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Display Fireworks Manual

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Table of contents

About this manual ..... **v**

Audience v

Where the manual applies vi

Where the manual does not apply vi

Authority under the *Explosives Act* and the *Explosives Regulations* vii

Amendments and updates vii

Chapter 1 Training and certification **1**

1.1 Display Assistant: duties and certification requirements 1

1.2 Display Supervisor: duties, restrictions and certification requirements 2

1.3 Display Supervisor with Endorsements: duties, endorsements and certification requirements 3

1.4 International Display Supervisors: certification requirements 4

1.5 Authorities Having Jurisdiction training 4

Chapter 2 Fireworks and equipment **5**

2.1 Projection- versus emission-type articles 5

2.2 High-level fireworks 5

2.3 Low-level fireworks 9

2.4 Ground-level fireworks 10

2.5 Chain-fusing methods 12

Chapter 3 Display site requirements **15**

3.1 Basic requirements 15

3.2 Minimum distances from the ramp to structures and vehicles 18

3.3 Minimum distances to overhead objects 18

3.4 Firing from a flatbed 19

3.5 Firing from a floating platform 19

3.6 Obtaining event approval 22

3.7 Basic requirements for event approval 22

3.8 Site plan, event description and special circumstances 22

3.9 Purchasing display fireworks 23

3.10 Display fireworks event approval form 24

Chapter 4 Operation of the display 25

4.1 Non-compliance and negligence 25
4.2 False or misleading information.....25
4.3 Fire hazards: smoking, matches and spark-producing devices 25
4.4 Alcohol and drugs 25
4.5 Authorized people on the display site 25
4.6 Maintaining the perimeter of the danger zone 26
4.7 Firefighting and first aid services 26
4.8 Fireworks sorting and inspection 26
4.9 Manufacturer's instructions 27
4.10 Wind speed 27
4.11 Inspection of mortars 27
4.12 Personal protective equipment 27
4.13 Safety equipment 28

Chapter 5 Loading and firing fireworks 29

5.1 Preparation 29
5.2 Loading 29
5.3 Manual firing.....29
5.4 Electrical firing 30

Chapter 6 After the display 35

6.1 Authorized people only 35
6.2 Dismantling and clean-up 35
6.3 Search of grounds: next day 36
6.4 Giving the "all clear" 36
6.5 Disposal of fireworks 36
6.6 Report of malfunctions 36
6.7 Notification of accidents and incidents 37
6.8 Investigations 37

Chapter 7 Storage of fireworks 39

7.1 Short-term storage without a licence 39
7.2 Storage with licence 39
7.3 Storage in a dwelling 39

Chapter 8 Transportation 41

8.1 Authorities: Transportation of Dangerous Goods Directorate (Transport Canada), Explosives Regulatory Division (Natural Resources Canada) 41

8.2 Classification of display fireworks 41

8.3 Transportation classes for display fireworks 41

8.4 Compatibility of display fireworks.....41

8.5 Placarding 42

8.6 Documentation 42

8.7 Training certificate 43

8.8 Employee's responsibility 43

8.9 Vehicles, drivers and passengers 43

8.10 Special situations.....44

Appendix 1 Explosives Regulatory Division, Natural Resources Canada.....47

A1.1 Explosives: legally speaking 47

A1.2 Explosives Regulatory Division 47

A1.3 Range of responsibility 47

A1.4 Use of explosives: who is responsible 47

A1.5 Locations 48

A1.6 Testing facilities: Canadian Explosives Research Laboratory 48

A1.7 Authorized effects 48

A1.8 Licences, permits and certificates for explosives of all types 49

A1.9 Age limit 49

A1.10 Police powers 49

Appendix 2 Background, characteristics and the basic chemistry of fireworks.....51

A2.1 In the beginning 51

A2.2 Fireworks compositions 51

A2.3 Finished products 52

A2.4 Constituents 52

A2.5 The reaction 52

A2.6 Fireworks versus high explosives.....53

A2.7 Fireworks: science and art 53

A2.8 Ignition 53
A2.9 Propagation 54
A2.10 Requirements 54
A2.11 Basic fireworks principles 54
A2.12 Commonly used chemicals 55
A2.13 Coloured flames and sparks 55

Appendix 3 Minimum separation distances for personal communications devices 57

Appendix 4 Fireworks categories 59
A4.1 Consumer fireworks (class 7.2.1 / F.1) 59
A4.2 Display fireworks (class 7.2.2 / F.2) 59
A4.3 Model rockets (class 7.2.3 / R) 59
A4.4 Practical use articles (classes 7.2.4 and 7.2.5 / S) 59
A4.5 Pyrotechnic special effects (typically class 7.2.5 / F.3) 59

Appendix 5 Safety instructions for firing consumer fireworks 61

Appendix 6 Unauthorized fireworks 63

Appendix 7 Common fireworks malfunctions 65

Glossary 67

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About this manual

The purpose of this safety manual is to raise the level of awareness of safety and legal aspects of using display fireworks.

Display fireworks include aerial shells, large Roman candles, ground-level effects and other articles. These articles are explosives and are classified as "high hazard" display fireworks, class 7.2.2 (F. 2[1]).

To use display fireworks safely and responsibly, you need a basic understanding of three things:

- how display fireworks work
- how to use and handle display fireworks
- the related laws and regulations

The manual also provides a guide to the Authorities Having Jurisdiction (AHJs) for the approval of display fireworks events.

Audience

This manual will be used by the following:

- People who are authorized – or who want to become authorized – to put on fireworks displays. In Canada, these people have the following titles:
  - *Display Assistant.* A Display Assistant can help at fireworks displays under the supervision of a certified Display Supervisor.
  - *Display Supervisor.* A Display Supervisor has certification of basic proficiency in the field. The main body of this manual pertains to Display Supervisors.
  - *Display Supervisor with Endorsements.* A Display Supervisor with Endorsements has certified expertise that qualifies him or her to perform tasks not permitted at less experienced levels. For example, they can produce displays at unconventional sites, such as floating platforms and rooftops, or use more powerful fireworks, such as large shells or nautical effects.
- Companies that sell or distribute display fireworks
- People who work where display fireworks are used
- AHJs

[1] The *Explosives Regulations* are being revised. Class 7.2.2 will be F.2 in the new regulations.

Where the manual applies

This manual corresponds with the federal *Explosives Act* and *Explosives Regulations* and applies to

- using high-hazard display fireworks (class 7.2.2 / F.2)
- buying, selling and storing display fireworks
- transporting display fireworks, which is regulated by the Transportation of Dangerous Goods Directorate (Transport Canada) and the Explosives Regulatory Division (Natural Resources Canada [NRCan])

Where the manual does not apply

This manual corresponds with the federal *Explosives Act* and *Explosives Regulations* but does not apply

- to pyrotechnic special effects (class 7.2.5 / F.3), which are covered in the *Pyrotechnic Special Effects Manual*
- to consumer fireworks (class 7.2.1 / F.1)
- if display fireworks are prohibited by provincial or territorial law or regulation or municipal or city by-law
- in jurisdictions that have pertinent, and more stringent, regulations and requirements

Note that

- You must comply with the laws and regulations of these jurisdictions, even where they differ from the Act and the Regulations (see section 29, *Explosives Act*).
- It is the responsibility of the Supervisor in Charge to be aware of the requirements of the jurisdiction in question and to ensure that the most restrictive regulation is followed.

Authority under the *Explosives Act* and the *Explosives Regulations*

Pursuant to the "Licences and permits" section of the federal *Explosives Act* (the Act), the Minister of Natural Resources may certify people to

- carry out activities related to fireworks
- train others in the use of fireworks

In accordance with the Act and the federal *Explosives Regulations* (the Regulations), inspectors of the Explosives Regulatory Division (ERD) of NRCan are authorized to

- publish training and safety manuals
- issue certificates
- enforce the *Explosives Act* and the *Explosives Regulations*

Amendments and updates

This manual will be amended and updated to account for changes in technology, law and practice. We welcome your comments and recommendations. The ERD will communicate major changes in policy and direction to the industry through bulletins, directive letters or newsletters.

Notes

Chapter 1 Training and certification

People who handle and operate fireworks must complete certified training for the levels of

- Display Assistant
- Display Supervisor
- Display Supervisor with Endorsements

The training is provided by the Explosive Regulatory Division (ERD) of Natural Resources Canada (NRCan). The Display Fireworks Safety and Legal Awareness course is held at various locations throughout Canada, depending on demand. Check the ERD Web site for course schedules at www.nrcan.gc.ca/mms-smm/expl-expl/erd-dre-eng.htm.

On completion of the Display Fireworks Safety and Legal Awareness course, you will be issued a **Fireworks Operator certificate** with the appropriate certification level, as detailed in the sections below.

1.1 Display Assistant: duties and certification requirements

Certification required: Fireworks Operator certificate at the level of Display Assistant

Work experience required: None

Length of certification: Five years

Duties:

- work as crew on fireworks displays while under direct supervision of the Supervisor in Charge (who is certified as a Display Supervisor)

Renewal of certification:

Application requirements:

- submit fee
- submit two recent photographs

If you do not receive the reminder to renew your certificate, contact your ERD regional office.

Replacement of lost or ruined certificates:

To receive a duplicate certificate, apply in writing to your ERD regional office.

Notes

Notes

1.2 Display Supervisor: duties, restrictions and certification requirements

Certification required: Fireworks Operator certificate at the level of Supervisor

Work experience required:

- Assisted and worked under the direct supervision and control of a Supervisor in Charge for at least three displays within five years from the date of completion of the course
- Proof of experience supported by letters of reference from the Supervisors in Charge with whom the candidate has worked

Length of certification: Five years

Duties:

- act as Supervisor in Charge
  - arranging for display approval through the Authorities Having Jurisdiction (AHJs)
  - purchasing display fireworks
  - training and supervising Display Assistants
  - ensuring safety and control of the display
  - firing the display

Liability: There is only one Supervisor in Charge at any display. The Supervisor in Charge is responsible for display approval and therefore is in a position of primary liability in the event of any mishap.

Fireworks restrictions:

- Shells must not be larger than 155 mm.
- Displays must be on conventional display sites – solid ground or ice. The dimensions of the site must meet specifications set out in Chapter 3, "Display site requirements."
- A Display Supervisor requires an endorsement to use flying saucers or nautical effects.

Renewal of certification:

Application requirements:

- proof of having assisted or acted as Supervisor in Charge in at least three displays during the last five years (such as copies of Display fireworks event approval/purchase forms)

- submit fee
- submit two recent photographs

If you do not receive the reminder to renew your certificate, contact your ERD regional office.

Replacement of lost or ruined certificates:

To receive a duplicate certificate, apply in writing to your ERD regional office.

1.3 Display Supervisor with Endorsements: duties, endorsements and certification requirements

Certification required: Fireworks Operator certificate at the level of Display Supervisor and individual endorsement(s).

A Display Supervisor must have specific endorsements to fire displays from unconventional sites or use fireworks articles – such as aerial shells larger than 155 millimetres (mm), flying saucers and nautical effects – that are normally restricted to the Display Supervisor.

Renewal of certification:

Application requirements:

- proof of having assisted or acted as Supervisor in Charge in at least three displays during the last five years (such as copies of Display fireworks event approval/purchase forms)
- submit fee
- submit two recent photographs

If you do not receive the reminder to renew your certificate, contact your ERD regional office.

1.3.1 Endorsements

Display Supervisors may apply for the following endorsements:

- Large Shells (aerial shells over 155 mm)
- Floating Platforms Firing
- Rooftop, Bridge and Flatbed Firing
- Flying Saucer
- Nautical Effects

Notes

Notes

Endorsement:

Application requirements:

- meet the requirements for the specific endorsement
- apply in writing to the ERD with proof of experience
- submit fee
- submit two recent photographs

If you do not receive the reminder to renew your certificate, contact your ERD regional office.

1.4 International Display Supervisors: certification requirements

If you are based outside of Canada and you plan to participate in the production of a fireworks display in Canada, you must comply with either the first two or the last of the following requirements:

- Obtain Visitor Certification from the ERD for yourself and each foreign fireworks assistant or supervisor employed. You must submit proof of experience and competency to the ERD for approval and include the required fee and two recent photographs for each participant.
- Employ a certified Canadian Display Supervisor of the applicable class.

or

- Obtain Canadian certification for your and your employees as Display Supervisors.

