Fireworks

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Fireworks over Miami, Florida, USA on American Independence Day

A **firework** is classified as a low explosive pyrotechnic device used primarily for aesthetic and entertainment purposes. The most common use of a firework is as part of a **fireworks display**. A **fireworks** event (also called a **fireworks show** or **pyrotechnics**) is a display of the effects produced by firework devices on various occasions. Fireworks competitions are also regularly held at a number of places. The biggest **fireworks event** in the world is held in Madeira, Portugal at the New Years' Eve celebrations, as referred in the Guinness World Records.

Fireworks (devices) take many forms to produce the four primary effects: noise, light, smoke, and floating materials (confetti for example). They may be designed to burn with colored flames and sparks. Displays are common throughout the world and are the focal point of many different cultural and religious celebrations.

Fireworks over Monterrey, Nuevo Leon, Mexico on Universal Forum of Cultures Monterrey 2007

Fireworks were originally invented by the Chinese, for entertainment purposes, as a natural extension of the Chinese invention of gunpowder. In China, they were first made by firework masters who were well respected for their knowledge of the many complex techniques used to create truly dazzling firework displays. Such important events and festivities as New Year's and the Mid-Autumn Moon Festival were and still are times when fireworks are guaranteed sights. China is the largest manufacturer and exporter of fireworks in the world. China is estimated to have exported over 6 million cases or 120,000 tons of fireworks to the US in 2005.*

Fireworks are generally classified as to where they perform, either as a ground or aerial firework. In the latter case they may provide their own propulsion (skyrocket) or be shot into the air by a mortar (aerial shell).

The most common feature of fireworks is a paper or pasteboard tube or casing filled with the combustible material, often pyrotechnic stars. A number of these tubes or cases are often combined so as to make, when kindled, a great variety of sparkling shapes, often variously colored. The skyrocket is a common form of firework, although the first skyrockets were used in war. The aerial shell, however, is the backbone of today's commercial aerial display, and a smaller version for consumer use is known as the festival ball in the United States. Such rocket technology has also been used for the delivery of mail by rocket and is used as propulsion for most model rockets.

Improper use of fireworks may be dangerous, both to the person operating them (risks of burns and wounds) and to bystanders; in addition, they may start a fire if landing on flammable material. For this reason, the use of fireworks is generally legally restricted. In the United States, fireworks are classified as either consumer or display fireworks based upon the amount of pyrotechnic composition an item contains. Display fireworks are restricted by law for use by professionals. Consumer items are available to the public and are smaller versions containing limited amounts of material to reduce potential dangers.

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History

The earliest unequivocal documentation of fireworks dates back to 12th century China,[1] where they were first used to frighten away evil spirits with their loud sound ("bian pao") and also to pray for happiness and prosperity.

Eventually, the art and science of firework making developed into an independent profession of

its own. In ancient China, pyrotechnicians (firework-masters) were well-respected for their knowledge and skill to mount dazzling displays of light and sound. Fireworks may have also led to the use of military rockets in China. It was recorded in 1264 that the speed of the rocket-propelled 'ground-rat' firework frightened the Empress Dowager Gong Sheng during a feast held in her honor by her son Emperor Lizong of Song (r. 1224–1264).[2] By the 14th century, rocket propulsion had become common in warfare, as evidenced by the *Huolongjing* compiled by Liu Ji (1311–1375) and Jiao Yu (fl. c. 1350–1412).[3]

An etching of the 'Royal Fireworks' display on the Thames in 1749.

Cultural contexts

Since then, any event—a birth, death, wedding, coronation, or New Year's Eve celebration—has become a fitting occasion for noisemakers.

Amédée-François Frézier published a "Treatise on Fireworks" in 1706. In this treatise, Frézier studied the recreational and ceremonial uses of fireworks, rather than their military uses. The book became a standard text for fireworks makers.

