing area once fireworks are present.
- Where fireworks are tied to stakes or other supports, tie them on the side facing away from the audience. Then, if a malfunction occurs and the firework falls over, it is probable

that any remaining projectiles or effects will fall away from the audience.

- Keep fireworks dry with the use of suitable sheeting or polythene bags.

CE/UKCA Marking and European Directives

Since mid 2017 all fireworks (with limited exceptions) in the UK must comply with the requirements of the EU Directive on Pyrotechnic Articles (2013/23/EC).

The UK withdrawal from the EU on 31 January 2020 is due to bring wider changes to the marking of products placed for sale on the market. As a holding measure while these changes to UK legislation and the practicalities underpinning them are finalised, it is accepted that existing products holding a CE mark can also be marked with the UKCA mark, currently until 31 December 2027.

A CE marked firework product placed for sale on the European/UK market has undergone rigorous testing and inspection procedures intended to make it fit for purpose. Therefore the additional of a UKCA mark extends the suitability for the product to be used in the UK.

Instructions on fireworks

EU Directives and the derived Standards require that suitable markings and instructions are provided with fireworks, giving clear advice on the safe method of their handling, storage and use.

Suppliers or manufacturers usually provide an instruction leaflet with the fireworks on how to use them safely. Read it well in advance of the display, and contact the supplier, manufacturer or importer with any queries. Follow the instructions closely during setting up and firing.

Part of the Standards required Category F4 Fireworks to have information provided that allows a person with specialist knowledge to determine a "safety" distance. The information is usually presented in the form of a series of coded information as shown below.

Firework intended for consumer use are labelled explicitly with instructions and minimum safety distances – however the UK argued successfully that professional display companies should be allowed to determine "safety" distances on a risk basis, and that these could change from one situation to another depending on a number of factors including, for shells for instance:-

- The mortars used to fire the shells (length and calibre)
- The firing angles
- Precautions taken to reduce risks in case of product failure

CE labelling table

The following table shows the meaning of the coded information on category F4 fireworks.

Table 5 - Codes on Category 4 fireworks

Code	Status	Description	Examples/Comments
A	M	Effect height	
B	M	Sound pressure level	Value @ distance
C	M	Debris distance	
D	M	If effect reaches ground	“✓” if effect reaches ground
E	M/O	Effect range	This parameter is mandatory for aqua fireworks.
F	O	Effect broadness	
G	O	Calibre	If not required in description
H	O	Initial fuse time	
I	Not used to avoid ambiguity		
J	O	Flight time	E.g., time to burst for shells
K	O	Effect time	E.g., duration of stars
L	O	Flash powder content	E.g., for compliance with UN default classification (in weight or in %)
M	O	Gross mass	
N	O	Effect	
O	Not used to avoid ambiguity		
P	O	Classification reference	
Q	O	Drift	
R	M/O	Overall duration	
S	O	If multiple effects	
T	O	Radial effect distance	
U	Not used to avoid ambiguity		
V	O	Burning rate	
W	M/O	Maximum firing angle	
X	Reserved for future use		
Y	Reserved for future use		
Z	Reserved for future use		

Key:-

Status – “M” = Mandatory, “O” = Optional

Own Use issues

During development of the European Directive it was agreed that use by a manufacturer (and where product is not supplied to a third party) and on the territory of the manufacturer was a special case where CE compliance and marking was not required. This is the so-called “Maltese question” and was raised by Malta to address the situation where local companies produce fireworks for local festivals and rig and fire them themselves and do not supply them to any third party.



Firing plan

It is advisable to prepare a firing plan well before the fireworks are set up.

This plan should include both a physical map of the display site and surrounding areas and a plan for the firing order of the display.

Where the crew rigging and firing the display are not those who visited the site and planned the display it is essential that they are

provided with adequate information to address the following:-

- Where the fireworks will be setup, where the spectators are, the likely fallout areas are etc
- How the fireworks will be rigged
- The prevailing wind direction
- Identification of local hazards
- Identification of any fireworks which may need to be removed from the display should conditions dictate (eg those fireworks with long burning stars)
- Contact details for the event organiser

Fusing

The setting up of category 4 fireworks may involve the modification or securing of a fuse or fuses at the firing area. Aim to complete work of this type well before spectators arrive. When fusing is in progress, limit access to the firing area to the display operator and those carrying out the fusing. Keep any members of the public at a

safe distance. Carry out fusing in daylight or, failing this, under suitable artificial lighting.

Manipulation of fusing presents a potential for accidental ignition. The following safety points are particularly important.

