CODE OF PRACTICE

Safe use of outdoor fireworks in Western Australia

Government of **Western Australia**
Department of **Mines and Petroleum**
Resources Safety

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Foreword

The Act

A key focus of the *Dangerous Goods Safety Act 2004* (the Act) is the duty to minimise risk from dangerous goods. This duty not only applies to employers and employees but to all persons, including members of the public. This duty is placed on everyone involved with dangerous goods, and goes beyond the workplace duties of the *Occupational Safety and Health Act 1984*. Public safety is one of the most important features of the Act.

Regulations

The Act is supported by the Dangerous Goods Safety (Explosives) Regulations 2007 (the Explosives Regulations). It is essential to understand and comply with this legislation and adopt a risk management approach using all relevant codes and standards.

The Explosives Regulations are enforceable, and breaches may result in licence suspension, prosecution or directions to cease operations and undertake remedial action.

Codes of practice

Approved and mandatory codes of practice provide safety recommendations to assist people in meeting their obligations under the Act and regulations. The codes are approved and gazetted by the Minister under section 20 of the Act, and may be used as a defence in law (s. 62 of the Act). Although compliance with an approved code is not mandatory, it is expected that deviations from recommended practice will be justified and it can be demonstrated that the use of alternative risk control measures provides an equivalent or lower level of risk. The codes are not intended to prevent innovative safety practice or use of equipment that improves safety performance.

Contents

1 Introduction

The management of fireworks in Western Australia is regulated under the *Dangerous Goods Safety Act 2004* (the Act) and Dangerous Goods Safety (Explosives) Regulations 2007 (the Explosives Regulations).

This code of practice covers the safe use of outdoor fireworks.

It does not apply to:

- theatrical fireworks
- ceremonial cracker chains
- parachuting with pyrotechnics
- model rockets
- use of pyrotechnics for non-recreational purposes (e.g. scientific demonstrations, distress flares)
- unrestricted fireworks (e.g. party poppers).

The code does not cover the safe use of:

- blasting explosives, detonators and detonating cord
- loose black and flash powders.

Note: A fireworks contractor or fireworks operator licence is not an authority to possess or use loose black or flash powders for special effects.

2 Fireworks equipment

2.1 Safety considerations

Equipment

The suppliers, designers, fabricators, owners and operators of fireworks event equipment are responsible for ensuring that it is properly designed, fabricated, maintained and used to minimise harm to people, including operators and their assistants.

Equipment must be:

- used in accordance with the manufacturer's instructions
- safe and suitable for use with specified fireworks (taking into account the effect of a catastrophic malfunction of the fireworks)
- accompanied by manuals for its use and maintenance, including details of the types of fireworks that can be used with the equipment and the equipment's service life
- properly identified, including the identity of the fabricator.

The documentation must be updated if information later becomes available regarding the safety of the equipment.

Unnecessary confinement

Fireworks must not be unnecessarily confined at any time as this can significantly alter the firing stresses, leading to a catastrophic failure of the firework or equipment. A firework is subject to unnecessary confinement when:

- more than 25 per cent of the sides (excluding the top and base) of the firework are enclosed by equipment not required for its functioning
- there is a clearance of less than 25 mm between the firework article and other equipment.

2.2 Materials used

Acceptable materials

Equipment associated with a fireworks event (e.g. mortar tubes, racks, stakes, pickets, stands) must be designed and manufactured from materials that do not fragment or splinter, such as:

- paper wound tubes (cardboard)
- non-brittle plastic, high density polyethylene (HDPE), fibre-reinforced plastic, glass-reinforced plastic or fibreglass
- timber supports.

Unacceptable materials

Do not use any material that is prone to brittleness and that can fragment in an explosion. For example, bamboo, ceramic and concrete must not be used, nor should clay or timber, other than in plugs.

Polyvinyl chloride (PVC) equipment is prohibited because it is brittle and can fragment unacceptably during abnormal functioning of fireworks.

Metal must not be used for mortars, other than as exempted below.

Metal

The use of metal fireworks equipment is restricted because it can produce lethal fragments when subjected to an explosion.

Mortar tubes up to 300 mm in diameter must not be made of metal as they present a serious fragmentation hazard. If safe materials for mortars over 300 mm in diameter cannot be readily obtained, then such mortars may be made of metal provided they:

- are at least three-quarters buried (e.g. mortar tube buried in sand-filled skip-bins)
- are positioned on a firm base and located no closer than a distance determined by the diameter of the largest shell to be used, with a minimum distance of 400 metres to spectators
- have been being previously tested for metal fatigue by non-destructive testing
- have been approved by the Chief Officer.

Metal may be used if it has been established that it will not present an unacceptable risk when a firework functions. The contractor and operator must have completed a risk assessment for the use of metal equipment. The equipment owner must retain all necessary documentation to demonstrate the safety and suitability of the metal fireworks equipment for its intended application. Such applications may include:

- round steel rods with a diameter from 10 to 20 mm for securing fireworks or fireworks equipment
- round metal rods used to secure non-metallic items
- steel posts and pickets used to support a set piece
- nails, screws, staples, pegs, wire or strapping used to secure non-metallic items such as mortars, tubes, base plugs, racks and firing lines
- metal pegs used to secure mortar racks and frames.

Where the sides of a trailer for holding fireworks items are constructed of wood or other non-metallic material, the frame of the sides may be made from metal such as mild steel. However, trailers with metal sides are subject to the following conditions

- the trailer must be lined with plywood at least 12 mm thick such that no internal ferrous material is exposed
- all fireworks must be secured in relation to each other, and in relation to the trailer.

Salutes must not be fired from metal trailers.

2.3 Mortars and racks

Design of mortars

The fabricator of mortars and any associated equipment is responsible for ensuring they are properly designed and tested.

Cardboard mortars must not exceed 200 mm in diameter and must be used in accordance with the manufacturer's directions.

Design of racks

Racks must be designed and constructed so the risk of harm to people and property is minimised if there is a catastrophic malfunction in a mortar tube. Any malfunction must not adversely affect:

- the orientation, location or performance of adjacent mortars
- the performance of adjacent fireworks within the rack.

The overall integrity of the rack must be preserved.

Condition of mortar tubes

Mortar tubes must only be used in accordance with manufacturer's recommendations and stated design, testing and performance criteria. Their age and serviceability must be readily identifiable.

2.4 Electrical firing units and firing cables

A competent person must undertake the design, construction and certification of electrical firing units. Electrical firing units and accompanying junctions must be manufactured specifically for use in the electrical ignition of fireworks or other pyrotechnic devices.

An electrical firing unit with a built-in circuit tester must:

- limit the test current to 50 mA or 20 per cent of the no-fire current of the electric match being used, whichever is lower
- be powered by battery or isolated power supplies used for firing purposes only
- be capable of providing a minimum electrical current of one ampere (1.0 A) through the maximum load (cable length and number of electric matches) recommended by the manufacturer
- include a key-operated switch or similar two-step device on manual electrical firing units
- incorporate some form of a dead-man's switch on computer-based electrical firing systems so that all firings cease from the moment that the switch is released
- have two switches or require two actions for firing on handheld electrical firing units and be designed so it cannot be fired without first being armed (i.e. one action or switch to arm the unit and another to fire it)
- be labelled or marked to clearly indicate the function of each switch used to apply power for testing or firing
- have protective measures to prevent switches from causing accidental firing
- have a light or other indicator (or both) that signals when the unit is armed and ready to fire
- incorporate a capacitor discharge design for handheld firing units that dissipate the stored charge within 15 seconds of the arming switch being released.

The electrical firing system must be shunted while loading fireworks.

If batteries are used, they must be self-contained in the firing unit or otherwise covered or protected to prevent accidental contact with wires leading to the fireworks.

Multimeters, such as volt-ohm meters, must not be used for testing electric matches unless the maximum current delivery potential has been measured and meets the above requirements.

Electrical firing cables must comply with the requirements of section B7 of appendix B of Australian Standard AS 2187.2 *Explosives – Storage and use – Use of explosives.*

3 Workshop operations

3.1 Workshop location and construction

The preparation of fireworks before delivery to the event site must take place in a dedicated fireworks workshop. The storage of explosives is subject to dangerous goods licensing, and the location of the workshop in relation to explosives magazines and protected works must meet regulatory requirements.

The fireworks workshop must have a concrete floor and be open on at least one side.

Note: Under r. 90 of the Explosives Regulations, a magazine or explosives storage area must not be used as a fireworks workshop, and only fireworks storage activities may take place inside a magazine.