Length of certification: Five years

Responsibility: When a foreign company hires a Canadian Display Supervisor, both the Canadian Display Supervisor and the foreign company are responsible for the proper and safe use of fireworks and for any accident, injury or damage arising from the use of the fireworks.

1.5 Authorities Having Jurisdiction training

Authorities Having Jurisdiction (AHJs) and members of agencies associated with fireworks displays (an agency member may also be an AHJ) can attend the Display Fireworks Safety and Legal Awareness course.

However, if they want to work on fireworks displays as Display Assistants or Display Supervisors, they must meet the standard requirements for certification (see sections 1.1 and 1.2).

Chapter 2 Fireworks and equipment

Notes

2.1 Projection- versus emission-type articles

A projection-type article launches vertically, and its effect occurs close to the apex of the trajectory. An aerial shell is an example of a projection-type article (see Section 2.2.1).

An emission-type article emits its effect from ground level upward, and the effect should be completely finished when it reaches maximum height. A mine is an example of an emission-type article (see Section 2.3.2).

These two types of articles require different distances for separation from spectators and for fallout from the fireworks. See the four tables in Chapter 3 for distance information.

2.2 High-level fireworks

Effects that reach more than 50 metres (m) are high-level fireworks. There are three kinds of high-level fireworks:

- aerial shells (including large shells and nautical effects)
- comets
- large Roman candles (larger than 50 millimetres [mm], inside diameter)

The essential piece of equipment for firing high-level fireworks is a mortar.

2.2.1 Aerial shells

Construction: Aerial shells are cylindrical or spherical, made of papier mâché and/or plastic and designed to be fired out of mortars (see Section 2.2.5). Aerial shells are projection-type articles.

Common elements or characteristics of an aerial shell:

- *Lift charge.* This charge propels the aerial shell upward.
- *Delay element. T*his element prevents the shell from functioning until the shell reaches the design burst height.
- *Burst charge.* The delay element sets off the burst charge. The explosion of this charge breaks the shell casing and ignites and projects the shell's pyrotechnic effects (stars).

Notes

- *Break.* The break is the bursting of an aerial shell. Single-break shells burst only once. Multibreak shells produce two or more bursts in succession.
- *Stars.* Stars are the pyrotechnic components within a shell that are ignited and projected by the burst charge to produce the design effect (patterns and colours).
- *Report.* The report is the loud noise produced by a pyrotechnic article. Not all shells contain reports. Shells that contain reports produce a powerful shattering effect and are thus limited to 85 grams of flash powder. During set-up, mortars (single or in mortar racks) that contain report shells should be buried or placed separately from other shells and effects.
- *Burst height.* The height at which a shell bursts is approximately 33 m per 25 mm of the nominal shell diameter.
- *Stars dispersion.* The maximum distance that stars (pyrotechnic effects) are projected by the explosion of the burst charge is approximately 27 m in diameter per 25 mm of the nominal shell diameter.

2.2.2 Large shells (aerial shells larger than 155 mm)

Note: These articles can be used only by a Display Supervisor with the *Large Shell* endorsement.

When you fire large shells, either on land or on water from a floating platform, the separation distances from ramps to spectators and the fallout zone must be further than those for other fireworks. Refer to Table 3-1 in Chapter 3 for the appropriate distances when firing large shells from a floating platform.

Set-up and firing:

Electrical only:

- Mortars: A steel (Schedule 40) HDPE or FRE mortar must be buried 1/2 to 2/3 of its length in sand or in drums (one mortar per drum) filled with sand.

  The mortars for shells larger than 155-mm inside diameter must be separated by at least 1 m from any other mortar or effect.

2.2.3 Nautical effects

Note: These articles can be used only by a Display Supervisor with the *Nautical Effects* endorsement.

Characteristics: Effects (usually shells) designed for use on water. Nautical effects fall into a body of water and produce an effect on the water's surface. These effects are normally fired in large competitive shows.

Usual minimum separation distance from spectators:

As per the manufacturer's instructions plus 50 m.

(**Note:** The angle of launch affects the separation distance.)

Set-up and firing:

- Place mortars close to the shoreline or the edge of the firing platform (i.e. barge), angled as per manufacturer's instructions toward the water, and make allowances for wind.
- Fire these shells electrically according to procedures specified for aerial shells.

2.2.4 Comets

Construction: Comets are built similarly to an aerial shell, but they contain a single solid pressed composition star. Comets are emission-type articles.

Common sizes: 50 to 76 mm inside diameter

Characteristics: Rising effect. The pyrotechnic composition is ignited at the same time as it is projected out of the mortar. This method produces a trail of sparks that resemble the tail of a comet.

2.2.5 Roman candles

Construction: Roman candles are paper or plastic tubes that house a series of projectiles such as stars and bombettes. Roman candles can be either projection-type (shells) or emission-type (stars) articles.

Characteristics: Roman candles rise into the air one at a time.

Set-up and firing:

Candles may be

- buried half their length in the ground or in sand-filled troughs
- secured in racks constructed to withstand common malfunctions without significant damage or deviation in the angle of fire

Note: Do not bundle candles together unless they have been assembled at the factory and authorized as a distinct fireworks article.

Notes

Notes

2.2.6 Mortars

A mortar is the essential piece of equipment for firing high-level fireworks. Mortars are tubes from which aerial shells are launched. The material the mortar is made of is an important factor in safe firing. Table 2-1 lists the characteristics and limitations of mortar materials.

Table 2-1 Mortar materials

Material	Characteristics	Limitations
FRE (fibre-reinforced epoxy)	Very strong Low risk of fragmentation	Use for all shells
HDPE (high-density polyethylene)	Strong Moderate to low-risk of fragmentation	Use for all shells
Schedule 40 steel	Very strong	Heavy
Sheet steel	No longer manufactured in Canada	Prohibited
ABS and PVC	Likely to fracture with high risk of fragmentation	Prohibited

The minimum distances for spectators and fallout zones apply only when mortars are properly positioned (see Table 3-1 in Chapter 3). The rules for positioning mortars are as follows:

- Single mortars
  - To ensure the mortars are stable, bury mortars at least 1/2 to 2/3 of their length in the ground, sand or earth, or place them in sandboxes or large drums filled with sand.
  - Any mortars larger than 155 mm must be at *least* 1 m from all other fireworks effects.
  - Maintain at *least* 30 centimetres (cm) between mortars and from all mortars to the outside walls of the sandbox or drum.
  - If reloading, group mortars of the same size together.
- Racked mortars
  - Racked mortars are secured in racks that are constructed to withstand any in-mortar explosion and still maintain the integrity of the rack. That means that if there is an explosion in one of the mortars, the rest of the mortars in the rack remain undamaged and in their original alignment. If the rack cannot withstand an in-mortar explosion, the rack must be situated inside or close to a barricade or mound or other design that provides the same protection.
  - Minimum separation distances are *triple* the regular distances when mortars are not properly buried, not placed in non-destructible racks as described above or not barricaded. See Table 3-1 in Chapter 3.
  - Do not reload mortars in racks.

2.3 Low-level fireworks

Notes

Effects that reach less than 50 m are low-level fireworks. Some low-level fireworks, such as mines, may have to be fired from a mortar.

There are four common kinds of low-level fireworks:

- Roman candles (see Section 2.2.5 for details)
- mines
- cakes (battery/combination)
- flying saucers

2.3.1 Mines

Construction: Mines have a light casing and contain no delay element. They may contain stars, whistles, salutes or small shells. Mines come with an integral mortar or as a separate shell or bag. Mines are an emission-type article.

Characteristics: Mines project multiple pyrotechnic items into the air, producing sparks, flame and/or sound effects. They peak lower than aerial shells of the same size.

Common sizes: 76 mm and 102 mm

Set-up and firing:

- Bury mines with half their length in the ground, a sandbox or a drum if the mine is in an integral mortar.

or

- Fire mines from single mortars or mortars situated in racks constructed to withstand common malfunctions without significant damage or deviation in the angle of fire if they are in a shell or bag.

2.3.2 Cakes (battery/combination)

Construction: A battery/combination contains small-diameter cylindrical tubes that are chain fused to fire in sequence after a single ignition.

Characteristics: Stars, comets, aerial whistles or small shells are fired into the sky in rapid sequence, displaying either stars or sound effects, and can reach an altitude of 45 m.

Set-up and firing: Fire batteries/combinations according to the manufacturer's instructions. Do not tamper with any part of a dual firing system.

Notes

2.3.3 Flying saucers

Note: These articles can be used only by a Display Supervisor with the *Flying Saucer* endorsement.

Construction: A series of gerbs attached to a plastic or wooden ring that is propelled in the air by the reaction of drivers fixed to the ring, or a cardboard tube with jets on the ends that is propelled by wings attached to the casing.

Characteristics: A flying saucer spins as it rises into the air, with the jets causing the rotation and the wings providing the lift. After a vertical climb of 50 m, a saucer starts an erratic horizontal course. Wind makes the flight of these devices even more difficult to predict.

Set-up and firing:

- The minimum safety distance to the spectators is 200 m for flying saucers.
- Flying saucers made of tubes must be fired from a flat surface, such as a sheet of plywood.
- Flying saucers made of rings are mounted on a pivot firmly fixed to a structure.
- Ignite electrically.

Special precaution: The device's erratic flight can unexpectedly expose spectators to spent casings and burning debris.

2.4 Ground-level fireworks

Effects that are designed to function at 15 m or lower are ground-level fireworks.

These effects include

- gerbs and fountains
- flares
- waterfalls
- set pieces with lances
- wheels

Ground-level fireworks often produce a lot of sparks. Ensure necessary precautions are taken to reduce the risk of fire to the surroundings.

2.4.1 Gerbs and fountains

Construction: A gerb or fountain is a cylindrical device that contains a spark-producing composition. The casing usually has a clay plug at the bottom and a choke at the top.

Characteristics: Gerbs and fountains produce a controlled spray of sparks.

Sizes: 13 to 76 mm in diameter (outside diameter) and about 125 to 300 mm long

2.4.2 Flares

Construction: Flares are thin paper tubes filled with coloured fire compositions.

Characteristics: Flares burn with an intensely bright flame. When flares are grouped together, to outline a subject such as a building or to reflect off trees, the effect produced is called an illumination.

2.4.3 Waterfalls

Construction: A waterfall is a string of gerb-like devices suspended fuse-side down above ground. Unlike gerbs, waterfalls have open-ended tubes. These devices are usually pre-fused.

Characteristics: Waterfalls produce a curtain of colourful, falling sparks.

Set-up:

- String devices between two poles, according to the manufacturer's instructions.
- After mounting the waterfall, secure the fuse to prevent it from blowing in the wind.

2.4.4 Set pieces with lances

Construction: A *set piece with lances* is a pattern of small tubes called lances, which are filled with colour-producing fireworks composition. Lances are about 10 mm in diameter and up to 100 mm long. Patterns are formed by attaching lances to a lattice. Lances are pressed onto exposed nails and then glued into place. Lances are chain-fused, using a quick match or Sticky Match® / Finale Match™.

Characteristics: Set pieces with lances form images in fire. The flames outline objects or spell out words. The lances burn for up to one minute. Most lances burn with a steady flame, but some produce sparks. Be aware that the lances generate a lot of smoke.

Notes

Notes

Set-up:

- Assemble the set pieces only at the site, in strict accordance with the manufacturer's instructions, unless permitted otherwise.
- Make sure the supporting frame is stable by employing sufficient bracing and guying.
- Secure the fuse for ready ignition.
- Protect the quick match with a safety cap.

2.4.5 Wheels

Construction: A wheel framework pivots at its centre, mounted on a pole, and is rotated by fireworks devices (known as drivers) that are fastened around the edge of the wheel.

Characteristics: Wheels can turn vertically or horizontally and can have various types of fireworks articles attached to them. In addition to powering the wheel, drivers provide visual effects, sending out streams of coloured sparks.