- Cut fusing by a method which does not cause sparks, eg using a sharp pair of clippers or scissors with cutting edges made of a non-sparking material, or a sharp knife on a cutting surface of non-sparking material. You are advised to contact the manufacturer or supplier of the fuse for guidance on the recommended method of cutting any specific products.
- Never tear fusing apart or use a blunt instrument or saw to cut it.
- Never expose electric igniters to sources of friction such as rough insertion into, or removal from, blackmatch.
- Make all joins so that they leave no exposed composition and are strong enough to withstand the stresses they will experience. Tape all joints if necessary.
- Hold the fuse in position by a method which will neither generate sparks while the fuse is being secured, nor damage it in any way. Plastic ties or adhesive tape are recommended. Do not staple fusing directly into place using staple guns or similar devices. Staple guns should only be used to fix cable ties or similar which are then used to secure the fusing.
- When joining different types of fuses, do not bring incompatible materials in contact with each other, eg sulphur and chlorates.
- Fuseheads may be easily ignited by friction, crushing or cutting and should be handled with care.
- Try to work at arms-length and with no part of your body over the muzzle of the firework being fused, loaded or modified

The above guidance relates only to the fusing of fireworks before use. The dismantling of fused fireworks or firework assemblies is a more complex undertaking requiring careful selection of procedures and may require special facilities.

When many fireworks are grouped or fused together, the potential for accidental ignition is greatly increased. Ensure boxes of firework sequences are not left open. Put fusing in a safe place and cover it to minimise the risk of accidental ignition from stray sparks etc. Keep the number of fireworks being worked on to a minimum, and keep the remainder covered or in closed boxes.

It is not considered good practice to lay out numerous shells onto the tops of mortar tubes before loading. A well planned and numbered

mortar layout should allow each shell to be loaded individually as it is removed from the carton it was transported in.

The use of fireworks supports

The use of tubes is not a preferred method of support and, in any case, may only be suitable for static fireworks such as roman candles, fountains, mines and shot tubes.

For other category 4 fireworks, the use of support tubes is not necessary – there are a variety of better, alternative methods of support. However, if support tubes must be used, please take the following simple precautions:

- Do not use metal tubes. Consider using only plastic/fibreglass tubes which, should the firework explode unexpectedly, will not shed high-energy fragments. Ideally, choose tubing which is made of non-brittle plastic and designed to withstand internal pressure, for example pipe made for water or gas supplies, from high density polyethylene (HDPE).
- Do use a tube with a diameter which will provide the required support to the firework without holding it too snugly. A snug tube may damage the firework when it is inserted and also increase the severity of a misfire.
- Where any support tube is attached to a stake or frame, attach it on the side away from the spectators. In this way, should an explosion occur, the effects will tend to be projected away from the spectators.
- Always remember to position fireworks as far as possible from spectators and at least the manufacturer's recommended minimum distance. Where specific safety distances are not provided, you should refer to information on the minimum recommended safety distances, and apply your specialist knowledge
- In any event, your arrangements for fastening, supporting and locating the fireworks should be justified in your risk assessment.

Maroon rockets

Avoid firing maroon rockets from a rocket cone or firing box. Cones may be used for other types of rockets provided their heads are clear of the cone. The use of rockets in professional firework displays is discouraged due to the undesirable flight path of the fallout – the rocket stick – which generally tracks into the prevailing wind, ie often towards the audience.

Shells

Use shells with the utmost care. Ensure you are familiar with the type of shell you are using and ensure you have read and understood the warnings and instructions supplied with the shell and mortar tube.



The main problems with firing a shell from a mortar tube arise where the shell is not projected correctly because the mortar tube has toppled over;

- bursts at a low height. This can happen when an incorrect mortar tube diameter or length is used, or when the shell is not lowered to the bottom of the mortar tube;
- bursts in the mortar tube due to malfunction. This may cause the mortar tube to burst and project fragments, and adjacent mortar tubes may be disrupted (commonly known as a shell in-tube "detonation");
- bursts at the mouth of the mortar tube on ejection. In this case it is likely the mortar tube is not fragmented, but stars and shell debris will be scattered around the immediate area;
- ignites prematurely where the fuse was not ignited at its tip.

You are strongly advised to remember the following basic rules when using mortar tubes.

- Ensure mortar tubes are of the correct diameter and length for the shell;
- Do not use undue force when inserting a shell into a mortar tube. The mortar tube dimensions and condition should allow the shell to be lowered smoothly to rest on the bottom of the mortar tube;
- Mortar tubes must not be free-standing;
- Preferably avoid firing maroons from racked mortar tubes;
- When mortar tubes are racked together, support them with a firmly fixed sturdy frame, eg by wooden stakes, so they cannot topple over;
- Bury or sandbag single mortar tubes deep enough to prevent them toppling over, and inclined away from spectators. Take precautions to ensure a misfire in one mortar tube will not disrupt other mortar tubes;
- Do not fire single shot maroons from metal mortar tubes.