3.2 Workshop operating procedures

Procedures for workshop operations (such as fusing and cutting) are required and may be included in the fireworks contractor's explosives management plan. The following requirements apply to workshop operations:

- either two people are present on-site during handling operations, or one person who regularly reports to other personnel off-site
- personnel must wear non-static clothing (cotton is recommended)
- fireworks must remain in their packaging until required
- any unused fireworks must be returned to their packaging and re-sealed
- damaged fireworks must not be used
- damaged fireworks must be disposed of safely
- the maximum quantity of fireworks permitted in the workshop at any one time is determined using risk assessment principles
- fireworks must not be altered or varied other than as prescribed by the manufacturer
- no more than two people at a time may fuse fireworks
- safety caps protecting fuses must be used when preparing fireworks for manual firing
- only natural lighting may be used in the workshop
- mortars must not be loaded in the workshop
- floors must be kept clean
- extra precautions must be taken during hot, dry conditions to minimise the build-up of static electricity
- appropriate fire-fighting equipment must be located in the workshop
- the doors on nearby explosives magazines must be kept closed when working inside the workshop

Note: Under r. 37 of the Explosives Regulations, activities capable of generating a spark, heat, flame or other means of ignition are prohibited within eight metres of where fireworks are being handled.

3.3 Fusing operations

Electric fusing operations

Electrically initiated fireworks are fused by inserting an electric fusehead into the quickmatch attached to the firework and securing the connection with tape or twine. Care must be taken when fitting and removing electric fuseheads from fireworks as fuseheads can easily ignite, being sensitive to stimuli such as friction, impact, pinching and shearing.

The following precautions apply when handling electric fuseheads:

- do not allow fuseheads to be knocked, crushed or come in direct contact with the ground or metal
- adopt handling methods that keep fuseheads sheathed before, during and after insertion into the quickmatch
- never put a fusehead straight into the lift charge of an aerial shell (i.e. only insert a fusehead into the quickmatch)
- fuseheads may be inserted into the base of the first tube of ground packs
- fusehead wires must always be kept shunted until final hook-up at the display site
- never pull fuseheads out of the quickmatch
- use approved cutters to cut the quickmatch
- where a concealed fuse head exists, expose the fusehead before cutting the quickmatch
- never cut through a fusehead.

Cutting tools, such as scissors, pliers and side-cutters must not be used to cut fuses. Fuses are cut safely using:

- a sharp knife on a wooden or other non-sparking surface
- blade-and-anvil type cutters or similar (where the blade cuts against a flat surface or anvil made from plastic, brass or other non-sparking material).

Minimise the quantity of fireworks being worked on at any one time. Do not store boxes of fireworks in the workshop and regularly remove fused fireworks from the workshop.

If mortars secured by racks are being used, the shells must be fused such that they are fired progressively from the outside to the inside of the array. This reduces the overall consequences if a shell malfunctions in an individual mortar tube.

Repairing fuses

A trained and competent person may perform minor repairs to fuses (e.g. repairing torn paper and fitting replacement electric matches) provided the composition has not been lost and safety is not compromised.

4 Event planning

4.1 Spectator exclusion zone

The spectator exclusion zone is the safety area prescribed by fireworks clearance distances and controlled by the fireworks operator to protect people, property and the environment from functioning fireworks.

The minimum clearance distance is used to establish the exclusion zone around the fireworks at the event and is a combination of the firework with the largest effect and its proximity to people and property.

Fireworks and mortars must be positioned so that any fireworks effects and hazardous debris, including dud shells, fall within the exclusion zone. Fireworks may be angled for aesthetic reasons to produce cross-over or other visual effects but must not cross over or burst above any area occupied by spectators.

4.2 Calculating minimum clearance distances for displays

The minimum clearance distance is critical as it is the basis for minimising risk by ensuring adequate separation distance between fireworks, people, property and the environment before, during and after the event.

Factors to be assessed when calculating the minimum clearance distance include:

- the requirements of this code
- the firework manufacturer's recommended minimum clearance distance to people and property
- known effects and performance of the fireworks and equipment
- wind speed and direction
- use of angled fireworks or presence of sloping land at the set-up area
- falling debris.

The calculation is based on the diameter of those fireworks having the greatest effect on the clearance requirements. For example, for 75 and 100 mm aerial shells to be fired from an area, the calculation would be based on the 100 mm aerial shells closest to the perimeter of the spectator exclusion zone (see Section 4.3). A calculation for the 75 mm shells is not required unless their firing location is known to produce a much wider spread of fireworks or fallout.

The minimum clearance distances for outdoor fireworks are presented in Tables 4.1 and 4.2.

Table 4.1 Minimum clearance distances for ground fireworks, based on zero wind speed and fireworks launched vertically

Ground fireworks	Minimum clearance distance
Lance-work only	15 m
Lance-work incorporating fountains	30 m
Fountains, revolving fountains and flares	30 m
Mine bags, multishot box items, Roman candles, comets, mines	45 m

Table 4.2 Minimum clearance distances for aerial fireworks

Diameter of aerial shell (up to and including)	Minimum clearance distance
75 mm	45 m
100 mm	75 m
125 mm	100 m
150 mm	150 m
200 mm	200 m
250 mm	250 m
300 mm	300 m
Over 300 mm	As required by the Chief Officer

Note: The manufacturer must provide recommended minimum clearance distances for their fireworks. If the manufacturer's recommended minimum clearance distances differ from the above clearance distances, the greater distance applies.

4.3 Preparation site

The contractor and operator are responsible for determining the location where the fireworks will be prepared, which also depends on environmental and regulatory requirements.

Fireworks may be prepared in:

- the set-up area
- a controlled area near the set-up area
- a fireworks workshop before being transported to the set-up area.

Table 4.3 lists minimum distances from preparation sites to other facilities.

4.4 Minimum separation distances to specific facilities

Table 4.4 lists the minimum distance for any fireworks type from the point of launch to vulnerable or sensitive sites, and bulk dangerous goods locations.

Effect of angled fireworks

Where fanned fireworks are supplied, the clearance distances must take into account the angle for the correct calculation of the exclusion zone.

An aerial shell will usually reach a vertical height of 30 metres per 25 mm of shell diameter (100 feet per inch of shell diameter). The tables in Appendix 1 demonstrate the effects of launch angle and wind drift on aerial shells and must be considered in the calculation of clearance distances. Aerial shells can also travel downwind at varying wind speeds. Tables A1.1 to A1.4 are calculated for a dud shell, with the range estimated for the dud returning to ground.

Suitability of exclusion zone

Consider the following factors when assessing the suitability of the exclusion zone:

- vegetation (e.g. trees, shrubs, fuel load) that may present a fire risk or obstruct the identification, location and recovery of dud aerial shells and other fireworks articles
- avoid areas where people and vehicles are likely to congregate (e.g. dwellings, buildings, temporary accommodation and parking areas)
- avoid any overhead structure or part of an overhead object (e.g. branches, power lines wires and buildings) that may be within ten metres of the set-up area at any time, allowing for the effects of wind, which may move obstructions
- locality, size and area of the site, taking into account the type, size and angle of fireworks to be used

Table 4.3 Minimum separation distances between preparation sites and specific facilities

Relationship with site or facility	Minimum separation distance
Preparation site to neighbours	Minimum clearance distance
Preparation workshop to explosive store	30 m

Note: See Section 4.2 for calculation of minimum clearance distance.

Table 4.4 Minimum separation distances to specific facilities for any type of firework

Facility	Minimum separation distance
Vulnerable site (e.g. hospital, aged care, petrol station)	2 x minimum clearance distance
Bulk dangerous goods locations	Whichever is the greater of 250 m or 2 x minimum clearance distance

Note: See Section 4.2 for calculation of minimum clearance distance.

- spectator locations and secured areas
- forecast weather conditions (e.g. wind) that could affect clearance distances
- vulnerable sites adjacent to the exclusion zone
- capacity of the operator and assistants to secure and monitor the exclusion zone.

The contractor and operator should plan for the exclusion zone to significantly exceed the calculated minimum clearance distance in order to minimise risk. Figure 4.1 shows a typical spectator exclusion zone and minimum separation distances to other infrastructure.

The operator must allow for changing wind conditions and the possibility of incorrect assumptions leading up to and during the event.

The number of required personnel within the exclusion zone must be kept to a minimum at all times.

Under certain circumstances, other people involved with the event (such as guests invited to initiate the fireworks) may be permitted within the exclusion zone if a risk assessment has been done and risk control measures implemented.