Music for the Royal Fireworks was composed by George Frideric Handel in 1749 to celebrate the peace Treaty of Aix-la-Chapelle, which had been declared the previous year.

The World Showcase Lagoon at Epcot during *IllumiNations: Reflections of Earth*, the nightly fireworks show

In the USA

America's earliest settlers brought their enthusiasm for fireworks to the United States. Fireworks and black ash were used to celebrate important events long before the American Revolutionary War. The very first celebration of Independence Day was in 1777, six years before Americans knew whether the new nation would survive the war; fireworks were a part of all festivities. In 1789, George Washington's inauguration was also accompanied by a fireworks display. This early fascination with their noise and color continues today.

A firework in Bratislava, Slovakia, 2005

In 2004, Disneyland in Anaheim, California, started using aerial fireworks launched with compressed air rather than gunpowder, the first time that such a launch system was used commercially. The display shell explodes in the air using an electronic timer. The advantages of compressed air launch are a reduction in fumes, and much greater accuracy in height and timing.[4]

Competitions

In many countries, pyrotechnical competitions involving fireworks are held. The World Pyro Olympics in Manila is an annual international competition amongst the most prestigious fireworks companies in the world. The event is the largest and most intense international fireworks competition worldwide.

Major events

New Year's celebrations

Major cities around the world host a spectacular firework display on New Year's Eve. One of the first to be seen worldwide is the Sydney New Year's Eve fireworks produced by Foti Fireworks and the City of Sydney.[5]

Although it is now just a custom to fire off fireworks on New-Year's eve, in the past the idea was to scare 'bad forces' so they would not enter the new year. As a consequence the most popular fireworks are still those that go off with a big bang or with a bright flash.

In Western Europe the sale of fireworks to the general public is usually restricted to a week before New Year's Eve. However this does not stop people buying a large

volume of fireworks in the weeks preceding New Years Eve to be picked up during the selling days. The retailing of fireworks in Europe is very different from the US, due to powder weigh limits stored in each building. In many countries around the world, people use fireworks in part of the celebration of New Year's Eve.

The Sydney Harbour Bridge and the Sydney Opera House illuminated under New Year's Eve Fireworks, 2005, Sydney, Australia.

Guy Fawkes Night in Great Britain (AKA Bonfire Night)

In 1605 Guy Fawkes and his fellow conspirators attempted to blow up the Parliament of England while the King was inside. Fawkes placed 36 barrels of gunpowder in the cellars of Westminster Hall. On 5 November, Fawkes was arrested and Parliament was saved. That night is now celebrated, both in the United Kingdom and in former British colonies such as South Africa and New Zealand as Guy Fawkes Night or *bonfire night* by filling the sky with exploding fireworks, and by burning an effigy of Guy Fawkes on a bonfire.

> *Remember, remember the fifth of November.*
> *Gunpowder, treason, and plot.*
> *I see no reason why gunpowder treason*
> *Will ever be forgot.*
> – a children's rhyme about the events, still spoken today

A Guy Fawkes Night Display.

The town of Lewes is famous for its annual Guy Fawkes Night celebrations, and so is Llangybi. Local groups, 'bonfire societies' conduct torch-lit marches around the town, vying with each other for the best fancy-dress outfits and typical celebrity figures that are later burnt. Examples of recent figures include the Pope, Margaret Thatcher, George W. Bush and Osama bin Laden.

The largest and probably the most impressive annual fireworks display in the UK is however held not in November, but in early September in Edinburgh. Since 1981 the world's largest arts festival has ended each year with a combination of live open air orchestral pieces (performed in the Ross Band Stand, Princes Street Gardens) whilst a panoply of fireworks are launched from the ramparts of Edinburgh Castle immediately behind. The natural amphitheatre which the Princes Street area provides creates a perfect setting for enjoying the music and fireworks.

Along the same lines, in Canada, during Victoria Day and Canada Day, many fireworks displays are seen throughout.

This event was also re-enacted in V for Vendetta along with the children's rhyme.