- Ensure mortar tubes are strong and durable enough for the shells. When deciding whether the mortar tube material should be cardboard, plastic, fibreglass or metal, think about using a material that would not fragment or produce hazardous debris if a shell malfunctioned in the mortar tube. If a mortar tube is made of material which could produce hazardous debris, sandbag or barricade it.
- Use enough sandbags or barricading to ensure firers and spectators would be protected if a shell malfunctioned in the mortar tube. Research suggests that you may get better protection from hazard debris if sandbags or protective barricades are in contact with the mortar tubes. An air gap between the mortar tubes and the barricade will reduce the effectiveness of the protection;
- Always clean out mortar tubes and check they are reasonably dry before use;
- Ensure mortar tube bungs are held firmly in place and checked before firing each display;
- Avoid reloading mortar tubes wherever possible during a display. Where mortar tubes must be reloaded, group them according to size to help avoid shell/mortar tube mismatches and ensure there is a known procedure in place for the reload operations during a display

In addition to those changes in rigging techniques outlined above, there have also been changes to the rigging methods of firing more traditional firework types. Two examples illustrate the issues involved:-



Roman candle batteries (particularly where the candles are “fanned”) used to almost exclusively be made by wiring the candle tubes to wooden frames, which were then secured to stakes for firing. The demands of modern display design have meant that today, candles are often rigged by inserting the tubes into holders on frames (often fabricated in metal) which have been designed to fire at exactly the desired angle. Furthermore such frames are often designed to interlink to provide a rigid and stable structure for firing.

Mortar construction, and the construction of mortar crates have also changed. The use of modern materials for mortars (eg HDPE, fibreglass or aluminium) has generally overtaken the use of fibreboard or steel. The advantages of the modern materials are in their durability, their strength/weight ratio, and their means of failure (ie not producing steel fragments if a shell bursts in the tube) but there are potential disadvantages too.

Similarly the use of mortar racks, and the means by which they are erected and positioned on site, should be subject to risk assessment by the company. Mortar racks offer significant advantages over the use of individually mortars for the firing of shells, particularly in reducing risks arising from the reloading of mortars during a display.

The BPA has worked with HSE and the insurance industry to assess the risks from a number of mortar and crate designs. Other than types of robust structure surrounding racked mortars, a key part of the research focussed on ways to mitigate the propagation of failure in adjacent mortar tubes when a failure occurred (usually through shell malfunction or tube wear) in a given mortar tube.

The findings concluded that greater separation (air-gap) between tubes was the most practical way to reduce the risk of tube failure propagation, without excessive degradation of functionality in terms of a tube count/physical space ratio (i.e. the physical space taken up by the mortar rack system on the firing site).

The recommended distance between mortar tubes as an output from the research is 0.5 times the diameter of the mortar tubes. So in a rack of 100mm mortar tubes, the recommended spacing between tubes is a minimum of 50mm in all directions.

A presentation showing the research and outcomes of the work can be found on the BPA website:

<https://www.pyro.org.uk/wp-content/uploads/Mortars.pdf>

Companies are advised to evaluate the use of their mortars and crates as they would any other aspect of their display setup, and where possible and practical adopt the tube spacing recommendations. Companies may also have their own methods to mitigate these risks

Electric Igniters

The use of electric firing systems and hence the use of electric igniters has increased significantly over recent years, particularly as display design has changed and there is increasing use of "single shot" fireworks.

Electric igniters are, by their nature, sensitive to a number of stimuli and should be handled with great care, especially when fitting to fireworks on a display site, or when derigging after the display.

Most accidental ignitions of igniters are due to

- Friction or impact
- Electrostatics

Recent studies have illustrated that there is a wide range of sensitivities and that sensitivity to one stimulus (eg impact shearing) is no indicator of sensitivity to another stimulus (eg static electricity).

Care should always be taken when fitting igniters to fireworks, and in particular:-

- To minimise the potential for accidental ignition by friction, impact or static electricity
- To minimise the consequences of an accidental ignition

Hazard Types

Hazard type defines and describes the nature of the hazard arising from an explosive in manufacture, storage or even use conditions. It is important to understand the hazards presented by fireworks on a display site may not be the same as they are in the form in which they are transported. Hazard Type determination is potentially a complex issue. The definition implies that the Hazard Type posed by a particular explosive may be dependent on a wide variety of factors such as:-

- The quantity of the explosives (if there is a hazard transition due to quantity – eg the depth of pyrotechnic composition in a drier potentially leading to self-confinement and a transition from a parallel to propagative type burning.
- The form of the explosive – is it as a substance or an article? Is it loose or compacted composition?
- The area around the explosive – does it accelerate or reduce the possibility of communication to other explosives nearby
- The nature of the building
- The orientation of the explosives within a building
- The orientation of the building
- Etc

Hence a more wordy, but more accurate, definition of Hazard Type might be:-

Hazard Type – the nature of the explosive hazard of an area or building containing explosives which may be related to the nature of the explosive(s) present, their surroundings, their nature, their orientation etc.

