

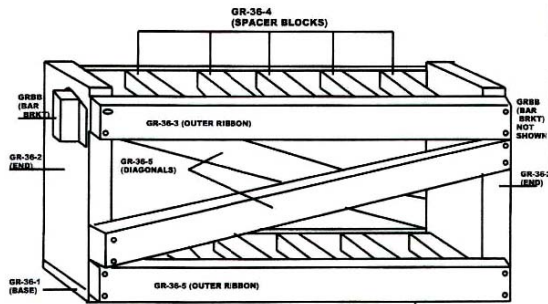
The following photos and diagrams are to be used only as examples of how to stabilize mortars, mortar racks, candles, and cakes. Stability is verified by the licensed fireworks exhibitor and fire official immediately prior to the fireworks exhibition. Each item shall be individually addressed in an appropriate manner (apply pressure and determine it cannot fall over or move on the ground) to ensure its integrity and stability prior to providing affirmative documentation of such stability on the required inspection checklist.

Refer to NFPA 1123 (2006 edition) and Ohio Fire Code 1301:7-7-33 for specific requirements.

Racks & Mortars

Q. What is a fireworks rack?

A. A fireworks rack contains a given number of aerial mortar tubes (aka “guns”) of a given size. Aboveground racks should be constructed to withstand a catastrophic malfunction in a mortar. Wooden racks should have sides and bottom plates of at least 2 in. (5 cm) nominal thickness. The racks should be boxed on both sides at the top and bottom by 1 in. x 6 in. (2.5 cm x 15 cm) nominal thickness boards or ½ in. (1.3 cm) thick plywood. Blocks of 2 in. (5 cm) nominal thickness should be attached to the horizontal boards between each mortar of inside diameter greater than 3 in. (76 mm). Boards should be fastened by nails, screws, or other fasteners that penetrate a minimum of 1 in. (2.5 cm) into the member to which a board is attached.



RACK WEIGHT (COMPLETE W/ MORTARS)

25 LBS.

Q. What is a mortar?

A. A mortar is the tube that is secured in the rack and holds the shells. Most display fireworks are shot from mortars. Mortars shall be of sufficient length to allow aerial shells to be propelled to the height at which the aerial shells were designed to burst. Paper, HDPE, and fiberglass mortars shall be permitted to be used. Cast iron, stove pipe, corrugated culvert, clay, bamboo, and wood shall not be used to make mortars. Metal mortars shall be permitted to be either seamed or seamless. Where seamed mortars are used, mortars shall be placed so that all seams face either right or left when the line of mortars are viewed. NFPA 1123 provides minimum mortar requirements. Mortars shall be positioned and spaced so that shells are propelled over the fallout area and to afford maximum protection to the shooter, loader, and audience.



Q. How do you secure the mortar racks for the show?

A. Racks should be secured to prevent tipping over by attaching stakes or spikes driven into the ground, banding, using A-frames, or other equivalent means. Aboveground wood frame mortar racks with lightweight mortar materials such as paper, HDPE, or fiberglass generally will not withstand a catastrophic aerial shell malfunction in a mortar (NFPA 1123 section A4.6.1)



There are a variety of techniques depending on what type of surface you are shooting from. Sandbags, trenches, boxes, screens, or barriers are additional methods used to secure aerial fireworks devices. **The AHJ will be the final judge as to what is acceptable. The fire safety inspector must be confident that the racks are set up and secured in a way that will allow for an incident free exhibition.** The important thing is that the racks & mortars are secured in an upright and safe position and stay secure throughout the show. As a shell lifts from the rack it does so with enough intensity to move or damage the tubes and whatever shells are left in the rack. If a rack is not safely secured it may fall over and the remaining shells will discharge into the crowd. If the rack is too unyielding, the force of a shell firing may damage the rack and/or any shells yet to be fired. This creates a situation where the remaining shells are being fired from unstable or damaged tubes and/or racks.



Mortars buried within drums or troughs are not considered to be buried in the ground. If troughs and drums are used, they shall be filled with sand or soft dirt and, in all cases, shall

be free of stones or other potentially dangerous debris. Troughs shall be reinforced or braced in a minimum of two places on the sides at intervals not greater than every 4 ft (1.2 m). Mortars shall be buried to a depth of at least two-thirds of their length, either in the ground or in aboveground troughs or drums.