Fireworks are now used extensively throughout the year in the UK for festivals and other events.

Thrissur Pooram fireworks, India

Thrissur Pooram is one of the most colourful and spectacular temple festivals of Kerala, India. It is a magnificent spectacle with fireworks, parasol exchange competition and a splendid elephant procession accompanied with percussion ensemble.

Fireworks in the festival is the one of the greatest fireworks in India, which is held in the wee hours of the day after the Pooram. The Thiruvambadi and Paramekkavu Devaswams present many innovative patterns and varieties of fireworks, which make spectators going into raptures. This famous and mighty exhibit of the magnificent display of fireworks add to the popularity of the Pooram festival.

Thrissur Pooram, the mother of all temple festivals in the state, is essentially one of spectacles. The two devaswams- Thiruvampadi and Paramekkavu- explore and exploit every source at their command to make this annual festival a memorable one. It is celebrated with a colourful procession of caparisoned elephants, parasol exchanges; drum concerts, display of pyro-techniques and refreshing scenes of public participation.

The firework shows at the Nemmara Vela in Palakkad district and Sri. Kottaram Bhagavathy temple, Maradu in Ernakulam district are the other major firework shows of Kerala.

U.S. Independence Day

Each year before the American Independence Day (4 July) retailers across the nation experience a surge in fireworks sales. Independence Day is a federal holiday celebrating the adoption of the Declaration of Independence on July 4, 1776, declaring independence from the Kingdom of Great Britain.

Independence Day is commonly associated with parades, barbecues, picnics, baseball games, and various other public and private events celebrating the history and traditions of the U.S. Fireworks have been associated with the Independence since 1777.

In many states, **consumer fireworks** are sold for personal use or as an alternative to a public show. Concerns about safety have led some states to ban fireworks or limit the sizes and types allowed, but illicit traffic from less restrictive border states is common.

Some of the most famous fireworks displays include Macy's - 4th of July Fireworks in New York (the largest in the country), Houston, and the Boston display on the Charles River esplanade. There are also many other spectacular displays in St. Louis, Washington D.C., and Philadelphia. Detroit, Michigan and Windsor, Ontario host one of the largest fireworks displays in the world over the Detroit River each year in celebration of both American Independence Day and Canada Day during the Windsor-Detroit International Freedom Festival.

Victoria Day (Canada)

Victoria Day is the official celebration in Canada of the birthdays' of Queen Victoria and Queen Elizabeth II. It is a federal holiday celebrated annually on the Monday before May 25th. Colloquially referred to as May Two-Four, along with Canada Day it is one of only two holidays, in most municipalities, where the public can purchase and ignite fireworks in Canada.

Canada Day

Canada Day (French: Fête du Canada) is Canada's national holiday, marking the establishment of Canada as a Dominion on July 1, 1867. It is a federal holiday celebrated on July 1, annually by all provincial governments and most businesses across the country. The celebration typically includes fireworks.

Thunder Over Louisville

Held annually in Louisville, Kentucky; this event is the kick-off for the two week long Kentucky Derby Festival. It is the largest annual fireworks display in North America. The event lasts throughout the day, including an extensive airshow. The fireworks show itself lasts for around half an hour, along with a synchronized soundtrack through PA and radio. Several hundred thousand people attend each year, lining the banks of the Ohio River in Louisville, and across the river in Jeffersonville, Indiana and Clarksville, Indiana. Some also watch from the river on boats, docked in positions auctioned off for charity.[1] Eight 400-foot (120 m) barges launch the fireworks, provided by Zambelli Fireworks Internationale, from both sides of the George Rogers Clark Memorial Bridge (Second Street Bridge), and more fireworks are launched from the bridge itself. In the event's first year, 1990, only 4,000 shells were used; by 1996 4,000 shells were fired within the event's first minute, and in 2007 the crowd for the event was estimated at 800,000 people.