HDs vs HTs

There is an obvious similarity between the Hazard Types (HTs) adopted by HSE for manufacture and storage and the Hazard Divisions (HDs) determined by the classification process. However it must be remembered that classification (determination of Hazard Division) is only:

The determination of the hazard of the explosives as presented for transport

“as presented for transport” is critical – this is the driver for UN classification and is hazard in general not an inherent function of the explosives.

For instance, and hypothetically, 75mm aerial maroons (fireworks or signalling devices) could present the following hazards

- 1.1G – mass explosion hazard – if enough are packed into a strong walled box
- 1.2G – fragment hazard – if a number are packed in a metal box (where it is the metal fragments from the box which create the hazard)
- 1.3G – fiery projection hazard – where the functioning of one maroon throws a second maroon past the 15m witness screens in the UN series 6c tests and thereafter the 2nd maroon functions
- 1.4G – relatively low hazard – where a single maroon is packed in a fibreboard box and on functioning no communication to other boxes, nor significant fragment throw occurs
- 1.4S – low hazard – where a single maroon is in an over-engineered and large box – such that the functioning of the maroon is not observed outside the box!

In the same manner explosives do not possess an inherent Hazard Type – the Hazard Type may depend on a variety of factors – and the purpose of this guide is to highlight those factors and to provide pointers to assessing what effect they have on the hazard.

The use of HDs for non-transport situations (including suitability for sale and for COMAH) is entirely erroneous and confusing. In part, of course, this is why the use of Hazard Types is much more logical and scientific – but the confusion still exists in the minds of users and enforcers alike.

Firing from Unusual sites

Barges

The important additional things to consider when rigging and firing displays from a barge include:-

- The layout of fireworks on the barge and the physical dimensions of the barge
- The stability of the barge
- The means of rigging the fireworks and supporting, for instance, the mortar crates (if used)
- Escape routes
- Firing position (if on the barge)
- How the barge is to be positioned (eg held by a tug or anchored/moored)
- Prevention from falling from the barge and appropriate safety devices, e.g. life jackets



Rooftops and other structures

Rooftops pose similar issues to barges, and in addition:-

- How will the fireworks be transported to the site
- The position of adjacent structures
- The position of people at ground level
- The quantity and types of fallout and debris
- Increased fallout areas
- The effect of local wind around the structure
- Firework effects being blown back onto the structure itself
- Adherence to "normal" safety distances
- The technicality of the rigging and specialist skills or equipment required e.g. harnesses, hard hats, guard rails

Firing the display

Protective clothing and equipment

Firers who will be in close proximity to the firing site during the display are advised to wear substantial outer clothing made of wool or some fire retardant material such as probanised cotton. They are also recommended to wear gloves, safety goggles, safety helmets and substantial closed footwear made of leather or similar material.

Firers are advised to wear ear protectors or other suitable hearing protection. Where the firers are at work, the Control of Noise at Work Regulations 2005 will apply. This means display operators have to assess the exposures of employees and themselves to noise during firing, and where necessary take adequate measures to protect their hearing from damage.

For electric firing, it is recommended to site the firing point far enough away from the fireworks for noise and fire exposure to be below the action levels given in the Regulations. In this case ensure that firers monitoring the firing from the firing site retire to an agreed position whenever firing is in progress, that allows them to carry out observations from a practical distance. Communication between the staff at the electrical firing desk and the firing crew on the firing site is essential throughout the display, by way of 2-way radios or similar means.

Firing procedures

It is important that the activities of the firing team are co-ordinated to ensure that everyone is in a safe position whenever fireworks are about to go off. Firers should be at least ten metres away from ground maroons.

We do not recommend the reloading of any shells or other fireworks during the display.

Take any mortar tube showing signs of distortion, heavy corrosion or damage out of use immediately.

Misfires

Leave a firework which fails to ignite for at least 30 minutes. In most cases, it will then be best to immerse it in a bucket of water. Never position any part of the body over a misfired firework. In the particular case of a shell in a mortar tube, never look down the mortar tube and do not pull a shell out of the mortar tube by its fuse. Leave the shell in the mortar tube for at least 30 minutes before proceeding as follows.