Set-up:

- Position the wheel outside of the ramp used for high-level fireworks.
- Poles must be set and braced securely enough to remain upright during operation.
- Wheels must turn freely and straight and be securely fastened to the pole.
- Drivers must be securely attached to the wheel.
- Fuses should be tied to the pole and not bunched together.
- Protect the quick match with a safety cap.

2.5 Chain-fusing methods

Chain fusing

- Chain fusing must be done only at an approved assembly building, area or firing site.
- At the firing site, chain fuse only with the effects installed in place (i.e. shells in the mortars).
- If the effect leaders are long enough, no additional material is necessary. Each fuse is inserted into the preceding one. Use extra fuses as needed.
- At a short distance from the end of the first shell leader fuse, cut a 25-mm slice into the paper covering the black match.
- Remove the safety cap from the second shell leader and cut off all but 25 mm of the black match on the end of the shell leader.

- Insert the end of the black match of the second shell into the slice made in the first shell leader.
- Ensure that the black match of each fuse is touching. Tape the exposed area to avoid producing sparks.
- Continue this method until you have chain fused all the shells that you want to go off in rapid succession.
- Other delay elements and types of black match can be used to chain fuse fireworks articles, as an alternative to the method described above.

Special precautions

- Remove all unnecessary fireworks material from the immediate area before you cut a fuse.
- Use only non-sparking tools.
- Never use scissors or other shearing action tool unless it is specifically designed for fuse cutting.
- Use only a sharp knife or an anvil/blade cutter.
- Cut the quick match fuse slowly and carefully. The quick match fuse is very sensitive and is therefore likely to ignite when being cut.
- It is recommended that you cover effects and fuses with aluminum foil or anti-static plastic film wrap to prevent premature ignition by sparks and to protect them from rain.

Notes

Notes

Chapter 3 Display site requirements

3.1 Basic requirements

The first consideration in planning a fireworks display is the availability of a safe and proper site. Safety requires that you observe minimum distances from the firing site to the public, structures, vehicles, etc. These minimum distances for projection-type articles are listed in Table 3-1. For emission-type articles, the minimum distances are listed in Table 3-4.

Table 3-1 Minimum distances from firing points of projection-type articles to the public – selected oblong and circular sites

Oblong site with 15° angled mortars or circular site with vertical mortars Projection-type articles (aerial shells, Roman candles, cakes, etc.) Winds to 40 km/hr[†]							
		Oblong site **15° angled mortars and articles[††]**			**OR**	**Circular site** **vertical mortars and articles[††]**	
Mortar size inside diameter (mm)		**Distance to spectators** (m)	**Fallout zone** (m)	**Total** (m)		**Radius to spectators** (m)	**Total** (m)
up to 30		45	35	80		50	100
to 50		65	60	125		75	150
to 60		70	80	150		90	180
to 80		75	95	170		95	190
to 102		80	130	210		115	230
to 127		100	165	265		145	290
to 155		125	200	325		175	350
to 180		145	230	375		205	410
to 205		165	260	425		230	460
to 255		205	330	535		290	580
to 305		250	400	650		350	700

[†] If pyrotechnic special effects (class 7.2.5) are used on a display site, you must

- maintain the same separation distances as for ground-level type effects (30 metres [m])
- obtain authorization from an Explosives Regulatory Division (ERD) inspector if shorter distances are desired

[††] When mortars are not properly buried, placed in non-destructible racks or barricaded, the minimum separation distances are *triple* the regular distances given in Table 3-1.

Notes

Figure 3-1 shows the typical layout of an oblong display site.

Figure 3-1 Oblong site layout

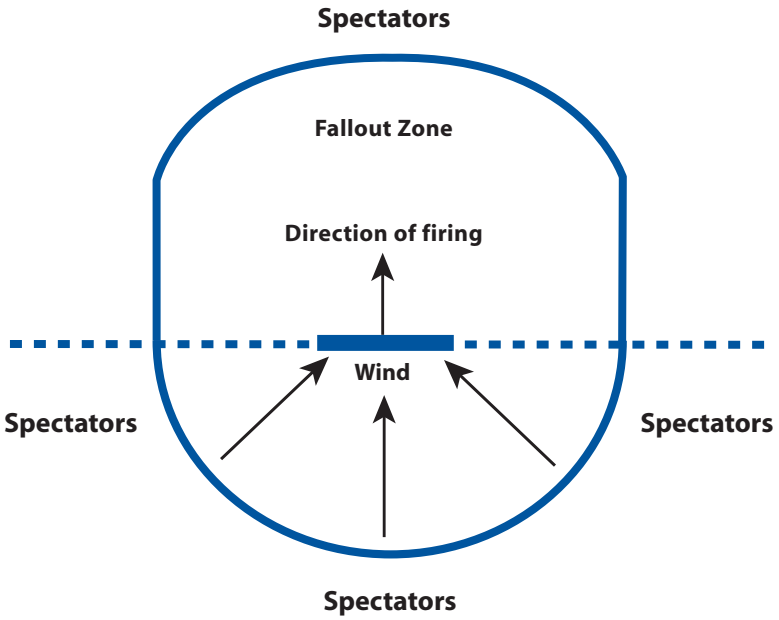
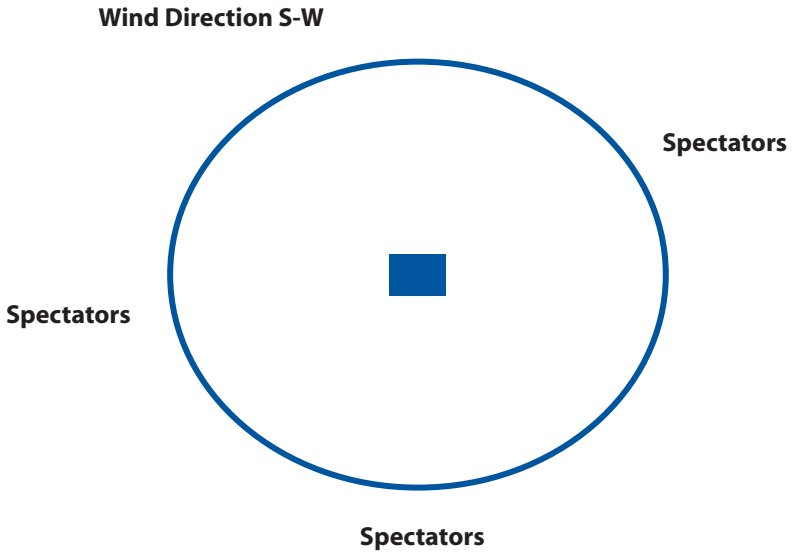


Figure 3-2 shows the typical layout of a circular display site.

Figure 3-2 Circular site layout



During the set-up, it is important to keep watch on the weather conditions. If the wind speed increases before the display starts, you must consider adjusting distances for the fallout or reangling mortars. You may also need to consider not firing the larger shell sizes if there is not enough time to adjust distances or mortars. See Tables 3-2 and 3-3 for the adjustment options for different wind speeds for oblong and circular sites.

Table 3-2 Adjustments for wind speed and direction – oblong site

Spectators downrange, all shell sizes			
Wind conditions (both must be present)	**Adjustment options** (choose one)		
	Increase fallout distance downrange	**Decrease mortar angle**	**Decrease shell size**
• Wind speed: 16 to 25 km/hr (occurs at 24% of displays) • Wind direction: toward the rear of the firing line, from any point between 4 and 8 o'clock (see Figure 3.1)	By 30 m	5 to 10°	Down *one* shell size. (Do not use the 155-mm shells. The maximum size you can use is 127 mm.)
• Wind speed: 26 to 35 km/hr (occurs at 7% of displays) • Wind direction: toward the rear of the firing line, from any point between 4 and 8 o'clock (see Figure 3.1)	By 65 m Also add side "angel wings," beginning at a line parallel to the firing ramp, on either side and running downrange at 20°.	0 to 5° Also add side "angel wings," beginning at a line parallel to the firing ramp, on either side and running downrange at 20°.	Down *two* shell sizes. (Do not use the 155- and 127-mm shells. The maximum size you can use is 102 mm.)
• Wind speed: 36 to 40 km/hr (occurs at 1% of displays) • Wind direction: toward the rear or either side of the firing line, from any point between 3 and 9 o'clock (see Figure 3.1)	By 80 m Also add side "angel wings," beginning at a line parallel to the firing ramp, on either side and running downrange at 20°.	0 to 5° Also add side "angel wings," beginning at a line parallel to the firing ramp, on either side and running downrange at 20°.	Down *three* shell sizes. (Do not use 155-, 127- or 102-mm shells. The maximum size you can use is 76 mm.)

Table 3-3 Adjustments for wind speed and direction – circular site

Spectators on the perimeter,[†] all shell sizes	
Wind conditions	**Adjustment options**
Wind speed: 21 to 30 km/hr (occurs at 10% of displays)	Angle the mortars windward by up to 10%. This change will further decrease the likelihood of dangerous debris falling into the audience.
Wind speed: 31 to 40 km/hr (occurs at 3% of displays)	Angle the mortars 10° to 15° into the wind. **OR** Reduce the maximum shell size. At a typical display, do not use 155-mm shells. The maximum size you can use is 127 mm. Angle the mortars windward by up to 10%.

[†] It is assumed that at circular sites, spectators may be found at any point on the circumference.

Table 3-4 Minimum distances from firing points of emission-type articles to the public

Emission-type articles (mines, gerbs, set pieces, wheels, etc.) **Vertical orientation**[†] Winds to 30 km/hr		
Type of effect	**Maximum elevation of effects** (m)	**Distance** (radius) (m)
Ground-level	0 to 15	30
Low-level	16 to 40	40
High-level	41 or higher	1 m per metre of elevation

[†] If pyrotechnic special effects (class 7.2.5) are used on a display site, you must
- maintain the same separation distances as for ground-level type effects (30 m)
- obtain authorization from an ERD inspector if shorter distances are desired

3.2 Minimum distances from the ramp to structures and vehicles

- The minimum distance to gas stations and bulk flammable and toxic storage areas is twice the required spectator distance.
- The minimum distance to institutional buildings, such as a hospital or senior citizens' home, is twice the required spectator distance. This distance may be reduced to a distance no less than the required spectator distance if permission of the building's administrator is obtained.
- The minimum distance to a solid, fire-resistant uninhabited structure is 10 m.
- The minimum distance to motor vehicles (except crew vehicles) is outside the fallout zone.
- During the display, crew vehicles and fire service vehicles should be parked at least 30 m from the ramp.

Note: Distances in this section may be reduced with approval by the local Authority Having Jurisdiction (AHJ).

3.3 Minimum distances to overhead objects

The minimum horizontal distance from an overhead object is the height of the object. For example, if you are working near a power line that is 10 m above the ground, ensure all articles are positioned at least 10 m from the point on the ground directly below the power line.

3.4 Firing from a flatbed

A Display Supervisor with the *Flatbed* endorsement may fire from a flatbed, which is a towed trailer that has mortars that are already mounted and secured.

The following conditions apply:

- The mortars are securely fixed to the platform.
- The flatbed must be placed on site in accordance with the appropriate separation distances to spectators.
- The towing vehicle must be separated from the flatbed and moved outside the display site during the loading and firing of the display.
- The mortars must be loaded at the firing site.
- The firing must be totally electric.

3.5 Firing from a floating platform

A Fireworks Supervisor with the *Floating Platform* endorsement may fire from a floating platform, such as a barge or raft.

A raft used as a launching ramp is unstable – waves, currents and recoil from the fireworks being fired cause the platform to shift and change the intended trajectory of the aerial shells.

Fireworks can usually be fired from a floating platform if they are fired electrically and the applicable separation distances to spectators are respected. High-level fireworks up to and including 155-millimetre (mm) shells can be fired from a raft if the construction of the floating platform meets certain standards. However, display shells larger than 155 mm, including report shells (maximum 100 mm), can be fired only from a certified barge that has ballast for stability and is well anchored by cables.