Diwali ('*Festival of Lights*') in India

Diwali is the most popular festival of India, which broadly celebrates the triumph of good over evil primarily symbolized in the epic of Ramayana in which the Hindu God Rama defeats his demonic adversary Ravana. Customary traditions include offering prayers to the Gods in the morning and exchanging sweets with friends and neighbors. During the night the houses are adorned with small lit oil lamps and colorful lights and then the entire family participates in the display of fireworks.

Unlike Western nations, retail of fireworks is largely unrestricted in India. People have access to a variety of fireworks and most of them in urban areas set them off on the public roads running in front of their houses. In smaller towns, the large temples of the town typically have public fireworks displays. Deepavali brings the spirit of goodwill and brotherhood and is celebrated across all religions in India. Some popular fireworks include the famous 'phoolthari' or 'sparkler' which is commonly used in lighting most other fireworks. The 'Anaar' or 'Flowerpedal' displays as a large mountain of fire when lit. The 'Zameen Chakra' is a spinning circle of fire with sparks emitting from it. The 'rocket' is popular but dangerous, as it can change its course and fly into buildings. Bombs like 'Chilli Bombs' and 'Laxmi bombs' are becoming popular, but are sometimes disturbing due to their high intensity.

Fireworks in an Indian house on Diwali day

Maltese Petards

A firework during a traditional Maltese feast.

In Malta, local patron saints' holidays are usually celebrated with spectacular fireworks and bombs called petards or *murtali* in Maltese. Petardry is a popular hobby and a traditional skill in Malta, and Maltese fireworks are usually homemade. Manufacture is often high-risk,[6] but the final results are extravagant.

In the opinion of many fireworks artists, Malta is one of the best places in the world for the manufacture of fireworks. The 'Malta International Fireworks Festival', held annually at the end of April in the Valletta Grand Harbour, is a fireworks competition open to all pyrotechnic manufacturers of the world. In 2003 the event began as just a festival to showcase Maltese talent, but in 2006 the committee decided to retool it into a competition open to manufacturers worldwide. The first of these international fireworks competitions was contended by two foreign groups and three Maltese groups. The title was won by the St. Mary Fireworks Factory, of Mqabba, which won five of the seven honours, including the shield for the best display overall, with the remaining two honours being won by another Maltese competitor, St Michael's Fireworks of Lija. The great extent of Maltese talent, however, is most evident during summer and spring, during which many cities and villages celebrate the feasts of their patron saints and local artists produce their best fireworks. The Maltese take pride in their renown as one of the foremost in the pyrotechnic industry.

Fireworks World Records

The current Guinness World Records as of 5th November 2007 are:

Largest Catherine Wheel

A self-propelled vertical firework wheel 25.95m 85ft in diameter was designed by the Newick Bonfire Society Ltd and fired for at least one revolution on 30 Oct 1999 at the Village Green, Newick, East Sussex, UK.

Largest firework display

The record for the largest firework display consisted of 66,326 fireworks and was achieved by Macedo'S Pirotecnia Lda. in Funchal, Madeira, Portugal, on 31 December 2006.

Longest firework waterfall

The world's longest firework waterfall was the 'Niagara Falls', which measured 3,125.79 m (10,255 ft 2.5 in) when ignited on 24 August 2003 at the Ariake Seas Fireworks Festival, Fukuoka, Japan.

Most firework rockets launched in 30 seconds

The record for the most firework rockets launched in 30 seconds is 56,405, in an attempt organized by Dr Roy Lowry (UK), executed by Fantastic Fireworks, at the 10th British Firework Championship in Plymouth, UK, on 16 August 2006.

Largest bonfire

The largest bonfire had an overall volume of 1,401.6 m^3 (49,497 ft^3). The bonfire was built by Colin Furze (UK) in Thistleton, Leicestershire, UK, and lit on 14 October 2006.