Q. Why are some racks at an angle?

A. Aerial shells, comets and mines, and Roman candles and cakes shall be permitted to be angled for a display to allow for wind and to carry their effects away from the main spectator viewing area. The mortars or tubes shall be angled so that any dud shells or components will drop in the fallout area.



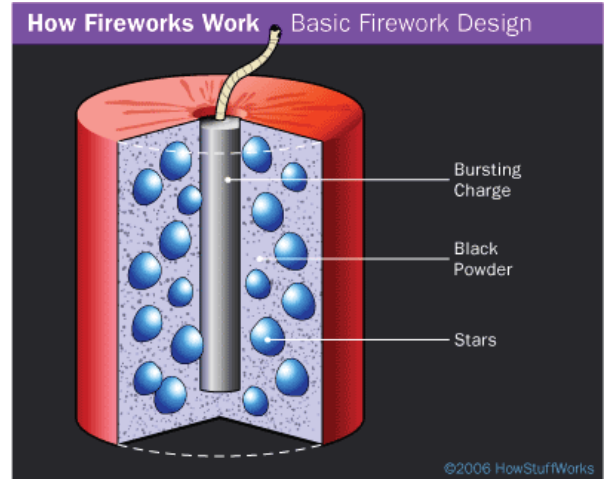
Shells



Q. What is a Firework Shell?

A. A cylindrical or spherical cartridge containing lift charge, burst charge and effect composition. Shells are most commonly 2 inches (50 mm) to 6 inches (152 mm) in diameter, and are fired from metal, high-density polyethylene (HDPE), fiberglass, or heavy cardboard tubes. Upon firing, the lift charge is consumed and the cartridge is expelled into the air. A pyrotechnic effect is produced near the apex of flight. Aerial shells are typically ignited by means

of a quick match fuse or electric match. The lift charge is a pyrotechnic composition used to propel the mine or shell device into the air. A lift charge is limited to black powder (potassium nitrate, sulfur, and charcoal) or similar pyrotechnic composition without metallic fuel. Aerial shells exceeding 10 inches (250 mm) in diameter or containing a burst charge that has metallic fuel may be approved under this NFPA 1123 as Fireworks, UN0333, 1.1G. Note: All aerial shells that are not contained in a launch tube (D.3.1.2.5) or sold as part of a reloadable shell kit (D.3.1.2.6) may only be approved under the provisions of NFPA 1123 as Fireworks, UN0335, 1.3G.



Each shell shall be identified only in terms of the inside diameter (not the circumference) of the mortar in which it can be safely used [e.g., 3 in. (76 mm) shells are only for use in 3 in. (76 mm) mortars]. Each shell shall be constructed so that the difference between the inside diameter of the mortar in which it can be safely used and the outside diameter of the shell is no less than 1/8 in. (3.2 mm) and not more than 1/4 in. (6.4 mm) for shells not exceeding 3 in. (76 mm) or 1/2 in. (12.7 mm) for shells larger than 3 in. (76 mm). Each shell needs to be marked with the type of shell, the diameter measurement, and the name of the manufacturer or distributor.

Cakes and Candles

Q. What is a Fireworks Cake?

A. The term cake refers to a dense-packed collection of mine/shell tubes in which multiple effects are chained together to fire back to back. It propels a series of aerial shells, comets, or mine effects into the air from collectively attached tubes. Total chemical composition including lift charges of any multiple-tube devices may not exceed 200 g.



Q. Why are some cakes covered with foil?

A. Weather-resistant coverings shall be placed over the mouth of mortars wherever there is imminent danger of water collecting in the mortars. Foil & black plastic are commonly used for this purpose. Foil may also be used to prevent premature ignition from any sparks produced by other devices in the show, particularly nearby cakes.