3.5.1 Construction of floating platforms

- All motorized and/or manned floating platforms used for display must have either a Certificate of Registry (Small Vessel Register) or a Small Commercial Vessel Licence. The applications for registry or licence are available through the Registrar of Ships at the Transport Canada Web Site.
- Motorized and/or manned platforms require a Notice of Inspection conducted by a Marine Safety Inspector of Transport Canada.
- Displays on floating platforms in a harbour or navigable waterway require approval from the Canadian Marine Authorities (Transport Canada and the Canadian Coast Guard).
- Displays on seaways such as the St. Lawrence Seaway must be fired from barges that have been inspected and certified by Transport Canada.

Notes

Notes

- If the display is fired from a barge, the firing shelter must be metal plated or equivalent and positioned at least 3 m from any mortar. An observation window made of laminated glass protected by expanded metal or LEXAN should be constructed to allow the fireworks crew to observe the firing.

Refer to the following publication for specific requirements of Transport Canada on the construction of barges:

Small Commercial Vessel Safety Guide. The Guide includes "Chapter 5, Construction Standards – TP1332" and "Chapter 2, Registering or Licensing Your Vessel." Transport Canada, Marine Safety, 2004. Visit www.tc.gc.ca/marinesafety/tp/tp14070/tp14070e.pdf.

3.5.1.1 Rafts (pontoons, multihulls)

- Rafts must float on pontoons or multihulls.
- Rafts must be fitted with inherently buoyant flotation material that provides sufficient buoyancy to keep the platform from sinking when swamped by water.
- The pontoons or flotation chambers must be of industrial design standard.
- Rafts cannot be power driven, outboard or otherwise.
- The raft must have only one deck.
- The flotation chambers must be fixed to a structured deck or rafters and not be simply sheet steel sitting on top of floaters.
- The platform surface must be fire resistant or covered with fire retardant material if the deck is wood.
- Rafts must be equipped with sturdy anchoring hardware for both anchoring and towing.
- The minimum dimension of the raft-type floating platform will be
  - rectangular – 3 m × 6 m
- Whether laden or unladen, the trim of the platform must sit neutral, and in both cases, the floating chambers must never sink more than half their diameter or chamber cross-section.
- Unladen, the multihulls must not be more than 305 mm below the water surface.
- The deck must not extend beyond the pontoons or multihulls.
- The outer perimeter of raft must be surrounded by safety railings. Railings must be at least 1 m high and covered by commercial grade, chain-link type fencing or the equivalent.
- The deck must be no more than 152 mm above the floatation chambers.
- The deck must drain freely.

Note: No personnel can remain on a platform or the rafts during the display. Firing must be done remotely and at a suitable distance from the floating platform. Firing from a shelter on the platform is not permitted.

3.5.2 Mortar shell density on floating platforms

The square footage required on any given floating platform for the display is determined by using the following formula:

$$M \times D/2$$

where: M is the number of mortars

D is the diameter (inches) of the mortars

Reference: *NFPA 1123: Code For Fireworks Display*, Chapter 4.

3.5.3 Communication (barge)

A wireless communication system, such as low-wattage cellular telephones, must be available on the barge to communicate with the land emergency-support team.

3.5.4 Positioning of floating platforms

Anchor the floating platforms at the fallout distance from the spectators applicable to the largest shell of the display. Barges that cannot be anchored can be secured with a tugboat if adequate precautions are taken to protect the crew and the tugboat.

3.5.5 Positioning of other watercraft

No other watercraft is permitted in the fallout perimeter or in the immediate area of the floating platform while it is being towed into position.

No other watercraft is permitted in the secured fallout perimeter after the floating platforms are in the firing position.

3.5.6 Authorized personnel on floating platforms

Only necessary personnel are permitted on-board a floating platform during the display.

3.5.7 Firing

All articles must be fired electrically.

Place mortars up to 155 mm in racks or sand-filled troughs.

Notes

Notes

Place each mortar that is 205 mm or larger in a separate drum that is filled with sand. Place each drum 1 m apart.

Note: It is prohibited to store display fireworks on-board floating platforms.

3.6 Obtaining event approval

After a site is determined to be appropriate, you must obtain event approval from the local AHJ. Obtaining event approval is a matter of meeting certain requirements. Some of these are general and constant; some will vary with the particular AHJ or display. The basic requirements are listed in Section 3.7.

3.7 Basic requirements for event approval

- a suitable site for the safe firing of the fireworks you plan to use. The Supervisor in Charge is responsible for preparing the site plan and event description.
- a completed Display fireworks event approval form. (The form on page 24 can be copied and used to obtain approval from the local AHJ.)
- written permission from the owner, lessee or agent of the area where the display will be held and any neighbouring land on which debris might fall
- proof of liability insurance: minimum C$1 million – or more if required by the AHJ. In some situations, the management of the venue or the company contracting for the fireworks services may arrange insurance coverage. In such cases, be sure to
  - Verify your coverage with the broker.
  - Obtain written confirmation of your insurance.
  - Know exactly what your policy covers.

3.8 Site plan, event description and special circumstances

3.8.1 Site plan

A site plan must be submitted to the local AHJ. The following details must be included, as well as any additional information the AHJ may require:

- separation distances to the public and vulnerable features
- position of ramps and mortars
- fallout zone
- direction of firing
- significant ground features, roads, public rights of way, buildings or structures, overhead obstructions, parking areas and spectator viewing areas

- location of emergency vehicles, if applicable
- a North arrow

3.8.2 Event description

Along with the site plan, an event description must also be submitted to the local AHJ. The following details must be included as well as any additional information the AHJ may require:

- date, time schedule of the events and the possible rain date
- description of fireworks, including type, size and quantity
- firing procedures – manual or electric
- emergency response procedures
- traffic control plans and attendance estimates, if known

Some sites are used frequently for public fireworks displays, and the AHJ may have a site plan suitable for your display on file. Be aware, however, that site conditions can change. If you use a site plan submitted for a previous display, be sure to verify the information it contains, and make any changes required to bring it up to date.

3.8.3 Requirements in special circumstances: additional approvals or notifications

In some areas, other approvals and notifications must be obtained in addition to the approval from the local AHJ:

- approvals by other AHJs when the site is under more than one jurisdiction
- police approval if the display makes it necessary to close roads or divert traffic
- notification to police of expected noise levels
- notification to Transport Canada if the display is near a commercial airport or heliport or on a navigable waterway

3.9 Purchasing display fireworks

After the AHJ approves your event and returns the approved Display fireworks event approval form to you, you can forward the approval form to a licensed vendor. The vendor will

- fill your order
- retain your Display fireworks event approval form (in accordance with section 123 of the *Explosives Regulations*)

Note: Remember to keep a copy of your application for your records. These records will be useful in determining your suitability if you apply to have your certification renewed. The Supervisor in Charge should also give copies of the event approval form to the Display Assistant for his or her use as proof of experience.

Notes

3.10 Display fireworks event approval form

Name of applicant (printed): _____

Mailing address: _____

_____

Telephone / Fax / E-mail: _____

Supervisor's certificate number: _____

Class: _____ Expiry date: _____

Company (if applicable): _____

Address: _____

Telephone / Fax / E-mail: _____

Sponsoring organization (if applicable): _____

Address: _____

Event location: _____

_____

Date(s): _____

Name of insuring agency: _____

Amount: _____

Address: _____

Telephone / Fax / E-mail: _____

Place and method of fireworks storage on site: _____

_____

Signature of Supervisor in Charge: _____ **Date:** _____

Permission of local Authority Having Jurisdiction

Name (printed): _____

Title: _____

Organization: _____

Address: _____

Telephone / Fax / E-mail: _____

Site plan attached: ❑ Yes ❑ No

Event description attached: ❑ Yes ❑ No

Signature of Authority Having Jurisdiction: _____

Date: _____

Comments: _____

_____

Chapter 4 Operation of the display

4.1 Non-compliance and negligence

Where there is evidence of non-compliance with the principles set out in this manual, the Explosives Regulatory Division (ERD) may

- suspend or not renew a Fireworks Operator's certificate
- prosecute under the *Explosives Act*

When there is evidence of gross misconduct or negligence, the Fireworks Operator may be charged under the *Criminal Code*.

4.2 False or misleading information

Anyone who submits false or misleading information in support of an application or letter of reference may be prosecuted. Certification may also be refused or suspended.

4.3 Fire hazards: smoking, matches and spark-producing devices

A designated smoking area must be established at least 10 metres (m) from the firing ramp.

4.4 Alcohol and drugs

No one is allowed on the display site while under the influence of alcohol, narcotics or any medication that could affect judgment, mobility or presence of mind.

4.5 Authorized people on the display site

From the time the fireworks are removed from the transport vehicle until the show is completely set up, the only people allowed on the display site are

- Supervisor in Charge and certified crew
- local Authority Having Jurisdiction (AHJ)
- ERD personnel
- security monitors
- sponsors and media, if escorted by a Display Supervisor (maximum *three* people at a time)

Notes

Notes

The only people allowed on a display site during the show are the Supervisor in Charge and the certified crew. ERD personnel and AHJs who need to go on the display site must report to the Supervisor in Charge before they enter the site. Exceptions that are approved by the ERD are allowed.

4.6 Maintaining the perimeter of the danger zone

From the time of the arrival of the display fireworks until after the clean-up, you must control access to the danger zone. Maintain crowd control by all available means (e.g. security personnel, signs, barricades, natural boundaries, roads and fences).

The minimum distance from the fireworks articles to the public must be 30 m.

The danger zone must be in effect as soon as the fireworks are brought on site and must be maintained until the full perimeter (as per distances in Table 3-1 and Table 3-4, Chapter 3) of the display site is established.

Note: Distances in this section may be reduced with approval by the local AHJ.

4.7 Firefighting and first aid services

The Supervisor in Charge will make arrangements for firefighting and first aid services for the protection of the audience and crew. Firefighting and first aid personnel and their vehicles should normally remain outside the danger zone during the firing of the display.

4.8 Fireworks sorting and inspection

The Supervisor in Charge must conduct an inspection of the products received. While inspecting, the Supervisor in Charge must

- Remove each article from its packaging.
- Check each fuse to make sure the safety cap is in place.
- Check each article for damage to the fuse, casing, etc.
- Inspect the bottom of the shipping box for signs of loose black powder, which may indicate that an article may be cracked or broken.
- Set aside any shells or articles that appear cracked or broken.
- Check fireworks and shipping cartons for water stains or other signs of wetness. If such signs are found, do not use the affected fireworks.
- Return damaged fireworks to the vendor.
- Make minor repairs if necessary (replacing a safety cap, taping a fuse or quick match).

4.9 Manufacturer's instructions

Always set off fireworks according to the manufacturer's instructions. These instructions are normally supplied on the fireworks labels and instruction leaflets enclosed in the shipping cartons. Remember that last-minute reading can lead to misunderstandings. Give yourself plenty of time to read and understand the instructions.

4.10 Wind speed

The maximum surface wind speed for discharging fireworks is **40 km/hr**.

4.11 Inspection of mortars

Before you set up a display, inspect all the mortars for defects (dents, bends, irregular interiors, loose or cracked plugs, cracks, bulges). Never use defective mortars. Clean the interior of mortars annually with soap and hot water to remove accumulated soot, which can make loading of the shells difficult.

4.12 Personal protective equipment

Clothing requirements

When loading fireworks:

Minimum (all crew members):

- clothing that is made of non-inflammable materials, such as heavy cotton
- no synthetic fabrics
- eye protection (i.e. safety glasses)

When firing fireworks:

Recommended minimum (all crew members):

- clothing that
  - is made of non-flammable materials, such as heavy cotton (no synthetic fabrics)
  - protects the skin (long-sleeved shirts, long pants)
- eye protection (i.e. safety glasses)
- hard hat
- hearing protection
- hand firing: complete firefighter's protective equipment or equivalent

Notes

Notes

4.13 Safety equipment

- A first-aid kit must be available at the display site. It is highly recommended that you also have a fire blanket and eye wash.
- Fire extinguishers (10 litres pressurized water or 3A, 60B:C) must be kept near the firing site when fireworks are handled.

Chapter 5 Loading and firing fireworks

Fireworks are loaded only at the ramps.

Note: Multibreak shells in racks, shells larger than 155 millimetres and report shells must be fired electrically.

5.1 Preparation

- If reloading is required, place those shells in ready boxes that are 8 metres (m) from the ramp and upwind of the mortar line.
- Cover the ready boxes with a fire-resistant material.