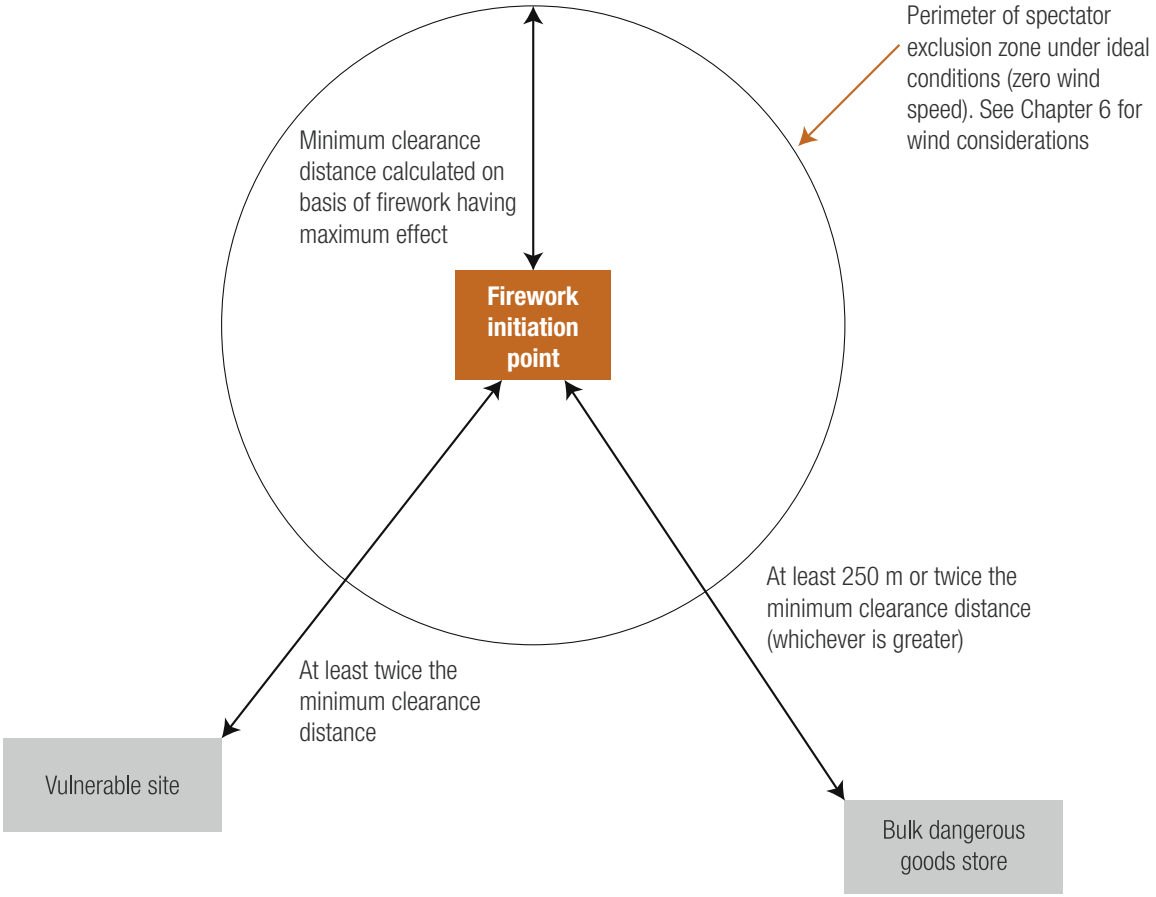

Figure 4.1 Example of set-up area showing minimum clearance distance, spectator exclusion zone and separation distances to facilities

4.4 Event notifications

The minimum requirement for any event is for all neighbours up to 200 metres away to be notified of the event date and time

For established events such as the City of Perth's Australia Day celebrations, the effective advertisement, promotion and publicising by the sponsors is considered suitable notification and individual notification to the neighbouring community may not be necessary.

5 Event management

5.1 General requirements

Planning and preparation

It is a regulatory requirement that operators and assistants are trained and competent in the handling of fireworks.

Trailers, racks of mortars, ground packs, set-pieces and other fireworks prepared at the workshop must be properly positioned, secured and primed for display and the fireworks are positioned in accordance with the event site plan.

Set-up separation distances

The minimum separation distances to the public during set-up activities are listed in Table 5.1.

Demarcation is required to keep the public out of the set-up area.

Sleeping fireworks must not be left unattended.

Rack limits

Mortar rack systems can rock violently when firing. To reduce the possibility of uncontrolled rocking, there is restrictions on the size and number of mortar tubes allowed on a rack. The number of mortars per rack for firing standard aerial shells (i.e. 1.3G and 1.4G classification) is limited according to Table 5.2. Mortars with an internal diameter exceeding 150 mm may not be racked due to increased explosive forces on firing.

Salutes must not be racked. However, one salute may be loaded in a rack if the remaining mortar tubes are left empty.

Mortars for perchlorate-based aerial shells

Table 5.3 lists the minimum separation distances, irrespective of the mortar manufacturer's recommendations, between mortars firing perchlorate-based aerial shells (i.e. 1.1G classification but not salutes). This affects the number of mortar tubes per rack for the firing of perchlorate-based 125 and 150 mm aerial shells such that the maximum number of mortar tubes per rack according to Table 5.2 may not be achievable.

Using Table 5.3, a mortar with an internal diameter of 150 mm would require a minimum separation from an adjacent mortar tube of 37.5 mm (i.e. 0.25 x 150 mm = 37.5 mm).

Mortars for salutes

Mortars for salute shells must be individually supported and separated from other mortars by at least ten times the inside diameter of the mortar.

Table 5.1 Minimum separation distance to the public for any firework type

Set-up distances	Minimum separation distance
While setting up	1/2 minimum clearance distance (determined by the firework requiring the largest clearance distance)
Sleeping	1/3 minimum clearance distance

Note: See Section 4.2 for calculation of minimum clearance distance.

Table 5.2 Rack limits based on mortar size for firing standard shells 1.3G and 1.4G

Internal mortar diameter (up to and including)	Number of mortars per rack (not including salutes and perchlorate shells)
75 mm	12
100 mm	10
125 mm	5
150 mm	5
Over 150 mm	Not allowed

Table 5.3 Minimum mortar separation for perchlorate-based aerial shells

Internal diameter of mortar	Minimum separation
Less than 100 mm	No separation required
101 mm to 150 mm	0.25 x diameter of largest mortar
151 mm to 225 mm	0.5 x diameter of largest mortar
226 mm to 300 mm	2.0 x diameter of largest mortar
Greater than 300 mm	Protection and separation are required

Trailer-mounted rack systems

Mortars no greater than 150 mm in diameter may be fixed to racks mounted on a trailer. The trailer for a rack system:

- must be of sufficient strength and with adequate supports to provide a stable level platform during firing
- must be fitted with an appropriate frame for attachment of the mortar tubes
- if fitted with a top, the top must be removable to permit firing.

Terminology

Figure 5.1 illustrates the terms used to describe grouped mortars and racks of mortars. All mortar tubes in a cluster must have the same diameter, with an internal diameter no greater than 75 mm. No more than nine mortars are permitted in a cluster.

Note: A dense pack is one rack or more surrounded on all four sides by other racks.

5.2 Securing fireworks

Methods

Fireworks and associated equipment must be securely positioned in accordance with the contractor's procedures. Fireworks operators and contractors are responsible for ensuring that appropriate securing methods are used for fireworks so they do not fall over during the event.

When securing fireworks, take into account:

- weather conditions, such as rain, which may reduce the strength of cardboard and render adhesives and fasteners ineffective
- the surface on which the fireworks are being secured, such as soil or sand.

The contractor's explosives management plan must document the methods, procedures, practices, equipment and materials for securing fireworks. The operator must secure fireworks in accordance with this plan. Fireworks equipment must be capable of withstanding large firing forces without being disturbed, dislodged or knocked-over. Using gravity as the sole method of securing fireworks is not acceptable under any circumstances. Fireworks must be checked by a second person for security and stability prior to display.

Where round 10 to 20 mm securing rods are used, the firework device may be attached directly to the round rod without spacers.

Fireworks must not be secured to flat metal (e.g. angle iron, star-picket).

Appendix 2 describes some recommended methods for securing fireworks for different surfaces and applications.

Delay-chain fusing of aerial shells

Additional protection measures should be considered when delay-chain fused aerial shells are fired (e.g. for sequential firing), such as:

- increasing the separation distance between the mortar tubes
- constructing suitable racks.

The stability provided must allow for the effects of sequential firing so that a malfunctioning shell does not damage or realign a neighbouring loaded mortar tube.