Tallest bonfire

The world's tallest bonfire tondo measured 37.5 m (123 ft) high, with a base of 8 m^2 (86 ft^2) and an overall volume of 800 m^3 (28,251 ft^3). The event was organized by Kure Commemorative Centennial Events Committee, and lit on 9 February 2003 at Gohara-cho, Hiroshima, Japan, as part of a traditional ceremony to encourage good health and a generous harvest.

Clubs

Enthusiasts in the United States have formed clubs which unite hobbyists and professionals. The groups provide safety instruction and organize meetings and private “shoots” at remote premises where members shoot commercial fireworks as well as fire pieces of their own manufacture. Clubs secure permission to fire items otherwise banned by state or local ordinances. Competition among members and between clubs, demonstrating everything from single shells to elaborate displays choreographed to music, are held. One of the oldest clubs is Crackerjacks, Inc.[[1]], organized in 1976 in the Eastern Seaboard region of the U.S.

PGI Annual Convention

The Pyrotechnics Guild International, Inc. or PGI, founded in 1969, is an independent worldwide nonprofit organization of amateur and professional fireworks enthusiasts. It is notable for its large number of members, around 3,500 in total. The PGI exists solely to further the safe usage and enjoyment of both professional grade and consumer grade fireworks while both advancing the art and craft of pyrotechnics and preserving its historical aspects. Each August the PGI conducts its annual week-long convention, where some the world's biggest and best fireworks displays occur. Vendors, competitors, and club members come from around the USA and from various parts of the globe to enjoy the show and to help out at this all-volunteer event. Aside from the nightly firework shows, the competition is a highlight of the convention. This is a completely unique event where individual classes of hand-built fireworks are competitively judged, ranging from simple fireworks rockets to extremely large and complex aerial shells. Some of the biggest, best, most intricate fireworks displays in the United States take place during the convention week.

Amateur and professional members can come to the convention to purchase fireworks, paper goods, novelty items, non-explosive chemical components and much more at the PGI trade show. Before the nightly fireworks displays and competitions, club members have a chance to enjoy open shooting of any and all legal consumer or professional grade fireworks, as well as testing and display of hand-built fireworks. The 'superstring', consisting of firecrackers numbering somewhere in the millions, as well as the 'megastring' are displayed as well. The week ends with the Grand Public Display on Friday night, which gives the chosen display company a chance to strut their stuff in front of some of the world's biggest fireworks aficionados. The stakes are high and much planning is put into the show. In 1994 a shell of 36 inches (910 mm) in diameter was fired during the convention, more than twice as large as the largest shell usually seen in the USA, and shells as large as 24 inches (610 mm) are frequently fired.

Halloween

In Ireland (both the Republic of Ireland and Northern Ireland), during the Halloween season, there are many spectacular fireworks displays. The largest are in Derry and Dublin. The sale of fireworks is restricted in the Republic of Ireland, though many illegal fireworks are sold throughout October or smuggled over the Northern Ireland border. There is a €10,000 fine for possessing them, or a five year prison sentence.

Both fireworks and firecrackers are a popular tradition during Halloween in Vancouver, although apparently this is not the custom elsewhere in Canada. The only known fireworks used during All Hallows' Eve in the United States is the annual "Happy Hallowishes" show at Walt Disney World's Magic Kingdom "Mickey's Not-So-Scary Halloween Party" event, which began in 2005.

Singapore Fireworks Celebrations

Singapore Fireworks Festival 2006, 8 Aug 2006

The Singapore Fireworks Celebrations (previously the *Singapore Fireworks Festival*) is an annual event held in Singapore as part of its National Day celebrations. The festival features local and foreign teams which launch displays on different nights. While currently non-competitive in nature, the organizer has plans to introduce a competitive element in the future.

The annual festival has grown in magnitude, from 4,000 rounds used in 2004, 6,000 in 2005, to over 9,100 in 2006.