5.2 Loading

- Lower a shell fully into the mortar by using the fuse or the cord provided with larger shells.
- Never force a shell into a mortar. If a mortar does not permit a proper "sliding fit," do not load it.
- Hang the end of the fuse down the outside of the mortar, and leave the safety cap on the fuse until just before you attach an electric match or fire the article manually.
- If aluminum or plastic wrap has not been placed over the muzzle of the mortar, you can place tape over the muzzle to indicate that the mortar is loaded. After firing occurs, unbroken tape on a muzzle indicates that the shell has not fired.

5.3 Manual firing

- To manually fire, use a portfire or highway flare that is firmly attached to a stick of suitable length to keep the flame away from the operator's body. Lay the portfire on the ground near the ramps in such a way that the flame keeps going for the duration of the display.
- Approach the firing line with caution, exposing as little of your body as possible. Pull off the safety cap and light the fuse.
- After you light the fuse, turn your head away from the mortar until the shell fires.
- Never place any part of your body over a mortar during the loading and firing of a shell. Wait until the mortars have been cleared after the display.

Notes

Notes

5.3.1 Reloading

- Reloading of mortars in racks is prohibited.
- Mortars must be cleaned before reloading.
- Do not reload until you are satisfied that the shell has fired and that the mortars are in proper condition and orientation.
- If practical, place tape over the muzzle of the mortar after loading the shell.

5.3.2 Interruptions

If any unsafe condition is detected, such as hazardous debris falling into the crowd or loss of crowd control, cease firing until the unsafe condition is corrected. This procedure may be repeated frequently during the display.

5.3.3 Misfires

- Mark the mortar of the unfired shell with tape or by another method. The unbroken tape indicates an unfired shell in a mortar.
- Do not reload or reuse the mortar while the shell remains a hazard. Warn others in the immediate area of the unfired shell.
- Wait 30 minutes before approaching or removing unfired shells from the mortar or dismantling any other fireworks article, because there is always a possibility that a slow-burning composition could set off fireworks.

5.4 Electrical firing

- Electrical firing allows Fireworks Operators to work at a distance from the articles that are being fired and is, therefore, safer for operators than manual firing.
- Electrical firing and manual firing are approximately equally safe for the public.
- Electrical firing units or controllers vary widely in complexity, from simple probe-firing panels (nail boards) to computer-driven units that are synchronized to music.

5.4.1 Electrical firing hazards

Electric matches used in conjunction with firing cables can be fired accidentally by electrostatic discharges, stray currents, radio frequency energy and electrical storms.

- *Radio frequency energy.* Do not use portable communication devices, such as radios and cellular telephones, if you are within 4 m of electric matches and electrically fired fireworks. Do not carry these devices if you are handling fireworks that have an electrical match (see Appendix 3, Table A3-1).

- *Electrical storms.* At the approach of an electrical storm, all personnel must evacuate the display site to the perimeter of the danger zone and return all loose articles to storage.

5.4.2 Clear line of sight

Position the electric firing unit such that there is a clear line of sight to the ramps and all fireworks being electrically fired.

5.4.3 Electrical firing unit and accessories

- Inspect the electrical firing unit, cables, junction boxes and testing equipment before the display starts. Make sure everything works and works together.
- Check that the power sources, either batteries or commercial direct power, have sufficient power to fire all the fireworks primed with electric matches. Two 12-volt batteries in series are recommended.
- Firing units must have at least a two-step positive interlock, which ensures the panel cannot fire unless both steps have been taken, to prevent actions or conditions that lead to hazardous conditions in the field. The crew member who is firing the display is responsible for any physical keying device at all times.

5.4.4 Electric matches

- When electric matches are being used, all fireworks must be primed with the electric matches at the display site. Shells must be in their respective mortars and other set pieces at their intended firing position.
- Attach the electric matches to the fireworks by inserting the electric match into the quick match fuse of the article and secure it into position so it cannot pull out of the quick match. Direct insertion of the electric match into the lift charge of the shell is prohibited on the display site.
- *Never* reload mortars in an electrically fired display.

5.4.5 Steps for setting up an electrically fired display

- The fireworks article must be in the mortar or in the intended firing position, for articles other than shells, before the electric match is attached.
- Lay the firing wires or cables from the fireworks to the firing point, keeping both ends of the wire shunted until you are ready to make the connection to the firing unit or battery. Ensure that no wire comes in contact with the battery or the firing unit. Identify or mark the wires in accordance with the firing plan or layout of the display.
- Connect all the electric matches to the firing wires or cables. Do not connect the wire to the firing unit until the unit is ready for testing if there is an integral tester in the firing unit.

Notes

Notes

5.4.6 Testing and repair

- While testing takes place, no one is allowed on the ramps.
- Using an ohmmeter, a stand-alone continuity tester or the built-in tester from the firing unit, verify the integrity of the electrical circuit. Note that the firing unit test circuit must be current limited to 20 percent of the no-fire current (as specified by the manufacturer) of electric matches being used.
- Before personnel go to the ramp for inspection or repair, the firing unit must be switched off and any physical key removed.
- If testing detects a fault, the Supervisor in Charge or crew member will visually inspect any cables, connections, splices or electric matches that appear defective and make the necessary repairs.
- Electrical faults can be detected by testing isolated sections of the electrical circuit and by testing individual wires or the electric match with an intrinsically safe continuity tester or ohmmeter until the fault is detected. Replace defective electrical matches or wires where the test indicates a fault of discontinuity.

5.4.7 Final connection to the firing unit

- After all circuits have been tested and are operational, connect the cables or wires to the firing unit. If the testing is done by using the firing panel, ensure only low, test mode power is applied during the testing period.
- The crew member responsible for firing the display must have control of any physical keying device at all times.
- Before arming the firing unit for actual firing, the Supervisor in Charge must confirm that the display site perimeter is cleared of all unauthorized personnel.

5.4.8 Post-display

Before beginning any clean-up or other work at the site

- Ensure that the power source from the firing system is disconnected (i.e. all field modules have been discharged).
- Remove any physical keys from the controller.
- Disconnect all cabling, starting at the power source.

5.4.9 Firing using batteries (without a firing unit)

When a battery is used, insulate the positive terminal with insulators to prevent accidental contact with the firing cables. Keep the battery in a covered box until it is time to fire.

- Do not remove the insulators from the terminals until all unnecessary personnel have left the danger area.
- To fire, apply the ends of the wires leading to the fireworks to the positive and negative terminals of the batteries, starting with the ground terminal (negative).

Notes

Notes

Chapter 6 After the display

6.1 Authorized people only

After the display is over, the Supervisor in Charge must ensure that no unauthorized people are on the display site until the area has been declared safe. The Supervisor in Charge is responsible for ensuring that all reasonable steps are taken to prevent unauthorized access to unfired or misfired fireworks.

6.2 Dismantling and clean-up

Basic inspection: 30 minutes after the show

- *Thirty (30) minutes* after the show, the Supervisor in Charge and certified crew members, as deemed necessary by the Supervisor in Charge, must inspect the ramps to locate fireworks that have misfired and search the areas on the display site where duds and stars may have landed. The Supervisor in Charge must collect these misfired articles and duds and place them in a proper storage unit for future destruction.
- The dismantling of the display equipment must be done with caution. Never discount the possibility that a live article or partially fired article may have been overlooked. Collect as much debris (boxes, cartons, shell casings, etc.) as possible.

Removal of electrical matches (e-matches) with the shell still in the mortar

- Locate the e-match (inside the quick match).
- Cut the quick match at least 5 centimetres down from the tip, or cut the tape or twine that holds the e-match inside the quick match.
- Gently remove the e-match.

Checking candles after firing

To make sure that all effects in fired Roman candles tubes have functioned

- Measure the inside length of the tube with a stick.
- Compare the inside measurement with the exterior length of the tube. If the exterior length is longer, it means that the candle contains unfired effects.

Notes

Notes

6.3 Search of grounds: next day

- The next morning after daybreak, the grounds must be searched again. If any duds or unexploded articles that were missed during the overnight search are located, a Display Assistant or Display Supervisor must be on-site to deal with the fireworks articles and arrange for their return to the vendor for destruction.
- Remove any debris not picked up the night before.
- If necessary, repair any damage to the grounds (fill holes, etc.).

Note: If the display is done during the day, ensure the grounds are searched after the display.

6.4 Giving the "all clear"

After the next-day search and after the site is free of fireworks, equipment and debris, the Supervisor in Charge must notify the Authority Having Jurisdiction that the area is clear and safe.

6.5 Disposal of fireworks

General

The destruction of partially fired or misfired fireworks and stars is a hazardous operation that requires planning and resources. Contact the fire department or bomb squad to determine a suitable method of destruction. They may assume the responsibility of destruction on your behalf.

6.6 Report of malfunctions

If an abnormal number of malfunctions occur during a display, the Supervisor in Charge must notify the Explosives Regulatory Division (ERD) in writing within *seven working days*. This is essential to maintain the quality of fireworks on the market. The report must include

- type of article
- description of the defect
- number of times the device malfunctioned
- number of duds or misfired shells recovered
- name of the manufacturer
- name of the vendor that sold the fireworks

6.7 Notification of accidents and incidents

You must inform the Chief Inspector of Explosives or his or her delegate within *24 hours* of

- injury or death from fireworks (include the name and address of the victim)
- fire that occurred from the use of fireworks that has resulted in property damage or required emergency response action
- fireworks articles that functioned abnormally and are suspected to have a design flaw

There is an incident report form (Form 34) available on the ERD Web site.

6.8 Investigations

The ERD, in co-operation with the appropriate authority, may conduct an investigation of any fireworks accident that resulted in bodily injury or major property damage.

Notes

Notes

Chapter 7 Storage of fireworks

7.1 Short-term storage without a licence

Where a fireworks display is scheduled to take place soon, a Supervisor in Charge

- may store for 14 days, without a licence, 125 kg or less of fireworks in a storage unit
- may store for 14 days, without a licence, more than 125 kg gross mass of fireworks in a storage unit, with the written approval of an Inspector of Explosives
- must locate the storage unit at an acceptable distance from any site in which people or property could be placed at risk by the fireworks being stored
- must ensure the storage unit be constructed such that unauthorized access is prevented and the contents are protected from the weather. The storage unit must be locked.
- must ensure a sign with the word "FIREWORKS" is posted outside the door of the unit to warn people. As an alternative, a placard that meets the *Transportation of Dangerous Goods Regulations* (1.1G.or 1.3G, as appropriate) may be used.
- must ensure that smoking and the use of open flame are prohibited within 8 metres of a storage unit where fireworks are stored
- must ensure that no flammable materials (e.g. gasoline) are allowed in the storage area
- must ensure that initiators (electric matches) are kept in a separate storage unit, away from the fireworks articles
- must determine if other jurisdictions have additional storage requirements

7.2 Storage with licence

The storage of fireworks either for sale or long-term use falls under the terms of licence in the *Explosives Regulations*.

7.3 Storage in a dwelling

Never store fireworks in a dwelling or in a building attached to a dwelling.

Notes

Notes

Chapter 8 Transportation

Notes

8.1 Authorities: Transportation of Dangerous Goods Directorate (Transport Canada), Explosives Regulatory Division (Natural Resources Canada)

Road transportation of explosives, including display fireworks, is regulated primarily by the Transportation of Dangerous Goods (TDG) Directorate of Transport Canada (www.tc.gc.ca) and *partially* by the Explosives Regulatory Division (ERD) of Natural Resources Canada.

8.2 Classification of display fireworks

The TDG Directorate derives its requirements from a classification system based on the type, potential hazard and compatibility of fireworks and explosive materials. This chapter sets out the pertinent information dealing with dangerous goods packaged for transportation. It has been prepared for use as a ready reference and has no legal force or effect. For legal interpretation, consult the official version of the *Transportation of Dangerous Goods Act* and *Transportation of Dangerous Goods Regulations* (the Regulations).