To prevent the repositioning of buried mortar tubes, tubes must be separated from each other by at least four times the mortar diameter.

Securing multishot boxed items

Multishot boxed items must only be fired in single or double rows.

Dense packing of multishot boxed items is not permitted.

To prevent deformation of the cardboard tube, do not over tighten wire if used.

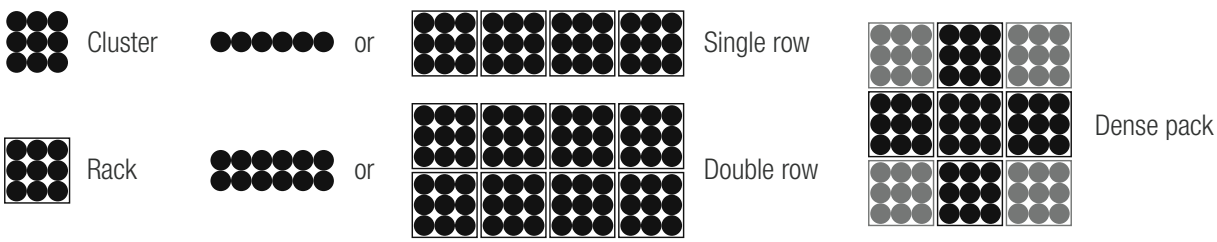

Figure 5.1 Terminology for grouped mortars and racks of mortars

Securing mortars

If the ground at the firing point is not level, operators must check the angle of mortar tubes against vertical. Mortars must be supported, braced or secured regardless of the location so that:

- they remain in position when fired
- are protected or separated from one another
- neighbouring mortars are not damaged or realigned due to a malfunctioning shell exploding in the mortar.

The systems used to support, protect and secure mortars must perform satisfactorily during normal and abnormal functioning of the fireworks to prevent misalignment. These include:

- securing mortar tubes to stakes or posts
- partial burial of mortars in the ground or a sand-filled bin or drum to three-quarters their length with some form of moisture protection (e.g. plastic bag)
- placement of sandbags around mortar tubes to at least three-quarters the length of the tube
- placement of mortar tubes in wooden troughs with internal bulkheads and with sand or other non-shrapnel-producing filling to support the mortars
- placement of mortar tubes behind a robust barrier or wall.

When stakes and posts are used, there must be a minimum vertical clearance of 20 mm between the stake or post and mouth of the mortar. The stake or post must not extend beyond the mouth of the mortar tube.

Star pickets must not be used to secure mortars.

Racks should be secured by attaching stakes or spikes driven into the ground and fastening with additional banding.

Securing clusters of mortars

Each cluster must have an appropriate independent means of support.

Securing multiple racks

Individual racks may be joined into a single group and secured, provided control measures have been adopted such as:

- use of racks of previously approved design and performance
- application of the same requirements as for to individual racks (e.g. clearance distances)
- suitable system for securing racks into a single group
- loading of mortar tubes from the inside to the outside (to avoid reaching across loaded mortars)
- number of mortars per rack does not exceed limits listed in Table 5.2
- shell size does not exceed 150 mm in diameter
- use of no more than 12 racks in any dense pack.

5.3 Loading aerial shells

Methods

The loading or reloading of aerial shells into mortar tubes during a fireworks event is prohibited.

Unless the manufacturer recommends otherwise, an aerial shell must be carried by its body and not the fuse.

Aerial shells must be checked to ensure a smooth, sliding fit into the mortar. Shells that do not fit must be labelled REJECT, put aside and not used, and the supplier notified.

Immediately before an aerial shell is loaded into a mortar tube, the tube must be examined to confirm that no water, debris or other foreign bodies have entered during set-up operations. The shell assembly must be loaded into the mortar tube such that the lifting charge is beneath the shell, and the arrow is pointing upwards while the shell is lowered into the mortar.

While being smoothly lowered into the tube, the aerial shell must be held by its fuse or by the lowering cord, where provided, so that it comes to rest gently on its lifting charge at the bottom of the tube. The correct seating of the shell may be confirmed by slightly raising and lowering the shell or by measuring the depth of the shell using a marked loading rod.

Once the aerial shell is loaded in the tube, no one is allowed in the line of fire (i.e. no part of their body may pass directly over the mouth of the tube). A mirror must be used if an inspection of the interior of the tube is required.

Preloaded trailers

Fireworks prepared on a trailer away from the set-up area may have to travel through spectators or past grandstands to reach the firing point, and the fireworks operator must ensure that the safety and security of the fireworks are preserved during the move.

A rolling exclusion zone of at least two metres must be maintained in all directions from the preloaded trailer as it is being moved into position. Control measures must include:

- isolation of the fireworks by fixing barriers between the fireworks and people (e.g. covering the trailer and fireworks)
- provision of a security escort to maintain the exclusion zone

- exclusion of ignition sources from the rolling exclusion zone
- provision of suitable fire extinguishers or water delivery on the route.

A preloaded trailer must not travel on a public road.

5.4 Firing methods

Extraneous electricity

The operators and assistants must take precautions against extraneous and static electricity during the display set-up.

Electronic and portable transmitting devices (e.g. radios, mobile telephones) are not permitted within 5 m of fireworks.

Specific precautions must be taken when preparing for electric firing, such as:

- twisting end wires so that they are shorted or shunted
- maintaining minimum safe distances from the sources of electromagnetic radiation such as radio transmitters and high voltage power lines
- at the approach of an electrical storm, evacuating the set-up area of all personnel to the perimeter of the exclusion zone and returning loose products to storage.

Electric firing

Electric firing is the preferred method for initiating fireworks.

Before the event, the operator or assistants must inspect the firing unit, cables, junction boxes, test equipment, power supply and electric matches for serviceability and compatibility.

The power source must be sufficient to fire all the fireworks primed with electric matches. Running repairs are permitted, provided the system can be returned to a safe operating condition prior to display.

The electric firing unit must be set up to permit a clear line of sight from the operator to the fireworks and exclusion zone. Where this is not possible, a spotter who has clear line of sight may be used provided there is direct communication with the operator controlling the electric firing unit.

The following steps must be taken to prevent inadvertent ignition of fireworks while they are being set up:

- disconnect the cables from the electric firing unit
- if the circuit is shunted, insert fuse wires into the system
- if a computer firing system is used, program a protection system into the computer.

When setting up for electric firing, the operator must:

- ensure potential ignition sources are isolated
- lay the firing cables from the fireworks to the firing point
- ensure firing system wires and cables are shunted
- ensure the firing wires are identified or marked in accordance with the firing order of the display
- ensure the lead wires of electric matches are kept shunted until the operator is ready to make the connection to the firing unit
- prime fireworks with an electric match in their respective positions at the set-up area
- connect the electric matches to the firing cables, with the splices protected by electrical tape
- ensure the cable to the firing unit is not connected until ready for testing if there is an integral tester in the firing unit.

Once the fireworks have been set up, the electrical circuits must be tested for continuity using a suitable circuit tester or the integral tester from the firing unit. During this test, no one is permitted closer than the minimum clearance distance to any fireworks that have been attached to the firing unit. Testing must be conducted outdoors and not under a roof or other covered area.

If the circuit testing is unsatisfactory, the operator or assistants should inspect the circuit and make the necessary repairs. This inspection may only be performed only after the electric firing unit has been switched off or disconnected from the power source and the key removed. The operator must keep possession of the key.

Electric firing point

When only electric firing is to be used, the operator and assistants must be positioned as far as practicable from any mortar and behind a suitable protective barrier if separation distances cannot be met. For events on barges or rooftops, a suitable protective barrier must be used unless the separation distance requirements are met. These protection measures are also recommended for the electric firing of lance-work and other low hazard ground-level fireworks.

The operator may only initiate fireworks when satisfied that it is safe to do so, and only personnel necessary for the proper and safe firing of the event are permitted near the electric firing unit at the time of initiation

Note: An invited guest or an official may electrically initiate fireworks under the direct supervision of the fireworks operator and with the approval of the fireworks contractor and event organiser.

Manual firing

Manual initiation, or hand-firing, must be done by lighting the tip of each fuse with a portfire using an extended arm technique. The operator must move away as soon as the fuse is lit. The delay between ignition of the fuse and initiation of the item must allow the operator sufficient time to retreat and avoid injury. No body part is to pass over the mouth of the mortar tube during initiation.

The firing order must be planned so that personnel can initiate fireworks safely. If more than one operator is firing, they must rehearse their actions to ensure they do not restrict each other. The layout must include a suitable means of exit so the operators can leave safely after firing.