- Cut off any fuse which is hanging outside the mortar tube by the method described below to prevent any possibility of 'hang fire' reigniting the fuse;
- Prepare for tipping the mortar tube over by removing any sandbags or earth (in the case of a buried mortar), or

releasing the mortar tube frame from its fixings. Take particular care to ensure no part of the body is over the mouth of the mortar tube during this operation;

- Where practical, tip the shell out of the mortar directly into a bucket of water. If this is not practical, flush the mortar tube containing the shell with water before tipping the shell gently onto the ground. In both cases, ensure the mortar tube is pointing away from the body during tipping.

Long duration effects

One of the particular issues which must be addressed is the way that long duration effects such as:-

- Willow
- Kamuro
- Strobes
- Glitter

are affected by wind and whether, in particular the way that they are fired means that the effects will still be burning when they reach the ground.

In some cases, of course, this can be both aesthetically pleasing (eg over water) and present a very low risk, but a risk assessment should consider whether the use of such effects is appropriate and in particular, where, for instance, a 100mm Kamuro shell fired vertically bursts at 100m and drops its stars 80m (ie 20 m above the ground), that when it is fired at an angle whether the lower apogee will mean that the stars reach the ground still alight.



Smoke issues

Following an incident in thick fog on the M5 motorway in the UK where several people were killed and there was a suspicion that a local firework display could have contributed, the Coroner made the following judgements and observations:-

- Smoke from the display was not found to be the cause of the incident “but the Coroner could not rule out it contributed”
- At the time there was no data on interaction of pyrotechnic smoke and fog
- There was no previous experience through Europe of situations where smoke from a display has caused an increase in fog density or had contributed to an accident

The investigations of the incident concluded that there was potential for firework smoke to cause a problem in particular:-

- When there were damp still nights
- Particularly in valleys and near rivers
- Where there was a temperature inversion (ie cold damp air with warmer humid air above it)

Of course, different fireworks produce different amounts of smoke at different levels in the sky and as a result it is important to consider the following when planning a display that may affect a local road or other transport infrastructure:-

- The venue – is it prone to fog?
- Local knowledge of the likely wind conditions and likelihood of fog
- The time of year – the issue typically only arises in Autumn and Winter

It is important, therefore that there should be sensible curtailment or cancellation criteria defined BEFORE THE SHOW (and in agreement with the event organisers) and means of communication between “spotters” and the firework team to curtail or stop the display if smoke is observed drifting towards a local road which is not able to be controlled and traffic stopped (eg a motorway).

Clearing up after the display

The cleanup of display sites, and disposal of any waste materials, is a concern to event organisers and display companies alike. However, it is difficult if not impossible for a display company to completely clean a site in the dark after a display. Proper co-operation between the event organiser, the venue and the display company and clear demarcation of responsibilities at an early stage in the planning of an event can avoid any misunderstandings later!

The following procedures are recommended as a practical arrangement for co-ordinating the work of the organisers and display operators in clearing up the display site, but are not intended to define all responsibilities.

Organisers should:

- keep the firing, safety and fall-out areas free of spectators until the display operator has had time to clear up, and locate and retrieve fireworks that may have misfired;
- arrange for the whole site, apart from the firing area, to be carefully checked for partly spent fireworks and other hazardous remains, and inform the display operator of any problems;
- arrange for at least one organiser to return to the site at first light to make sure that it is clear of partly spent fireworks and other hazardous remains. If hazardous material is found, contact the display operator for advice on its disposal;
- ensure the bonfire is completely extinguished and keep spectators out of the bonfire area until this has been done.

Display operators:

- are responsible for clearing up the firing area and leaving it in a safe condition on the day of the display;
- destroy misfires and partly spent fireworks at the display site wherever possible, and come prepared to carry out their destruction in accordance with the recommendations contained in Disposal of explosives waste. It may be necessary to enlist the help of the organisers to keep everybody at a safe distance while destroying fireworks. It is advisable to discuss this with the organisers before the display. Do not transport partly spent fireworks or misfires away from the site on public roads, unless you are satisfied that you can do so in accordance with legal requirements (see Part 4);
- advise the organisers on how to deal with partly spent fireworks or misfires which may be found after the display operator has left the site.



Part 4 - Other information

Legal issues

General advice on the application of health and safety legislation and responsibilities is given below and cover some requirements of other sections of the HSW Act and other health and safety legislation which is of particular relevance to firework displays, and should be read by organisers and display operators.