8.3 Transportation classes for display fireworks

The most common transportation classes for display fireworks in Canada are

- 1.1G (e.g. shells larger than 155 millimetres and report shells) UN 0333
- 1.3G (e.g. aerial shells) UN0335
- 1.4S (e.g. electric matches, squibs) UN0454

8.4 Compatibility of display fireworks

"G" fireworks articles can be stored and transported together.

1.4S electric matches (listed as initiators) must be

- partitioned to isolate 1.4S items from other articles in the same container

  or

- transported in a separate container

Notes

8.5 Placarding

Placarding is required to communicate to the police, the emergency response team and the public the greatest potential danger of the materials you are transporting.

10 kg NEQ or less

Placarding is not required if you are transporting 10 kilograms (kg) NEQ or less of fireworks articles.

Note: NEQ = net explosive quantity: the actual weight excluding packaging, wiring or cases. It is generally accepted that 50 percent of the gross weight of display fireworks constitutes the NEQ.

More than 10 kg NEQ

Placarding is mandatory if you are transporting more than 10 kg NEQ of fireworks articles.

If you are transporting 1.4G fireworks articles, placarding is required for 1000 kg or at quantities that require an emergency response action plan (ERAP).

Placarding procedure

- Place one plainly visible orange placard on each of the vehicle's four sides.
- Always placard to the highest risk of danger or risk faced by the public, not to the most sensitive item. For example, if you are transporting 1.3G materials together with 1.4S initiators, the proper placard is 1.3G.

8.6 Documentation

If you are transporting any type or quantity of display fireworks, your shipping document must comply with Part III of the *Transportation of Dangerous Goods Regulations* (unless exempted) and include

- date
- name and address of sender
- name of first carrier
- description of the explosives in the following order: shipping name; primary classification, including compatibility group; UN product identification number; and total quantity of the explosives (NEQ)

8.7 Training certificate

If you employ yourself or others in the handling and transportation of any fireworks or explosive (excluding 1.4S products), you must

- ensure that you or your employees have the training necessary to perform the work safely. Training may be formal, informal or just on-the-job. It should provide a sound knowledge of
  - the products being carried
  - safe methods of handling the products
  - emergency procedures in the event of an accident
  - required shipping documents
- issue a certificate of training for each person that states
  - nature of the training undertaken
  - date that the training was completed
  - renewal date of the certificate (every 36 months)

8.8 Employee's responsibility

When handling, presenting or transporting dangerous goods, employees must

- possess a valid training certificate
- have the certificate available for inspection

8.9 Vehicles, drivers and passengers

- You must be at least 18 years old to drive a vehicle carrying explosives.
- A list must be available in the vehicle stating who is permitted to drive and accompany the vehicle.
- When a vehicle contains any quantity of UN0333 and/or UN0334 fireworks or more than 20 kg of UN0335 and/or UN0336 fireworks, no passengers (people not involved with the fireworks) are allowed to travel in the vehicle.
- Never smoke in or near the vehicle.
- Your vehicle must be mechanically sound. It must
  - be able to pass a safety check
  - be fully serviced before it is loaded
  - be inspected for defects before each trip
- Carry a 10 B:C fire extinguisher within easy access to the driver.
- Keep the cargo area fully enclosed and locked.

Notes

Notes

- Load, stow and unload fireworks and other dangerous goods separately.
- Never tow a vehicle transporting fireworks without written permission from the ERD unless you are transporting in a tractor trailer configuration.
- Never leave your vehicle unattended while it is carrying fireworks or explosives.

8.10 Special situations

For special transportation situations, request a Permit for Equivalent Level of Safety from the TDG Directorate.

Appendices

Appendix 1 Explosives Regulatory Division, Natural Resources Canada

A1.1 Explosives: legally speaking

Explosives are defined under the *Explosives Act* (the Act) as anything made, manufactured or used to produce an explosion or a detonation or fireworks effect and includes anything prescribed to be an explosive by the Regulations.

A1.2 Explosives Regulatory Division

The Explosives Regulatory Division (ERD) of Natural Resources Canada (NRCan) administers the *Explosives Act*. The ERD's jurisdiction extends to all explosives in Canada. It regulates

- authorization
- importation
- manufacture
- sale
- storage
- use of fireworks

A1.3 Range of responsibility

The ERD is responsible for a broad range of items, including

- sparklers
- toy pistol caps
- fireworks
- smokeless powders
- ammunition
- industrial high explosives

A1.4 Use of explosives: who is responsible

The use of explosives is in most cases a matter of provincial or territorial jurisdiction. However, the ERD is responsible for regulating the use of all types of fireworks.

Notes

Notes

A1.5 Locations

The ERD has its headquarters in Ottawa. The five regional offices are in Halifax, Saint-Hyacinthe, Ottawa, Calgary and Vancouver.

A1.6 Testing facilities: Canadian Explosives Research Laboratory

The Canadian Explosives Research Laboratory (CERL), situated just west of Ottawa, tests all pyrotechnic compositions contained in legally manufactured or imported effects, along with the devices themselves. The CERL and ERD are integral parts of the Minerals and Metals Sector of Natural Resources Canada.

A1.7 Authorized effects

In general, only explosives authorized under the Act and the *Explosives Regulations* may be

- imported
- manufactured
- sold
- purchased
- owned
- kept and stored
- used

A1.8 Licences, permits and certificates for explosives of all types

If you want to	You need
import any explosives, including pyrotechnic effects	importation permit (annual or general)
manufacture any explosive	factory licence
sell any quantity of high explosives, pyrotechnic special effects, display fireworks and smokeless or black powders (if storage is more than *12 kg*) or consumer fireworks (if storage is more than *1000 kg*)	vendor licence
store more than *75 kg* of smokeless or black powder, or more than *125 kg* of pyrotechnic effects and display fireworks	storage licence
purchase and store (for up to 90 days) up to *75 kg* of high explosives and/or *100* detonators	purchase & possession (P&P) permit
purchase and store (for over 90 days) more than *75 kg* of high explosives and/or more than *100* detonators	high explosives storage licence
purchase, store or use pyrotechnic and display fireworks	certification
fire high explosives	"Blaster's Ticket" (in certain provinces, territories or municipalities)
transport more than *2000 kg* of explosives	Explosives Vehicle Certificate (EVC) issued by the TDG Directorate

Note: *Nothing in the* Explosives Regulations *relieves any person of the obligation to comply with the requirements of any licence, law or other law or by-law of any province, territory or municipality with respect to explosives.*

A1.9 Age limit

Except for toy pistol caps and model rocket engines, fireworks cannot be sold to anyone under the age of 18.

A1.10 Police powers

Direct responsibility for the administration of the Act and Regulations rests with the ERD of NRCan and the deputy inspectors of police forces specified in the Act. Note that deputy inspectors may, without a warrant, exercise their powers of search and seizure and lay charges under the Act and Regulations.

Notes

Appendix 2 Background, characteristics and the basic chemistry of fireworks

Notes

A2.1 In the beginning

Fireworks effects are the earliest types of explosives known to man. The use of chemicals to produce heat, light, gas, smoke or noise originated several thousand years ago, probably in China or India.

"Greek fire," the best known ancient firework, was reported to have been used during the Arab naval siege of Constantinople in 673 AD. It contained a blend of sulphur, organic fuels and saltpetre that generated flames and dense smoke when ignited.

Around the 10th century, adventurous people discovered that with the help of fire, an intimate mixture of potassium nitrate, charcoal and sulphur could produce a very impressive effect. In 1627, Kaspar Weindl, at the Royal Mines in Hungary, fired the first commercial blast of black powder, thus introducing the modern high energy composition.

A2.2 Fireworks compositions

Fireworks are made up of compositions that burn energetically and, if confined, may explode or detonate. They are classed as low explosives, in contrast to the much more powerful high explosives, such as dynamite.

Fireworks burn or *deflagrate*; high explosives *detonate*. Fireworks compositions contain all the oxygen necessary for a chemical reaction (and are therefore very difficult to extinguish in a firefighting situation).

The principal reactants are nitrates, chlorates or perchlorates, along with a combustible material. The nature of the composition and the state of the ingredients, such as particle size, determine the reaction rate; the appearance of the flame, smoke or other pyrotechnic effect; and the noise and flash of the explosion.

Black powder (gunpowder) is a versatile mixture. It is used in various granulations as a propelling charge, a source of noise or a constituent of other compositions, or as part of ignition fuses and timing systems. Black powder should not be confused with smokeless powder (propellant powder) – a more modern mixture that came into use in the late 1800s after the discovery of nitroglycerine. Smokeless powder generates high pressures if confined, as in small-arms ammunition.

Notes

Other compositions produce coloured flames, twinkles and smokes and may be either loose or compacted. When compacted (pressed into cubes and pellets or rolled into spheres), they are called *stars* and burn over their exposed surfaces to produce a brilliant ball of fire.

Other formulations that contain powdered aluminium or magnesium react violently, resulting in explosions accompanied by a flash, and are known as flash or concussion powders.

All fireworks compositions are energetic materials. They are therefore DANGEROUS. In general, fireworks compositions are sensitive to flame, spark, friction, impact and heat. All are sensitive to water in any form, and most are rendered completely inert by it. Note, however, that water may cause spontaneous reactions in a few compositions (e.g. magnesium powders).

A2.3 Finished products

In contrast to the compositions, finished products are much less dangerous unless the case is ruptured and the composition leaks out. Pyrotechnic casings are made up of rolled paper, plastics or aluminium. Do not tamper with manufactured articles.

A2.4 Constituents

A pyrotechnic mixture contains

- oxygen donor (oxidizer)
- one or more fuels that burn with the released oxygen when the oxidizer is heated
- other chemicals that serve as binders and create colour, sparks or other visual or audible effects

A2.5 The reaction

- The heat generated by the reaction between the oxidizer and the fuel causes the other effects to occur.
- All compositions contain their own source of oxygen – air is not necessary for combustion.

A2.6 Fireworks versus high explosives

Notes

In general, pyrotechnics deflagrate at a velocity of less than 350 metres per second (m/s).

High explosives, in contrast, detonate at velocities ranging from 2000 to 7000 m/s.

Other comparative velocities are

- light: 299 792 500 m/s
- expansion of a nuclear fission bomb: 1 000 000 m/s
- 30-06 rifle cartridge: 825 m/s
- sound: 342 m/s
- commercial aircraft: 135 m/s
- slap shot, baseball pitch: 40 m/s
- vehicles on the Trans-Canada highway: 30 m/s

A2.7 Fireworks: science and art

While the chemistry of pyrotechnics is a science, the development and manufacture of effects is an art.

OXYGEN + FUEL = HEAT + reaction products (solid, liquid or gas)

HEAT --> Light, colour, sparks, whistle, rapport, smoke, propulsion

A2.8 Ignition

Ignition occurs when sufficient external energy interacts with the pyrotechnic composition. This energy can be in the form of flame, sparks, high temperature (hot wire), impact or friction.

Typical means of igniting pyrotechnic devices include

- flame/sparks (fuse)
- electric current (electric match)
- impact (percussion primer)
- friction (safety match)

Notes

A2.9 Propagation

Propagation of the reaction occurs when the heat generated by the initial ignition continues in the composition itself (an exothermic reaction).

Energy input to pyrotechnic mixture = broken chemical bonds

New chemical bonds form = energy is released

Released energy:

- lost to surroundings
- transferred to the composition in sufficient quantity to yield a self-propagating reaction

A2.10 Requirements

Fireworks must

- produce the desired effect
- be safe to manufacture
- be chemically stable (in transportation, storage and use)
- have low hygroscopicity (tendency to absorb moisture from the air) and toxicity
- have a moderate production cost

A2.11 Basic fireworks principles

Several key factors affect the performance of pyrotechnic compositions. Even if no identical formulas are used to manufacture a pyrotechnic mixture, the effects produced can be quite varied. The reasons for this include

- *water/moisture*. One of the oldest sayings in the field of pyrotechnics is "Keep your powder dry." Water absorbs heat when it vaporizes. Powder with a high moisture content can be difficult to ignite and may produce a dangerous dud. In some cases, water can sensitize certain compositions, such as magnesium powder.
- *extent of mixing*. A poorly mixed blend of oxidizer and fuel may burn quite slowly (if at all), while the same mixture blended to a high degree of homogeneity will tend to be quite reactive when ignited.
- *particle size*. Fireworks mixtures made from oxidizers and fuels of small particle size (high surface area) will tend to be considerably more reactive than compositions made from coarser chemicals, even if the same percentages and mixing methods are used.