Q. Is there any special considerations for the larger cakes?

A. A cake fires one after another from start to finish with no way to stop it. Therefore, if a tube explodes, the other surrounding tubes could be knocked out of place pointing in an undesirable direction. To prevent this, you can place large cakes in the wooden boxes to keep all tubes pointed straight up even in the event of a malfunction. Another option is to bury $\frac{3}{4}$ of the cake. All bundles, box items, cakes, candle placements, and mortar racks shall be inherently stable or be properly secured and

braced to prevent repositioning. It is not acceptable to create inherent stability of mortar racks only by connection to other mortar racks. The stability of all mortars, bundles, box items, cakes, candle placements and mortar racks shall be verified by the licensed fireworks exhibitor and fire official immediately prior to the fireworks exhibition. Each such item shall be individually addressed in an appropriate manner to ensure its integrity and stability prior to providing affirmative documentation of such stability on the required inspection checklist. **The AHJ will be the final judge as to what is acceptable. The fire safety inspector must be confident that all devices are set up and secured in a way that will allow for an incident free exhibition.**

Q. What are the required distances?

A. For aerial shells, comets, mines, Roman candles, and cakes that are discharged vertically, the minimum required spectator separation distance shall be the same as the minimum required radius specified in chart 5.1.3 in the 2006 Edition of NFPA 1123. Where there is doubt concerning the strength of racks holding chain-fused mortars, the separation distances from those racks to spectators shall be twice those listed in Table 5.1.3.1 for the largest mortar in the sequence. Keep in mind that the distances in this chart are the minimum requirements. The AHJ can increase the distance if so desired.

Table 5.1.3.1 Distances for Outdoor Aerial Shell Display Sites: Minimum Separation Distances from Mortars to Spectators for Land or Water Displays

Mortar Size ^a		Minimum Secured Diameter of Site ^b		Vertical Mortars ^c		Angled Mortars ^d 1/3 Offset		Mortars to Special Hazards ^e	
in.	mm	ft	m	ft	m	ft	m	ft	m
≤1	25	150	46	75	23	75	23	150	46
1.5	38	210	64	105	32	75	23	210	64
2	50	280	85	140	43	95	29	280	85
2.5	63	350	107	175	54	115	35	350	107
3	76	420	128	210	64	140	43	420	128
4	102	560	171	280	85	190	58	560	171
5	127	700	213	350	107	230	70	700	213
6	152	840	256	420	128	280	85	840	256
7	178	980	299	490	149	320	98	980	299
8	203	1120	341	560	171	370	113	1120	341
10	254	1400	427	700	213	460	140	1400	427
12	305	1680	512	840	256	560	171	1680	512

Note: >12 in. (>305 mm) requires the approval of the AHJ.

a See 4.1.1.

b See 5.1.3.

c See 5.2.1.3.

d See 5.2.1.3. Note that for angled mortars, the minimum secured diameter of the display site does not change. Only the location of the mortars within the secured area changes when the mortars are angled.

e See 5.1.4. Note that this is only the distance to the special hazards. The minimum secured diameter of the display site does not change.

Q. What is a candle?

A. Candles come in different sizes and effects. All are constructed of heavy paper or a cardboard tube containing not more than 20 g of chemical composition.

Q. How do we setup a fireworks candle?

A. All chain-fused aerial fireworks devices, including those not in mortar racks such as roman candle batteries and multi-tube aerial items, shall be positioned using stakes, racks, sandbags, earth, or equivalent means to prevent tip over or hazardous movement during operation.



Hand Firing or Electronic Firing

As with varying techniques to securing a rack, the exhibitor/shooter may have a personal preference for hand firing and electronic firing. **The AHJ will be the final judge as to what is acceptable.**



Typically, for electrical ignition, electric matches are attached to or inserted into fireworks devices prior to the display and are connected to wires leading back to an electrical firing unit. During the display, the operator or an assistant controls the ignition of the fireworks using the electrical firing unit.

Electrical firing/ignition is often used for larger displays, for displays fired on frequent occasions at a fixed location, and for other displays where precise control over the timing of the fireworks is

desired for aesthetic reasons. The operator and all assistants shall be positioned a minimum of 75 ft (23 m) from any mortar or shall be positioned behind a protective barrier approved by the AHJ during an exhibition that is using an electrical firing system. The electrical firing unit shall be set up and located so that there is a clear line of sight to the mortars and to other parts of the discharge site, unless a spotter is in direct communication with the shooter controlling the electrical firing unit. Only those persons necessary for the firing of the display shall be permitted in the vicinity of the electrical firing unit during the display.

Where more than one shooter is to hand ignite the aerial shells for an outdoor fireworks display, the line of mortars should be separated in some manner, and only one shooter should be lighting shells in each area.

Where both manual firing and electrical ignition are used during a display, the mortars to be used for manual firing shall be separated from the mortars to be used for electrical ignition by a distance of at least 25 ft (7.7 m)