- Health and Safety at Work Act 1974 (HSWA) - The over-arching legal instrument for all at work activities in the UK
- Explosive Regulations 2014 (ER2014) - The fundamental regulations covering the manufacture, storage and licencing of explosives in the UK
- Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2009 (CDGUTPER) as amended - Regulations, adopting UN and European agreements regarding the transport of dangerous goods (including fireworks) into UK law

Although only the courts can give an authoritative interpretation of law, in considering the application of this guidance to people working under another's direction, the following should be considered.



If people working under the direction and control of others are treated as self employed for tax and national insurance purposes, they are nevertheless treated as employees for health and safety purposes. It may therefore be necessary to take appropriate action to protect them. If any doubt exists about who is responsible for the health and safety of a worker, this could be clarified and included in the terms of a contract. However, remember that a legal duty under section 3 of the HSW Act cannot be passed on by means of a contract, and there will still be duties towards others under section 3

of the HSW Act. If such workers are employed on the basis that they are responsible for their own health and safety, legal advice should be sought before doing so.

The two requirements detailed below, coupled with the requirement for a risk assessment explained in Appendix 2, are closely related and can be considered together:

- Section 2.2(a) of the HSW Act requires employers to provide and maintain plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health.
- Section 3 of the HSW Act requires employers to conduct their undertakings in such a way that, so far as is reasonably practicable, people who are not employees are not exposed to health and safety risks. It also imposes a similar duty on the self-employed towards themselves and other people.

Where any event involves a work activity, the person who is providing the premises for the event may also have duties under section 4 of the HSW Act in relation to people other than their employees.

The Explosives Regulations 2014 require that the manufacture of fireworks (which includes dismantling them) shall only take place in a licensed factory. The Regulations allow the preparation, assembly, disassembly and fusing of firework displays at the place of intended use without a factory license. The Regulations also allow the preparation, assembly and fusing of fireworks, in quantities of no more than 10 kilograms at a time, at a site in relation to which a person holds a licence or registration for the storage of explosives, for the purposes of a firework display to be put on by that person. The destruction of fireworks in a safe manner does not require a factory licence.

Under the Explosives Regulations 2014, an unlimited quantity of hazard type 3 and 4 fireworks may be kept for up to 24 hours without licensing or registering the place of storage. Specified amounts may be held for longer periods without licensing or registration as shown in the table below.

Table 6 Amounts of fireworks which may be kept without licensing

Type of fireworks	Maximum amount (kg)	Maximum storage period (days)	Condition
Hazard type 3	100	3	In place of intended use
Hazard type 4	250	3	In place of intended use
Hazard type 4	50	21	Not for sale or use at work

The above list of health and safety legislation is far from exhaustive. People who are responsible for health and safety at the display and those who are providing premises are recommended to consult the local authority enforcement officer for advice if they are in any doubt as to the application of health and safety legislation.

Information on legislation, other than health and safety legislation, which may apply to firework displays is given in below.

The requirements are not requirements under health and safety legislation.

The information which follows has been supplied by representatives of organisations responsible for enforcement and is only a brief guide to some of the main provisions other than health and safety legislation which firework display organisers will need to consider. The appropriate organisation will be able to advise on how these and other related provisions apply to an individual case.

Entertainments licensing and statutory controls on noise nuisance

England and Wales

The public entertainments provisions of the Local Government (Miscellaneous Provisions) Act 1982 allow local authorities to control events such as pop festivals and open-air entertainments of which music forms a substantial part.

Public entertainment licensing is carried out by the district or metropolitan council. Enquiries must be made at least 28 days before the event in order to comply with the notification procedures. To allow public entertainment to be carried out without a licence is an offence which can carry severe penalties.

In licensing events, the enforcing authority can impose conditions for securing the safety of performers and anyone else present at the entertainment, and for preventing people in the neighbourhood from being unreasonably disturbed by noise. It will be a condition of the licence that any recommendations made to the enforcing authority by the police and fire brigade are complied with.

If the local authority has adopted the Private Places of Entertainment (Licensing) Act 1967, similar conditions may be imposed on similar types of entertainment held on private premises, including those in the open air. This is to cover private clubs etc where admission is restricted to members (ie the general public are not admitted). The licensing function is dealt with in exactly the same way as above, but extends the controls to private entertainment provided for private gain.

Displays which are not subject to licensing under the above legislation will still be subject to legislation relating to noise nuisance, enforced by the environmental health department of the district or metropolitan council.

Scotland

Public entertainments licensing is carried out by the district or regional council.

Where a firework display involves the use of premises as a place of public entertainment, some councils will require an application to be made for a Public Entertainment Licence under section 41 of the Civic Government (Scotland) Act 1982 and, as a condition of licence, may require the organisers to consult with the local fire authority and the police. In the Act, the term 'place of public entertainment' is defined (subject to certain exclusions) as any place where, on payment of money or goods to the same value, members of the public are admitted or may use any facilities for the purposes of entertainment or recreation.