- *confinement* (through packaging or pyrotechnic mass). Unlike high explosives, fireworks mixtures show a sharp increase in burn rate when they are confined and ignited. Also, the burn rate of a mixture tends to increase as the surface area of the burning material increases. On ignition, gases and heat are produced; if the gases are held sufficiently long in the vicinity of the burning front, the heat will act on the gases, and if they cannot escape, the pressure increases. This elevates the reaction rate and establishes a vicious circle, whether it is in a paper tube, a steel pipe or a quantity of fireworks composition approaching the critical mass.

Notes

A2.12 Commonly used chemicals

Oxidizers: Ammonium perchlorate, barium, nitrate, potassium chlorate, potassium nitrate, potassium perchlorate and strontium nitrate.

Fuels:

- *Elemental:* boron, carbon, phosphorus, silicon and sulphur.
- *Organic compounds:* natural gums, plastics, polymers and starch.
- *Metals:* aluminum, magnalium, magnesium and titanium.

Noise effects:

- *Report or noise effects and concussion powders.* These effects typically contain potassium perchlorate or nitrate oxidizers and aluminum.
- *Whistle effects*. These are usually made up of potassium perchlorate, sodium salicylate or sodium benzoate.

A2.13 Coloured flames and sparks

The show-related applications of pyrotechnic mixtures are infinite, but usually involve the production of coloured flames or sparks. The common colour and spark-producing chemical groups for fireworks-type reactions are as follows:

Colour	Chemical group
Red	Strontium salts
Green	Barium salts
Yellow	Sodium salts
Blue	Copper salts
White	Aritimony salts or aluminium powder
Amber sparks	Charcoal or iron particles
Gold sparks	Iron or iron titanium alloy
Silver sparks	Titanium, aluminium or magnesium

Notes

Appendix 3 Minimum separation distances for personal communications devices

The minimum distances that must separate fireworks from mobile transmitters and cellular telephones, including amateur and citizen's bands, are listed in Table A3-1. These distances are excerpted from the *Safety Guide for the Prevention of Radio Frequency Radiation Hazards* in the use of commercial electric detonators, which is published by the Institute of Makers of Explosives.

Table A3-1 Minimum separation distances for personal communications devices

Minimum separation distances (in metres rounded off after conversion from feet)					
	MF 1.9–3.4 MHz fixed, mobile, marine	**HF** 28.0–29.7 MHz amateur	**VHF** 35–36 and 42–44 MHz public use, 50–54 MHz amateur	**VHF** 35.0–36.0 MHz amateur, 150.8–161.6 MHz public Use	**UHF** 450–470 MHz public use, cell phones above 800 MHz
Transmitter power (watts)	**Distance** (metres)				
5	10	22	19	7	4
10	13	31	25	10	7
50	27	71	55	22	13
100	37	98	80	31	19
180	52	132	107	40	25
200	55	141	113	43	26
250	61	153	125	49	28
500	86	217	177	68	37
600	92	238	196	74	43
1 000	122	308	250	95	55
1 500	150	371	308	116	68
10 000	379	986	793	302	171

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Tel.: 202-429-9280
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Web site: www.ime.org
E-mail: info@ime.org

Notes

Appendix 4 Fireworks categories

In Canada, fireworks are classified into categories depending on their construction and use.

A4.1 Consumer fireworks (class 7.2.1 / F.1)

outdoor, low-hazard recreational fireworks such as showers, fountains, golden rain, Roman candles, volcanoes, sparklers and caps for toy guns

A4.2 Display fireworks (class 7.2.2 / F.2)

outdoor, high-hazard recreational fireworks such as display shells, bombshells, large wheels, barrages, bombardos, waterfalls and mines

A4.3 Model rockets (class 7.2.3 / R)

propellant rocket devices

A4.4 Practical use articles (classes 7.2.4 and 7.2.5 / S)

low-hazard practical fireworks such as highway flares, railway fuses and other small distress signals; also, high-hazard items such as large distress signals, railway track signals, distress and line-throwing rockets, and wildlife control devices

A4.5 Pyrotechnic special effects (typically class 7.2.5 / F.3)

Pyrotechnic special effects are created through the firing of pyrotechnic, propellant and explosive materials and devices and are used by the entertainment industry for indoor and outdoor performances. Examples are bullet effects, flash powders, smoke compositions, gerbs, lances and saxons.

For practical reasons, the manual also treats black and smokeless powders as well as special-purpose pyrotechnics as part of this category. Special-purpose pyrotechnics are compositions and/or commercial high explosives used with other fuels (diesel, gasoline, propane, napalm, etc., and other gases and solids) to produce a one-of-a-kind pyrotechnic effect.

Notes

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Appendix 5 Safety instructions for firing consumer fireworks

- If you are under 18, do not use fireworks without adult supervision.
- Choose a wide, clear site away from overhead obstacles (for example, 30 m × 30 m for firing Roman candles) and make spectators stand at the perimeter. Spectators must be at the safe distance specified on the fireworks' label.
- Do not fire in windy conditions.
- Read all instructions on the fireworks. Plan the order of firing before you begin.
- Use a good firing base, such as pails or boxes filled with earth or sand.
- Bury fireworks half their length if they have no standing base, unless the labelling on the fireworks directs otherwise. Set them at a 10° angle, pointing away from people.
- Never light fireworks in your hand or hold lighted fireworks in your hand, other than a sparkler.
- Light carefully. Always light the fuse at its tip.
- Keep water nearby. Dispose of used fireworks (including debris) in a pail of water or return to vendor.
- Never try to relight fireworks that did not go off. Never try to fix fireworks that are defective. Wait at least 30 minutes before approaching such fireworks.
- Keep fireworks in a cool, dry, ventilated place and in a locked container, away from children.

Notes

Notes

Appendix 6 Unauthorized fireworks

You cannot lawfully manufacture, store or own unauthorized articles. An article that is permitted in another country is not automatically permitted in Canada. Unauthorized effects include the following.

Violent effects

- M-80 salutes
- silver salutes
- cherry bombs
- flashcrackers

Joke effects

- cigarette loads or plugs
- exploding golf balls
- sparkling or exploding matches

Miscellaneous effects

- table rockets and bottle rockets
- champagne party poppers
- throw-down torpedoes, snap caps, cracker balls
- sprite bombs

Note: You can find out which fireworks effects are authorized in Canada by obtaining Part 3 of the *List of Authorized Explosives*, available from the Explosives Regulatory Division.

Notes

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Appendix 7 Common fireworks malfunctions

Tables A7-1 and A7-2 list common malfunctions of fireworks articles.

A7-1 Aerial shells and comets

Malfunction	Common causes	Action
Premature ignition A shell fires from the mortar before it is intentionally lit.	There is burning debris in the mortar. There are sparks from neighbouring articles.	Clean mortars before refiring. Cover exposed fireworks with aluminum foil for prevention.
Hangfire A shell fuse suddenly starts burning more slowly than it is supposed to. Just as suddenly, it may resume burning at its normal rate.	The fuse is wet or damaged.	Wait at least 30 minutes before you attempt to remove the shell from the mortar.

A7-2 Roman candles

Malfunction	Common causes	Action
Low burst Burning projectiles fall to the ground.	The article is wet or damaged.	Discontinue the display until an inspection of the immediate area in which the malfunction occurred proves the display to be safe.

Notes

Glossary

Notes

3A, 60B:C

The numbers refer to the size rating of a fire extinguisher. The letters indicate what type of fire the extinguisher can be used on (flammable solids, liquids, electrical fires).

ABS

Abbreviation for acrylonitile-butadiene-styrene polymer, which is a material used in the manufacture of mortars.

aerial shell (display shell)

Generally a cylindrical or spherical shell casing (projectile) containing stars or other effects, with a quick match shell leader, a time fuse and a lifting charge.

all-fire current

The minimum electrical current that must be applied to an igniter or initiator to produce 100 percent ignition.

ampere

Unit of measure for electric current. Produced by one volt acting through a resistance of one ohm.

Authority Having Jurisdiction (AHJ)

The agency responsible in any area for granting approvals for fireworks displays. The most common AHJ is the fire department, but other agencies in provinces, territories, cities or municipalities also serve as AHJs, for example, an airport under the jurisdiction of Transport Canada, the Coast Guard or a police explosives-technician unit. The Supervisor in Charge is responsible for knowing the AHJs for the location of the display.

authorized (explosives, fireworks)

The explosives or fireworks (cited in the *List of Authorized Explosives*) that the Chief Inspector of Explosives has declared to be capable of being safely manufactured, handled, stored, transported and used.

barrage (bombardo/boards)

A group of shells fired in rapid sequence from a mortar loaded in advance. Also called a finale.

Notes

barricade (substantial)

A protective structure, such as a roll-on-roll-off garbage container, positioned so that it protects the public from potential fragments and debris caused by the malfunction of a shell in a mortar. Can deflect the trajectory of the shells fired from a displaced mortar. To be effective, a barricade must be at least two metres high, and the row of mortar racks must be within two metres of the base of the barricade.

battery

A collection of fireworks fused together for quick firing. For example, a group of mortars (finale battery) or a bundle of Roman candles (candle batteries). Also see chain fusing.

black match

A string fuse containing black powder and used in display fireworks. Also see quick match.

black powder (gunpowder)

One of the main ingredients in fireworks. Black powder is an intimate ground mixture of finely powdered potassium nitrate (75 percent), charcoal (15 percent) and sulphur (10 percent). It may be granular or finely ground and have unconfined velocities to confined velocities of 170 to 600 metres per second, depending on particle size and confinement. Black powder is used for the bursting charge in shells and serves as a propellant in many fireworks devices.

blasting ohmmeter

A testing instrument used to establish continuity and total resistance of electric firing circuits. It produces a sensing current much smaller than that needed to initiate electric matches.

break

An aerial shell explosion that produces a visual or sound effect. A single-break shell presents only one burst effect; a multibreak shell presents two or more burst effects in succession.

bridge wire

A fine wire in an electric match that either heats up or ignites when an electric current is applied.

burst(ing) charge

An internal charge designed to burst an aerial shell at or near the top of its flight to disperse the visual and sound effects.

capacitive discharge firing unit

An instrument that fires initiators by discharging the large amount of energy stored in its capacitors.

chain fusing

A series of two or more aerial shells fused together to fire in sequence from a single ignition. Finales and barrages are typically chain fused.

chemical reaction

A process in which one substance is changed into others. In a chemical reaction, existing chemical bonds are broken and new ones are formed. An input of energy is required to break chemical bonds; energy is released when new bonds form.

chemical sensitivity

A qualitative measure of a material's chemical stability and tendency to undergo undesirable reactions when subjected to a defined stimulus, most notably high temperature or moisture.

Chief Inspector of Explosives

A federal official appointed pursuant to the *Explosives Act* (the Act) who is responsible to authorize explosives under the Act.

choke

A plug (often clay) with a centre hole is found in the end of a gerb or fountain. The plug restricts the release of the gases produced by the burning of the composition, causing the effect to be thrust to higher heights.

comet

A mortar-fired effect that has a pellet composed of fireworks composition that typically produces a rising trail of sparks.

compatibility

Refers to a safe combination of explosives. Two or more types of explosives (or related hazardous materials) are considered "compatible" when they can be stored or transported together without substantially increasing the probability of a dangerous incident or hindering emergency response action.

competent authority

A company or individual considered to be an expert in carrying out assessments of safety-related or technical issues.