When firing manually, the fireworks must be laid out so the sequence of firing is conducted into the wind, and burning debris is blown away from unfired fireworks

If both manual and electric firing methods are used to initiate mortars during a display, the two mortar groups must be separated by a distance of at least ten metres.

Safety caps protecting fuses must not be removed until immediately before the aerial shells or rows of aerial shells are to be fired.

Manual initiation must not be used for:

- dense packs of aerial shells
- aerial shells greater than 200 mm in diameter
- ground fireworks from elevated positions, or
- aerial shells on floating vessels or platforms.

Salutes require a minimum delay of three seconds between lighting the fuse and initiation of the lifting charge.

Inexperienced operators firing aerial shells also require a three-second delay. Experienced operators may reduce this delay to a minimum of one second.

5.5 Alternate firing locations

Alternate locations

Additional requirements apply to fireworks fired from alternate locations such as:

- elevated locations (e.g. tops of buildings)
- floating platforms and vessels (e.g. barges, pontoons)
- moving platforms
- moving vehicles and aircraft

Elevated locations

Considerations

An elevated location is a location, such as a building or bridge, where the point of initiation of fireworks is more than six metres above ground level. The written consent of the owner of the structure must be obtained before an event involving an elevated location is planned.

Elevated locations do not include:

- devices normally fired off stakes, provided the stakes are fixed in the ground or devices designed to be fired off chains
- theatrical fireworks initiated from elevated locations
- ground fireworks fired on embankments or where the ground has been raised.

Aerial shells are not permitted to be fired from elevated locations.

Structure

The structure or platform from which fireworks are fired must:

- be sufficiently stable to endure the setting up and firing of fireworks even under unexpected weather conditions
- have a safe means of exit
- have a barrier fitted to the edge of the platform or, where no barrier is fitted, the operator has conducted a risk assessment.

The surface from which the fireworks are to be fired should be made from non-combustible materials. Where this is not possible, a risk assessment must be conducted and mitigation put in place.

Fire prevention

If the structure is a building, any openings should be suitably protected to prevent the entry of embers and unnecessary activation of fire and smoke alarms.

Fire detection systems must not be interrupted or turned off during the event unless:

- the building owner or agent has approved any shut-down
- the building is vacant during the event or
- a fire risk assessment has been conducted with the assistance of a specialist consultant or the Department of Fire and Emergency Services (DFES).

Products

The products used at elevated locations must be:

- ground or theatrical fireworks
- tested previously by the operator to determine their suitability to be fired from elevated locations
- of a type that is all consuming, producing little or no debris
- of a type that any pyrotechnic materials have extinguished before returning to the normal firing height of the firework.

Loading operations

When transporting fireworks to elevated locations, the following requirements apply:

- the firework pieces must be brought to the set-up area in their original packaging
- for building roofs, the fireworks are to be brought to the set-up area outside of peak traffic hours
- for stadium roofs, fireworks should only be loaded when the public is not present
- where fireworks are to be fanned, they must not be angled more than 15° off vertical.

Positioning of fireworks

When positioning fireworks, take into account:

- the requirement for minimum clearance distances to the public (see Table 5.4)
- for roofs that have a barrier, placing the fireworks behind the barrier furthest from the public
- the effect of sloping roofs causing fireworks to be angled off vertical
- where there are radio or telephone transmitters or other sources of electricity nearby, the need for fireworks to be located outside the safe separation distance recommended for transmitters (see Section 5.4 Extraneous electricity).

Exclusion zone

When determining the area of the exclusion zone around a building, the firing position is placed within an imaginary cylinder where the radius R is the standard clearance distance for the largest firework being fired. This cylinder extends indefinitely upwards from the point of initiation, and downwards for a distance of 2 x R from the firing point level or until the ground is reached. The exclusion zone extends outwards at 45°, as shown in Figures 5.2 and 5.3.

Where the firing platform provides a spark-proof barrier (e.g. stadium rooftop), the above requirements still apply, but spectators may sit under the platform provided the distance R does not extend beyond the edge of the stadium roof (Fig. 5.4).

Table 5.4 Minimum clearance distances for ground fireworks fired from elevated locations

Elevated ground fireworks	Minimum clearance distance
Set pieces	
Lance-work only	15 m
Pieces incorporating fountains	30 m
Fountains, revolving fountains and flares	30 m
Mine bags, multi-shot box items, Roman candles, comets and mines	45 m

Securing fireworks

Fireworks at elevated locations must be appropriately secured with allowances made for the likelihood of stronger winds with increasing height.

Initiation

Firing of ground fireworks from elevated locations may only be done by electric initiation. Remote electric initiation using a radio transmitter producing an encrypted signal is permitted with prior approval from the Chief Officer.

A minimum of one assistant is required at the elevated location to assist the operator. The use of spotters to ensure safety of the exclusion zone and watch for debris should be considered.

Floating platforms and vessels

Considerations

Firing fireworks from a floating platform or barge presents additional hazards such as:

- proximity of the operator and assistants to the fireworks
- platform moving under firing forces
- greater exposure to adverse weather and changing condition of the water surface
- encroaching vessels, particularly at night.

Construction

The platform or vessel must have sufficient strength and stability to enable the safe conduct of all activities associated with the firing of the event. The type and placement of the fireworks and fireworks equipment (including mortars and securing devices) must not compromise the stability of the set-up area or seaworthiness of the platform or vessel when the fireworks are fired.

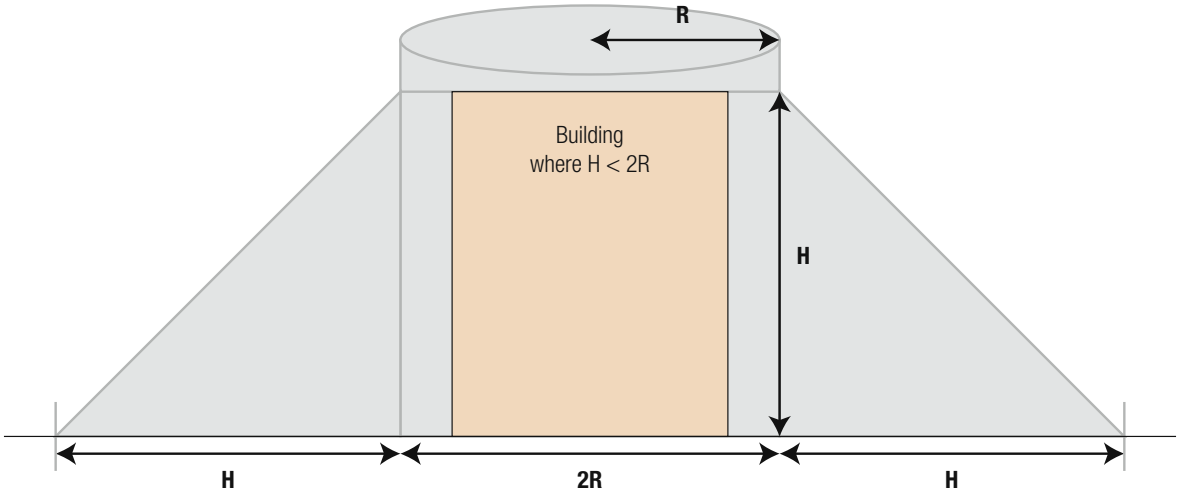

Figure 5.2 Side view showing exclusion zone for ground fireworks on a low building where H is less than 2R

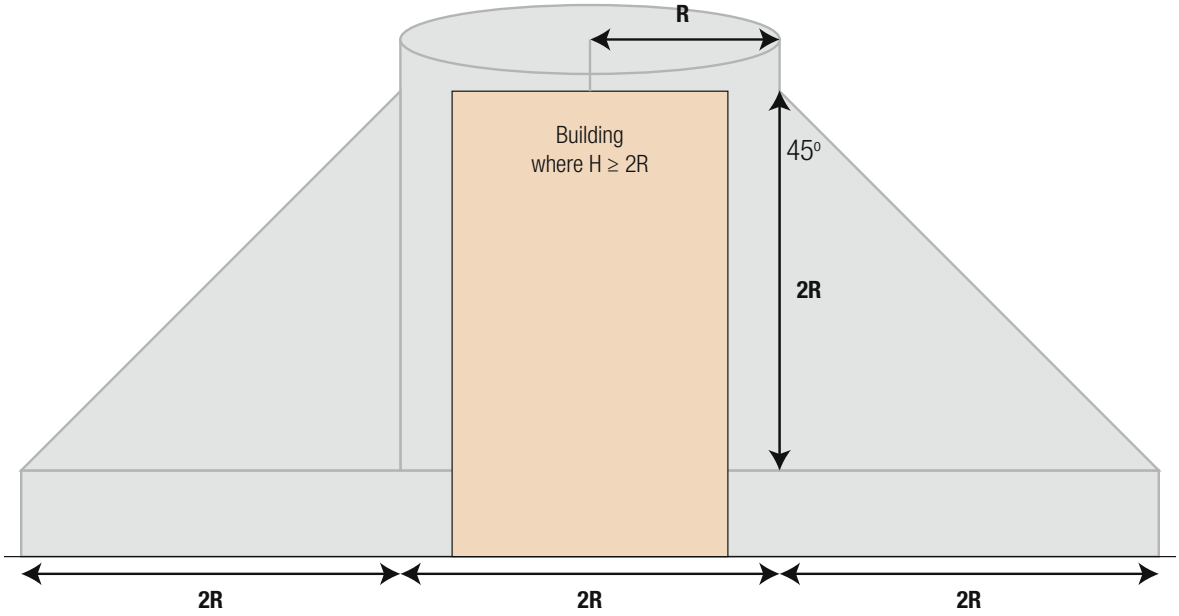

Figure 5.3 Side view showing exclusion zone for ground fireworks on a high building where H is 2R or more