Some councils require charitable organisations which hold public firework displays to seek permission for the display irrespective of whether an entrance fee is to be levied or not.

Comments on noise nuisance are as for England and above.

Firework displays near aerodromes

The Civil Aviation Authority has issued detailed guidance on the operation of lasers, searchlight and fireworks in UK Airspace (CAP 736). This document can be downloaded from the CAA website (www.caa.co.uk) or obtained using the contact details given below.

International Standards

Occasionally display organisers may suggest that Standards developed outside the UK would be appropriate for UK displays. We do not believe that in general such Standards provide a safe system of working subject to the fundamental Risk Assessment approach adopted in the UK.

Comparison of current Standards

Most Standards (USA, Canada, France, Germany, Australia) have adopted so-called “fixed rule” Standards where the minimum safety distances are predominantly a function of the calibre of the firework being fired.

In general such “fixed rule” systems pay little or no attention to critically important factors such as

- Wind speed and direction
- Firing angles
- Firework types, their fallout and potential debris

ElG does not recommend or endorse the use of any such Standards which do not adequately relate to the risks.

ISO Standards

A series of ISO Standards for professionally organised firework displays are currently under development. The UK had lodged objections to these Standards and does not recognise them – indeed the UK believes that if adopted they would negatively impact on display safety in the UK.

Training

In addition to BPA training there are additional relevant training courses which might be of interest.

- Pyrotechnic chemistry – an introductory course
- Risk Assessment for Fireworks Displays
- ShellCalc and the family of related tools

These courses have been developed and delivered by CarnDu limited.

Myths

We are aware of the following myths circulating within the event industry, enforcing authorities and display companies, and hope the following will assist readers.

Table 7- Myths

Myth	Comments
A formal qualification is required before a storage licence would be issued by a local authority	There is NO requirement for such a qualification and we do not believe any such qualification exists. The BPA courses specifically address the setting up and firing of firework displays. However importers and wholesalers have a duty of care to ensure they supply F4 fireworks only to persons with suitable licenced storage and who have some recognised level of specialist knowledge.
The level of qualification would be higher for a licence than for a registered premises	See above – there is NO requirement for such a qualification. The BPA currently has two levels of award “Senior Firer” and “Firer” but these relate explicitly to display practices. In addition after 2014 all local authority sites are effectively “licenced” rather than registered – the old “registered premises” (Mode A and B) are no longer relevant
Before issuing a licence Local Authorities check to see that there was adequate insurance and that all risk assessments had been done and that they should be checked on every visit	There is no requirement for insurance to be established before issuing a licence. Of course, general Health and Safety provisions may require formal written Risk Assessments to be carried out but these are not a pre requisite for granting a licence
All display fireworks were Category 4 (the most hazardous) and therefore should be considered as HT1 (the most hazardous)	This fundamentally confuses suitability for supply (Category) with classification for transport (HD) and in storage or manufacture (HT)
That the public are not able to purchase Category 3 fireworks	This is simply not true. The public may purchase Category 1, 2 and 3 fireworks without needing to demonstrate their status as a “Person with Specialist Knowledge” – the criterion for supply of Category 4 fireworks
That Category F4 fireworks have no fuses	Category 4 fireworks are intended for “professional” use and may or may not be fitted with fuses depending on their intended use. They may also be modified by display companies prior to transport to site, or on site (eg by combining fuses or fitting an electric igniter)
That the Hazard Type posed by fireworks relates to their suitability for sale to the public and intended use (eg Garden, display or professional)	There is no correlation between suitability for supply and hazard posed in transport (HD) or storage and manufacture (HT)

Myth	Comments
That all display fireworks are classified 1.3G and all consumer fireworks are classified 1.4G	This is again confusing suitability for supply and hazard posed in transport. The classification of display fireworks (like all explosives) is fundamentally related to their packaging "as presented for transport") and may be 1.1G – UN 0333 1.2G – UN 0334 1.3G – UN 0335 1.4G – UN 0336 1.4S – UN 0337 Depending on the nature of their fireworks and the way they are packed
That professional displays do not use Category 1, 2 or 3 fireworks but only category 4	A display company may use the whole range of fireworks (and other pyrotechnic devices) depending on the event and site. In some cases the fireworks may be modified on site prior to use (by fitting a fuse for example) but this is considered a process "in use"
All professional firework display companies must operate out of premises falling under the "Control of Major Accident Hazard" Regulations (COMAH)	The nature of the legal instruments required for a display company operation is dependent on the scale of the company (ie how much explosives is stored) and the way it operates. There is no requirement for professional display companies to be COMAH sites, or indeed to be licenced by HSE.
All professional display companies will hold a manufacturing licence from HSE	Display companies may operate under the so-called "Firework fusing exemption" which allows limited operations at a local authority licenced site but does not remove the need to all fireworks to be properly classified before transport. In addition it is possible for all rigging and fusing to be done legitimately at the display site without any form of licence as they are at the point of use.
All fireworks must comply with BS 7114	BS 7114 is an obsolete standard and has been replaced by the following European Standards:- Category F1/F2/F3 fireworks – EN 15947 Category 4 fireworks – EN 16261 Theatrical pyrotechnic articles – EN 16256
All fireworks should bear the UK "Kite mark"	There has never been a requirement for UK fireworks to bear a kite mark – indeed placing an erroneous "kite mark" on fireworks would have been illegal. Fireworks put on sale to the UK market may begin to show the UKCA mark following the UK withdrawal from the EU.