Notes

Notes

consumer fireworks

Recreational fireworks (Canadian class 7.2.1 / F.1) such as small fountains, volcanoes, pinwheels, cakes, preloaded articles, sparklers and Roman candles. These items are classified as "low hazard" and can be purchased by anyone over 18.

container

A box or other receptacle suitable for storing explosives. According to the *Explosives Regulations*, suitable containers allow explosives to be kept safely in buildings that have not been adapted for the storage of hazardous materials. Containers must be kept clean, closed, ventilated, locked and away from flammable substances. They must be used only for the storage of explosives and must conspicuously display the word FIREW0RKS or the applicable orange placard from the *Transportation of Dangerous Goods Regulations*.

continuity

An unbroken or low-resistance flow of electrical current.

conventional display site

A site that meets the dimension requirements detailed in Table 3-1 of Chapter 3 and from where the fireworks are fired from ground-level ramps.

current

The flow or rate of flow of electric charge in a circuit, expressed in amperes.

danger zone

The area in which display fireworks expose people to a significant risk. This designation applies from the time the fireworks are brought onto the firing site until the time the Supervisor in Charge declares the zone clear and safe. Also see display site.

dangerous occurrence (unusual)

An accident or near miss caused by the use of fireworks or explosives. Also means an unexpected result or problem concerning fireworks or explosive materials.

deflagration

An exothermic reaction in which the reaction front advances at subsonic speed (<350 metres per second [m/s]).

detonation

An exothermic reaction in which the reaction front advances more quickly than supersonic speed (>350 m/s) in the unreacted material. Typically, the reaction front in high explosives travels at more than 5000 m/s.

Display Assistant

A person who has successfully completed the Display Fireworks Safety and Legal Awareness course and who works under the direction of the Supervisor in Charge to put on outdoor fireworks displays.

display fireworks

High-hazard recreational fireworks (Canadian class 7.22), such as aerial shells, mines and larger Roman candles, designed for use at public gatherings. Only Supervisors in Charge are permitted to fire display fireworks.

display site

A protected perimeter closed to the public during the fireworks display. This site includes the separation distance from the ramps to spectator viewing areas and the fallout zone.

Display Supervisor

A person who has certification of basic proficiency in the field. The main body of this manual pertains to Display Supervisors.

Display Supervisor with Endorsements

A person who has certified expertise that qualifies him or her to perform tasks not permitted at less experienced levels. For example, they can produce displays at unconventional sites such as floating platforms and rooftops or use more powerful fireworks such as large shells or nautical effects.

distance (separation)

A distance required between a ramp where fireworks are positioned for firing and the public, structures and vehicles, etc.

driver

A small tubular device that powers set pieces, wheels and tourbillions and sends out streams of coloured sparks.

dud

A shell that rises from the mortar but fails to function.

duty of care

A person who has an explosive substance in his or her possession or under his or her care and control has a legal duty to use reasonable care to prevent bodily harm and death to people or damage to property by that explosive substance. (*Criminal Code*, S.79)

electric firing junction

A box or slat connected by wire or cable to the firing unit that contains electrical connectors intended to be attached to electric matches.

Notes

Notes

electric firing unit

A switching device that distributes and controls the electric current used to ignite fireworks. Wires or cables attach a firing unit to a junction that is connected to the electric matches, which in turn are attached to fireworks devices. Manual firing units have thrown switches. Automatic firing units are usually operated by computer.

electric match

A firing device comprised of an electrical element and a small charge of fireworks composition. When current is applied, the resistance of the element generates enough heat to cause the composition to burst into flame, igniting the fireworks. Electric matches are sensitive to impact, friction and heat, and must be handled with care.

electrical firing

The discharge of fireworks by applying electric current to an electric match (as opposed to applying flame to a fuse by hand). The presetting made possible by electrical firing allows for precision timing and presentation of displays.

exothermic reaction

A chemical reaction that is self-sustaining.

explosive (adjective)

Any chemical compound or mixture that, when subjected to heat, friction, detonation or other initiation, undergoes a very rapid chemical change that creates large volumes of highly heated gases that exert pressure in the surrounding medium.

explosives (noun)

Anything that is made, manufactured or used to produce an explosion or a detonation or a fireworks effect and includes anything prescribed to be an explosive by the *Explosives Regulations*.

fallout area (zone)

The area into which dud shells or unsafe fireworks debris may reasonably be expected to fall. This area must be kept clear of people, vehicles and combustible materials.

finale

A show-closing sequence of rapidly fired aerial shells. The shells are loaded into mortars before the display and are usually chain fused.

fire retardant

Chemicals applied to a material to increase resistance to ignition or burning.

firecracker

A small fused cylinder filled with explosive fireworks composition and designed to produce a sound effect. They range in size from a baby's finger (ladyfinger) to a man's thumb (M-80).

fireworks

Devices that explode or burn to produce visual or sound effects.

firing current

The current, expressed in amperes, used to ignite an electric match.

flare

A thin paper tube filled with coloured fire compositions. When flares are grouped together to outline a subject such as a building or to reflect off trees, the effect produced is called "illuminations."

flash fire

The accidental ignition of a large quantity of fireworks materials within the display site.

flatbed (trailer)

A flat trailer without sides that is towed by a truck for road transport of materials such as vehicles, heavy equipment or containers. The trailer is supported at the front by the rear axle of the truck or by retractable leg supports when the trailer is not connected to a truck.

flowerpot

The malfunction of an aerial shell in which the shell explodes inside the mortar, at or near the mouth of the mortar. The erupting stars and burning material give the mortar a flowerpot appearance.

flying saucer (Tourbillion/Girandola)

(1) A series of gerbs attached to a plastic or wooden ring that is propelled into the air by the reaction of drivers fixed to the ring or (2) a cardboard tube with jets on the ends propelled by wings attached to the tube. Flying saucers are also known as Tourbillons or Girandolas.

fountain

A cone-shaped or cylindrical device that produces a controlled spray of sparks. Fountains are normally set off on the ground.

fuel

Anything that can burn or act as a chemical reducing agent.

Notes

Notes

gerb

A kind of fountain that, when ignited, emits a spray of fire and sparks. Gerbs are commonly used on set pieces and as a pyrotechnic special effect.

ground display piece

A firework device that functions on the ground. Typical ground display pieces include fountains, gerbs and set pieces.

hangfire

A fuse or firework composition that suddenly starts burning more slowly than it is supposed to; it may suddenly resume burning at its normal rate. This unpredictability can be dangerous. If the hangfire goes out completely, it is called a misfire.

hazardous debris

Any potentially injurious material produced by the firing of an explosive or fireworks device.

HDPE

Abbreviation for high-density polyethylene. A material from which mortars, among other things, are made. Do not confuse with PVC and ABS.

igniter

Anything used to fire fireworks.

lance

Small paper tubes filled with pyrotechnic composition. Lances are used to make set pieces.

leader

The length of quick match attached to a fireworks article.

leg wires

A pair of insulated wires attached to an electrical ignition element (bridge wire) in a firing device.

lift(ing) charge

The charge in an aerial shell that propels it into the air.

magazine (storage unit)

An isolated, secure, locked storage unit or structure that is lined with non-sparking material and is marked "FIREWORKS."

manual ignition

Firing by hand; usually done with a portfire.

metal rack

A sturdy metal structure used to support a mortar in an upright position.

mine

A mortar-fired device that projects numerous effects (stars, whistles and salutes) into the air at the same time.

misfire

A shell that remains live and *in* the mortar after being lit.

mortar

A tube in which aerial shells are launched. Mortars are made of various materials. Also see Table 2-1, Chapter 2.

mortar box

See mortar trough.

mortar rack

A mortar rack is a general term that includes metal racks and wooden racks.

mortar trough (mortar box)

A portable wooden or metal structure, normally filled with sand, used for the aboveground placement of mortars. Also known as a mortar box.

muzzle break

An aerial shell malfunction in which the shell bursts just as it leaves the mortar, scattering stars and burning material in all directions near ground level.

nautical effects

Effects (usually shells) designed for use on bodies of water. Nautical effects fall into a body of water and produce an effect on the water's surface.

net explosive quantity (NEQ)

The weight of the fireworks or explosive itself, excluding the packaging, wiring or cases.

no-fire current

The maximum electrical current that can be applied when testing the continuity of a circuit or article without causing an ignition or degradation of the device.

non-sparking tool

A tool constructed from materials (brass, copper, aluminium, wood, stainless steel, etc.) that will not spark when scraped or struck.

Notes

Notes

ohm

Unit of electrical resistance equal to the resistance of a circuit in which an electromotive force of one volt maintains a current of one ampere.

open circuit

An electrical circuit that has a break preventing current from flowing through.

oxidizer

Usually oxygen rich, ionically bonded chemicals that decompose at moderate temperatures and release oxygen that combines with the fuel.

parallel circuit

An electrical circuit in which the current is split through several individual devices, in contrast to a series circuit.

placard

A sign placed on a vehicle to indicate the type of cargo. Required by Transport Canada's Transportation of Dangerous Goods (TDG) Directorate.

portfire

A long tube containing slow-burning fireworks composition, which is often used to ignite fireworks at manually fired displays.

probe firing panel (nail board)

A device made of a series of terminals and a probe on a wire. The act of touching the probe to one of the terminals completes the electric circuit.

quick match

A fast-burning fuse made of black match encased in a loose-fitting paper.

ramp

A specific and well-defined area on a display site where a group of fireworks is positioned for firing.

ready box

A wooden box for holding manually fired shells at the display site.

report

A very loud "crack" or sharp sound.

report shell (also known as salute or sound shell)

An aerial shell that contains effects that produce a loud noise and a bright visual flash.

resistance

The property of a material to impede the flow of electrical current. The unit of measure of resistance is the ohm.

Roman candle

A paper or plastic tube that houses a series of projectiles such as stars, shells, reports or firecrackers. The projectiles rise one at a time, either emitting a coloured shower of stars or producing a report.

safety cap

A thimble-shaped paper casing that is placed over the end of a fuse to protect it from accidental ignition.

salute

See report shell.

salute powder

A fireworks mixture that produces a large flash and a loud report. Salute powder (also called flash powder) consists of potassium chlorate or potassium perchlorate, sulphur and aluminium powder.

separation distance

The minimum required distance or the actual distance (if greater than the minimum required distance) between fireworks or fireworks in mortars and the nearest spectator.

series circuit

An electrical circuit in which the current flows from one device to only one other device, in contrast to a parallel circuit.

series-parallel circuit

An electrical circuit made up of a combination of series and parallel branches. Total resistance equals the sum of the series and parallel branches.

set piece

A lattice fixed to the ground and arrayed with lances, gerbs or flares that form an image, word or design. Set pieces are classified as ground-level displays.

shell detonation "in mortar"

A particularly dangerous malfunction of an aerial shell in which the shell explodes violently inside the mortar, often shattering it.

Notes

Notes

shunt

An intentional short circuiting of an electrical circuit to improve safety.

skyrocket

A rocket-shaped shell with a flight-stabilizing stick attached to its base. On ignition, the rocket rises into the air and produces a burst of colour and/or a report at the height of its climb.

sound shell

See report shell.

stars

Small masses of fireworks compounds that are projected from aerial effects and mortars, and produce colour or streamer effects.

static discharge

The passing of a previously stationary electrical charge from one point to another. All conductive objects (clouds, clothes, mechanical equipment, human bodies) are capable of storing static electricity. Under certain conditions, static electricity can be transferred to powders, electric circuits or firing devices, which causes premature explosions.

storage unit

See magazine.

stray currents

Electrical currents from conductive or semiconductive material that have "leaked" from typical transmission sources. Stray currents can be strong enough to fire explosives charges.

Supervisor in Charge

A person certified to conduct a public or private fireworks display. The Supervisor in Charge is responsible for ensuring that all fireworks are properly installed and that all appropriate safety measures have been taken.

support personnel

People who are neither part of the audience nor part of the actual display, such as

- security guards
- emergency response teams

sympathetic communication

The movement of sparks, heat or sudden force from one effect to another, which causes ignition and premature functioning.

Tourbillon/Girandola

See flying saucer.

training course

A course recognized by the Minister of Natural Resources Canada as a means of becoming qualified to use display fireworks.

trunk line (electrical)

A wire or cable of wires running from a firing panel to the area of the effects.

unattended

Fireworks are unattended if they have been removed from a magazine or are in transport and are not under the care and control of someone capable of taking immediate corrective action in response to a real or potential hazard.

wheel

A spinning fireworks article that is fixed by an axle and attached to a post.

whistle

A small fireworks article that produces a whistling sound by the burning of a pyrotechnic composition.

wooden rack

A sturdy wooden structure used to support mortars in upright positions.

Notes

Notes