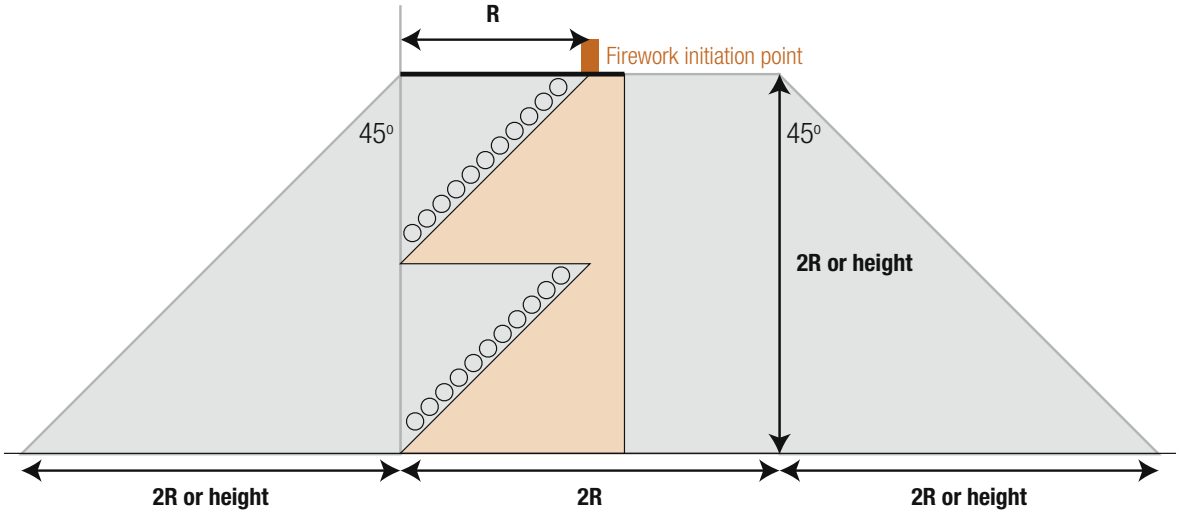

Figure 5.4 Side view showing exclusion zone for ground fireworks on a stadium

Identification

The platform or vessel must be identified as carrying explosives from the time that the fireworks are taken on board, until the fireworks operator declares the platform or vessel free from fireworks.

It must be fitted with warning signs that display the word FIREWORKS in red. The letters must be at least 150 mm high on a white reflective background. The signs must be visible from the perimeter of the exclusion zone and from all sides of approach.

Other maritime requirements may also apply under other legislation.

Manning

The platform or vessel does not need to be manned provided:

- the fireworks operator has control of it at all times
- the security of the exclusion zone is maintained.

Flammable and combustible materials

Floating platforms and vessels must be free of all non-essential flammable or combustible materials.

Any permanently mounted equipment on board that contains flammable or combustible material must be shielded from exposure to fireworks.

Portable power-generation and materials-handling equipment required for the event are permitted.

Safety shelter

Floating platforms and vessels that are manned during firing must have a suitably designed and constructed safety shelter located as far from the fireworks as practicable. The shelter must be able to accommodate all personnel present during the firing of the event.

Provided it is adequately protected, an observation window may be provided to allow the operator and assistants to view the firing.

Requirements for fireworks

Fireworks may be fired from a floating platform or vessel if:

- aerial fireworks are fired electrically
- calculated minimum clearance distances are complied with, and the calculation provides for fireworks with an additional angle of 5° from vertical as a contingency.

Moving platforms, vehicles and aircraft

The approval of the Chief Officer is required for the firing of fireworks from a moving platform, vehicle (land- or water-based) or aircraft. The request for approval must be accompanied by a risk assessment.

6 Conducting the event

6.1 Weather conditions

If weather conditions are unfavourable, the operator may have to delay, postpone or cancel the event.

Wind

In windy conditions, the clearance distances used for aerial shells must be increased on the downwind side of the exclusion zone by the distances given in Table 6.1.

An event must not proceed if the wind speed is greater than 50 km/h (27 knots or nautical miles per hour).

Figure 6.1 illustrates the effect that wind can have on an exclusion zone.

Angling mortars to mitigate wind effect

Mortar tubes may be angled intentionally to negate the effects of wind and carry dud shells away from spectator viewing areas. Fireworks should only be angled upwind if this is away from spectators and buildings. Even if fireworks are angled away from spectators, the minimum clearance distance must not be reduced.

Operators must consider the potential for wind shift to increase the flight distance of an aerial shell when the wind blows in the same direction as the mortar tube is angled.

Vertically launched aerial fireworks may be fired upwind from the centre of the exclusion zone to negate wind effect but the minimum clearance distance must be maintained.

6.2 Final event preparations

Checking

On the day of the event, the operator must ensure that all permits, licences, notifications and approvals are in order and all required personnel are available.

Once the set-up is complete, the operator must run checks to ensure that everything is ready. The details must be recorded in writing. This includes checking and confirming:

- the start time
- local weather conditions
- minimum clearance distances are correct
- the exclusion zone is secure
- the fireworks and equipment are correctly positioned
- assistants and the event organiser or manager are briefed and ready
- all fireworks are suitably primed.

The operator may have to alter the set-up immediately before the event due to changing weather conditions. This could involve eliminating larger fireworks, increasing the exclusion zone or relocating part of the crowd.

The event may need to be temporarily delayed until local weather conditions improve or until such time as the operator is satisfied that the event may proceed safely.

Event organiser

The event organiser or firework contractor must not direct or pressure the operator to proceed with a fireworks event if the operator considers that it is unsafe or inappropriate to do so.

Personal protective equipment

All personnel within the exclusion zone must wear personal protective equipment (PPE) during the event. The PPE must suit the identified hazards and person's location during the event.

If various items of PPE are not considered necessary to protect personnel within the exclusion zone, the operator must undertake a written risk assessment to confirm that such equipment is not required.

Spotters

The operator may appoint spotters to observe the flight and behaviour of aerial shells and other fireworks.

The trajectory of the first firework fired must be carefully observed to confirm that the remaining fireworks will function over the exclusion zone and any hazardous debris or duds will fall within the exclusion zone. If the first firework fired is not an aerial shell, then the first aerial shell fired must also undergo the same assessment.

If an unsafe condition is detected, the spotter must immediately notify the operator to cease firing until the hazardous situation is corrected. The spotter must be in direct communication with the operator during the conduct of the event.

Ignition sources

Only ignition sources that are approved by the contractor in the explosives management plan are permitted within the exclusion zone. Firework events must be postponed or cancelled if lightning strikes are assessed as presenting a hazard to the display.