Myth	Comments
Local authority storage licences are only available for fireworks	Local authorities can licence stores for any explosives and it is very important that where other explosives are kept (for instance theatrical items) these are explicitly referenced on the licence, or that the licence refers only to the Hazard Types of explosives to be kept
Local Authorities can only grant licences for stores in the run-up to November 5th	This is not the case – indeed it is a reasonable expectation that an application at any time of the year should be processed promptly and efficiently
Local Authorities are not able to grant any explosive licence – this must be done by HSE	This is incorrect. ER2014 allows (and in fact demands) that Local Authorities is the proper place to apply for licences for appropriate sites within certain “fixed rule” parameters

General Legislation

Table 8- Links to general legislation

Information	Summary	Reference
Firework (Safety) Regulations 1997 SI 1997/2294		ISBN 0 11 064962 1
Firework (Safety) (Amendment) Regulations 2004 SI 2004/1372		ISBN 0 11 049315 X
Managing crowds safely: A guide for organisers at events and venues HSG154		ISBN 0 7176 1834 X
Management of Health and Safety at Work Regulations 1999 SI 1999/3242		ISBN 0 11 085625 2
The Dangerous Substances in Harbour Areas Regulations 1987 SI 1987/37		ISBN 0 11 076037 9
Civil Aviation Authority CAP 736	Guide for the Operation of Lasers, Searchlights and Fireworks in United Kingdom Airspace Version 1	ISBN 0 8603 9956 7
Control of Noise at Work Regulations 2005 SI 2005/1643		ISBN 0 11 072984 6
Five steps to risk assessment Leaflet INDG163(rev2)		www.hse.gov.uk/pubns/indg163.pdf ISBN 0 7176 6189 X
Private Places of Entertainment (Licensing) Act 1967 C19		
Local Government (Miscellaneous Provisions) Act 1982 C10		
Civic Government (Scotland) Act 1982 C45		

Bibliography

Table 9- Bibliography

Information	Summary	Link
Explosive Entertainment: Getting the most from your firework display	Book by Dr Tom Smith for organisers and practitioners of firework displays	http://www.fd-ee.com
The "Purple" Guide	"The Purple Guide has been written by The Events Industry Forum in consultation with the events industry. Its aim is to help those event organisers who are dutyholders to manage health and safety, particularly at large-scale music and similar events. The Health and Safety Executive was consulted in the production of the workplace health and safety parts of this publication.	https://www.thepurpleguide.co.uk/

Other useful links

Table 10- Other useful links

Information	Summary	Link
Pyroworkshops	A variety of courses tailored for the professional display industry in the UK	www.pyroworkshops.com
ShellCalc ©	Trajectory and fallout modelling tool	www.shellcalc.co.uk
Health and Safety Executive Explosives section	Links to current legislation and other guides	www.hse.gov.uk/explosives

Contact Information

The following contacts may be useful:-

The Confederation of British Industry, Explosives Industry Group (CBI/EIG)

Cannon Place
78 Cannon Street
London
EC4N 6HN

Tel: 020 7395 8063
www.cbi.org.uk

The British Pyrotechnists Association (BPA)

8 Aragon Place, Kimbolton, Huntingdon, Cambridgeshire PE28 0JD

Tel: 01480 878621
www.pyro.org.uk

The Health & Safety Executive – Explosives Inspectorate

Health and Safety Executive
Redgrave Court
Merton Road
Bootle
Merseyside
L20 7HS

Tel: 0151 951 4000
www.hse.gov.uk

While every effort has been made to ensure the accuracy of the references listed in this publication, their future availability cannot be guaranteed.



EIG also publishes "Giving Your Own Firework Display: How to run and fire it safely" which is intended for events where the fireworks are rigged and fired by amateur organisations.