Table 6.1 Typical aerial shell drift when fired vertically in windy conditions

Wind speed	Descrption	Shell diameter		
		75 mm	150 mm	300 mm
		Approximate shell drift		
Light breeze 8 km/h (5 mph)	• Wind felt on face • Leaves rustle • Ordinary vane moved by wind	15 m	16 m	17 m
Gentle breeze 16 km/h (10 mph)	• Leaves in constant motion • Wind extends light flags	30 m	32 m	34 m
Moderate breeze 24 km/h (15 mph)	• Raises dust and paper • Small branches move	45 m	48 m	52 m
Fresh breeze 32 km/h (20 mph)	• Small leafy trees sway • Crested waves form on inland waters	60 m	65 m	69 m
Strong breeze 40 km/h (25 mph)	• Large branches move • Wires whistle • Umbrellas difficult to use	75 m	81 m	87 m
> 50 km/h – event must not proceed or continue				

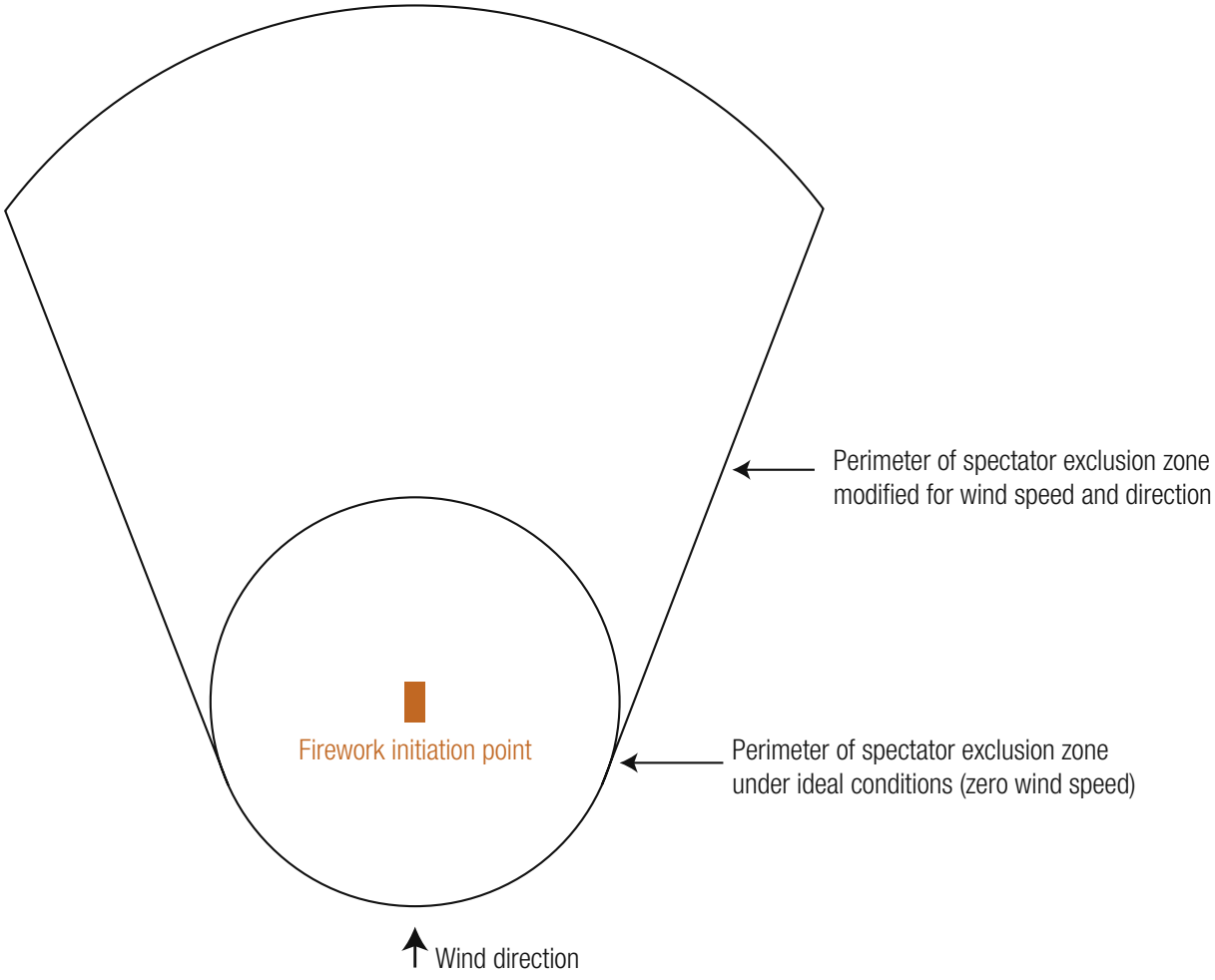

Figure 6.1 Example showing effect of wind on the spectator exclusion zone

First aid

At least one dedicated first aid provider should be on duty at the event outside the exclusion zone.

Fire-fighting equipment

The operator must provide at least one 2A water (9 L) fire extinguisher and one 20 L container of water at each point of launch at the event. This should be regarded as a minimum, however, and fire-fighting equipment should match the fire risk.

Other personnel

The operator must authorise and control all personnel permitted within the exclusion zone during the event. While at least two people are required to conduct a fireworks display, the total number of authorised personnel should be kept to a minimum.

Assistants working unsupervised within the exclusion zone must be at least 18 years of age.

Emergency services

If a situation requires the entry of emergency services personnel into the exclusion zone, the operator must halt the event until the situation is resolved and the exclusion zone is clear.

Crowd control personnel

Personnel with responsibilities for crowd control and security of the exclusion zone must be properly identified, trained and competent for their duties.

6.3 Commencing the event

The operator may initiate fireworks, in accordance with standard operating procedures, when satisfied that the exclusion zone is clear and they have control of the event.

6.4 During the event

Control of event

The operator may have to respond to changing circumstances during the event. The event must be stopped if the situation becomes unacceptably dangerous.

The licensed operator and their assistants may have to work with performers using cues and signals, but the operator retains full control of the event.

Adverse weather

If the wind changes direction or its speed increases during the event, the operator must reassess the situation and take appropriate action.

The operator must stop the event if weather conditions cause significant fallout to extend beyond the spectator exclusion zone. The event may resume when fallout for the remaining fireworks is assessed as not extending beyond the exclusion zone. Changes may be made to the exclusion zone to permit recommencement of the event at a tolerable level of risk. However, the event must be postponed or cancelled if the weather deteriorates to the point where the risk is unacceptable.

Exclusion zone incursions

The operator must stop the event if a member of the public or other unauthorised individual enters the spectator exclusion zone during the event. The event may only resume when the operator is satisfied that the exclusion zone will not be compromised and that public safety is re-established.

Malfunctioning fireworks

The operator must stop the event if malfunctioning fireworks cause, or may cause, harm to people or damage to property. The event may only resume when the operator deems it safe and appropriate to do so.

When a manually initiated aerial shell fails to leave a mortar tube, that tube must be marked or tagged as soon as practicable to indicate the presence of an unfired aerial shell.

6.5 Responding to incidents

Unsafe conditions

If a spotter detects an unsafe condition, such as debris falling outside the exclusion zone, the operator must be notified through direct communication and the operator must stop the event. For minor incidents, the event may recommence when the operator considers that it is safe to do so.

Significant incidents

If a significant incident occurs during the event, the operator must stop the event, activate the emergency plan and follow appropriate emergency procedures. The operator must:

- ensure that the incident area is isolated and left undisturbed until the control of the site has been handed over to Resources Safety or other appropriate authority
- record, and make available for investigation, the names and other details of the people injured by, involved in, or witness to the incident.

7 After the event

7.1 General requirements

Immediately after the event

Immediately after the event, and before proceeding with other activities, the operator must ensure that:

- electric firing unit has been turned off and disconnected
- portfires have been extinguished.

A thorough inspection of the initiation point must then be conducted to ensure that no unfired fireworks remain and no other fireworks hazards exist. Until the operator has deemed it safe to enter the site and surrounding areas, no one may enter the initiation area to commence post-event activities.

Mortar tubes must be checked from the outside of the rack or cluster towards the inside. If an electrically fired aerial shell is discovered during the check, it must be tagged so personnel entering the area to assist with the clean-up are aware of its presence.

Debris fallout and erratic or malfunctioning fireworks may have extended beyond the exclusion zone. Fireworks remnants should be checked for any malfunction. If it is not possible to conduct a thorough inspection and clean-up immediately after the event, the operator must at least determine that no burning material remains.

If poor lighting prevents a thorough inspection and clean-up of the zone and surrounding areas, the operator must arrange for the entire site to be secured overnight and inspected and cleaned up the following morning.

Once satisfied that the area is clear and any unfired fireworks have been made safe, the operator may then declare the area safe and return control of the site to the event organiser.

Personal protective equipment

Personnel involved in post-event activities must wear appropriate PPE as instructed by the contractor and according to the explosives management plan.

First-light inspection

A more thorough inspection must be conducted at first light the following day to check that no unfired fireworks, hazardous debris or rubbish remain.

Inspecting fireworks equipment

The operator should inspect all equipment (including items and methods for securing the fireworks and equipment) for damage and failure. Any damaged equipment must be identified and tagged. Equipment must either be repaired before reuse or disposed of. Repaired equipment must not be reused until assessed as fully serviceable.

7.2 Dealing with unfired or misfired fireworks

Potential hazards

A hangfire is a fuse or firework composition that starts burning more slowly than expected. No one may approach a suspected hangfire until 30 minutes after the time of firing. Hangfires must be dealt with in accordance with the operating procedures of the firework contractor's explosives management plan. These procedures must be based on the following requirements or equivalent safety performance.

The area surrounding an unfired or misfired firework (including any aerial shell found during the search) must be cleared to a sizeat least equivalent to its bursting diameter.

Misfired mortars

Any misfired mortars must be tagged as soon as possible, irrigated with water and left for a further five minutes before the shell is removed.

Salvaging fireworks

Fireworks that are fully serviceable but have not been fired for various reasons (e.g. changing weather conditions) must be properly packaged for transport away from the site for future use.

If electrical initiation was used and the cause of a misfire is identified as an electrical failure, the fireworks (including aerial shells) may be appropriately marked and salvaged by the operator.

Faulty fireworks must be returned to the contractor for return to the supplier or stored at a licensed magazine prior to disposal.

Records of any unused fireworks at an event must be kept by the contractor and operator, and indicate the actions taken for those fireworks. The transport and storage of these fireworks must be undertaken in accordance with the Explosives Regulations.

7.3 Notifications

As soon as practicable, the operator must notify the firework contractor, who in turn must advise the fireworks supplier, if there are any safety or quality issues associated with the fireworks.

Appendix 1 Shell drift

These tables demonstrate the approximate wind drift and launch angle effects on dud aerial shells. Even when fired in ideal conditions (i.e. zero wind speed and zero degrees from vertical), aerial shells do not have a range of zero metres.

They randomly scatter from the firing point due to such things as spin generated when firing and swing produced by the shape of the shell.

Table A1.1 Approximate shell drift (in metres) in still conditions

Shell diameter	Angle from vertical						
	0°	5°	10°	15°	20°	30°	45°
50 mm	< 24	24	48	69	88	120	152
62 mm	< 29	29	57	82	105	143	179
75 mm	< 33	33	64	93	119	161	202
100 mm	< 40	40	79	114	145	197	245
125 mm	< 47	47	91	132	169	229	284
150 mm	< 53	53	103	150	191	258	319
175 mm	< 59	59	114	165	211	285	351
200 mm	< 64	64	124	180	230	310	382
225 mm	< 73	73	143	207	264	355	434
250 mm	< 82	82	159	230	294	396	482

Table A1.2 Approximate shell drift (in metres) at a wind speed of 5 km/h

Shell diameter	Angle from vertical						
	0°	5°	10°	15°	20°	30°	45°
50 mm	13	38	61	83	102	134	163
62 mm	14	43	71	96	119	157	191
75 mm	15	48	79	108	134	176	215
100 mm	15	56	94	130	162	213	259
125 mm	16	63	108	149	186	246	299
150 mm	16	70	120	167	209	275	334
175 mm	16	75	131	183	229	302	366
200 mm	17	81	142	198	248	329	397
225 mm	17	90	160	225	282	374	451
250 mm	17	98	177	249	313	415	500

Table A1.3 Approximate shell drift (in metres) at a wind speed of 10 km/h

Shell diameter	Angle from vertical						
	0°	5°	10°	15°	20°	30°	45°
50 mm	26	51	74	96	116	147	175
62 mm	28	57	85	111	134	171	204
75 mm	29	62	94	123	149	191	228
100 mm	31	71	110	146	178	229	273
125 mm	32	79	124	166	203	262	313
150 mm	33	86	137	184	226	293	350
175 mm	33	92	148	201	246	321	382
200 mm	33	97	159	215	266	346	412
225 mm	33	107	177	242	301	392	467
250 mm	33	115	194	266	331	433	515

Table A1.4 Approximate shell drift (in metres) at a wind speed of 20 km/h

Shell diameter	Angle from vertical						
	0°	5°	10°	15°	20°	30°	45°
50 mm	53	77	102	123	142	173	198
62 mm	56	85	113	140	162	199	227
75 mm	59	92	123	154	179	221	254
100 mm	62	102	141	177	210	261	301
125 mm	64	111	157	199	236	296	343
150 mm	65	119	170	218	261	327	380
175 mm	66	124	182	235	282	356	414
200 mm	66	130	192	250	302	382	444
225 mm	67	140	211	278	336	428	499
250 mm	67	147	228	301	367	470	548

Appendix 2 Securing fireworks

Descriptions of the methods for securing fireworks are given in Table A2.1.Table A2.2 details preferred and alternate methods for securing fireworks items.

Table A2.1 Description of methods for securing fireworks items

Shell diameter	Brief description	Notes
Method 1	Stake and tape and/or tie wire	Single stake of appropriate length, and several turns of strong wide adhesive tape or tie wire. Item to be rigidly immobilised.
Method 2	Multiple stake and tape	As for the above but using more than one stake, includes staking racks.
Method 3	Box	Box with wide stable base with or without sandbags. Item to be rigidly immobilised within box using pins, tape, brackets or wedges.
Method 4	Purpose-built support	75 x 100 mm timber post, purpose-designed attachment, post secured to star-pickets.
Method 5	Burial	Burial to depth, or sandbagging sufficient to immobilise item.
Method 6	Bolt to frame	Rack or box bolted to frame in case of trailer mounting.
Method 7	Ply panels	Secure to horizontal ply panels using tape and screws, or brackets. Item to be rigidly immobilised.
Method 8	In rack	Mount in rack, secure rack by staking or sand bagging.
Method 9	In bucket or bin	Mount in self-supporting bucket or skip-bin full of sand and item to be buried to three quarters length.

Table A2.2 Matrix of methods for securing fireworks

A Preferred option for securing item

B Alternate option or additional measure for extra security needed (e.g. sandbags or barriers)

Notes:

- *The methods for securing fireworks described in this matrix are provided as a guide. Alternative methods of securing fireworks may be available, and should be used if they offer better security.*
- *Unrestrained sand must not be used to secure items. Sand must be bagged or contained.*
- *All items must be held rigidly.*
- *Zip ties must not be used to secure any fireworks item.*

Type of firework item and application	Location / ground	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7	Method 8	Method 9	Remarks
Mortars, single	Earth	B	A			B				B	Rack or bucket
	Sand					B				A	Rack or bucket
	Hardstand								B	A	Rack or bucket
	Barges						B		A	B	Rack, bucket or skip full of sand
	Trailers						A		B		Rack or bucket
Mortars in racks	Earth		A						B		
	Sand		B			B			A		At least 600 mm into ground
	Hardstand								A		Timber feet
	Barges						A		B	B	Timber feet, skip full of sand
	Trailers						A		B		

Type of firework item and application	Location / ground	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7	Method 8	Method 9	Remarks
Flares, strobes	Earth	A	B								
	Sand	A	B								
	Hardstand							A			Ply panels
	Barges							A			Ply panels
	Trailers							A			Ply panels beside trailer
Fountains	Earth	A	B								
	Sand	A	B			B					
	Hardstand							A	B	B	Ply panel, rack or bucket
	Barges							A	B	B	Ply panel, rack or bucket
	Trailers							A	B	B	Ply panel, rack or bucket
Candles	Earth	B	B						A		Rack and minimum two stakes
	Sand		B			B			A		Rack and minimum two stakes
	Hardstand								A		Rack with timber feet
	Barges							B	A		Rack with timber feet
	Trailers							B	A		Rack with timber feet
Unstable cakes	Earth		A	B							Minimum two stakes
	Sand		A	B							At least 300 mm into ground and minimum of two stakes
	Hardstand			A							
	Barges			A							
	Trailers			A							

Type of firework item and application	Location / ground	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7	Method 8	Method 9	Remarks
Stable cakes	Earth		A	B							At least 150 mm in ground and minimum two stakes
	Sand		A	B							At least 300 mm into ground and minimum two stakes
	Hardstand			B				A			Ply panels
	Barges			B				A			Ply panels
	Trailers			B				A			Ply panels
Wheels	Earth				A						75 x 100 mm timber post, purpose designed attachment, post secured to star-pickets
	Sand				A						75 x 100 mm timber post, purpose designed attachment, post secured to star-pickets
	Hardstand				A						75 x 100 mm timber post, purpose designed attachment, post secured to brackets
Wheels - mounted	Barges				A						75 x 100 mm timber post, purpose designed attachment, post secured to brackets
	Trailers				A						75 x 100 mm timber post, purpose designed attachment, post secured to brackets

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