Japanese Fireworks Festivals (花火大会)

During the summer in Japan fireworks festivals are held nearly everyday someplace in the country, in total numbering more than 200 during the month of August. The festivals consist of large fireworks shows, the largest of which use between 100,000 and 120,000 rounds (Tondabayashi, Osaka), and can attract more than 800,000 spectators. Street vendors set up stalls to sell various drinks and staple Japanese food (such as Yakisoba, Okonomiyaki, Takoyaki, shaved ice), and traditionally held festival games, such as Kingyo-sukui, or Goldfish-catching.

Both men and women don Yukata, summer Kimono (women only), or Jinbei (men only) and attend these events, collecting in large social circles of family or friends to sit picnic-like, eating and drinking, while watching the show.

Uses other than public displays

Consumer fireworks are fireworks the general public can buy. They typically involve using a punk to light them with and have less explosive power than professional fireworks, but can still produce a decent show. Some examples of consumer fireworks are firecrackers, rockets, and smoke balls.

Fireworks can also be used in an agricultural capacity as bird scarers.

Fireworks classifications in the United States

The United States government has classified fireworks and similar devices according to their potential hazards.

Previous US Department of Transportation (DOT) explosives classifications

Independence Day fireworks in San Diego, California

Explosives, including fireworks, were previously divided into four classifications for transportation purposes by the DOT.

- **Class A** explosives included high explosives such as dynamite, TNT, blasting caps, packages of flash powder, bulk packages of black powder and blasting agents such as ANFO and other slurry types of explosives.
- **Class B** explosives included low explosives such packages of flash powder and "special" fireworks" which were the larger and more powerful fireworks used at most public displays.
- **Class C** explosives included other low explosives such as igniters, fuses and "common fireworks", which were the smaller and less powerful fireworks available for sale to and use by the general public.

At the time most purchases and use of all of these explosives, with specific exceptions for high explosives purchased and used in state, black powder used for sporting purposes and common fireworks, required either a Bureau of Alcohol, Tobacco and Firearms {previous name for Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)} license or permit to purchase and use, and/or a state or local license or permit to purchase and use.

New explosives classes

The U.S. government now uses the United Nations **explosives shipping classification system**. This new system is based on hazard in shipping only, vs. the old USA system of both shipping and use hazards. The BATF and most states performed a direct substitution of **Shipping Class 1.3** for **Class B**, and **Shipping Class 1.4** for **Class C**. This allows some hazardous items that would have previously been classified as **Class B** and regulated to be classified as **Shipping Class 1.4** due to some packaging method that confines any explosion to the package. Being **Shipping Class 1.4**, they can now be sold to the general public and are unregulated by the BATF.

A code number and suffix (such as **1.3G**) is not enough to fully describe a material and how it is regulated, especially in **Shipping Class 1.4G**. It also must have a **UN Number** that exactly describes the material. For example, common consumer fireworks are **UN0336**, or **Shipping Class 1.4G UN0336**.

Here are some *common* fireworks classes:

- **Class 1.1G** (Mass Explosion Possible:Pyrotechnics) **UN0094** Flashpowder
- **Class 1.1G** (Mass Explosion Possible:Pyrotechnics) **UN0333** Fireworks (Salutes in bulk or in manufacture)
- **Class 1.2G** (Projection but not mass explosion:Pyrotechnics) **UN0334** Fireworks (Rarely used)
- **Class 1.3G** (Fire, Minor Blast:Pyrotechnics) **UN0335** Fireworks (Most Display Fireworks) Current federal law states that (without appropriate ATF license/permit) the possession or sale of any display/professional fireworks is a felony punishable by up to 5 years in prison. Although some large firecraker items may be called "M-80's", "M-1000's", "Cherry bombs" or "Silver Salutes" by the manufacturer, they must contain less than 50-milligrams of flash or other explosive powder in order to be legally sold to consumers in the United States.
  - any ground salute device with over 50 milligrams of explosive composition
  - torpedoes (except for railroad signaling use)
  - multi-tube devices containing over 500 grams of pyrotechnic composition and without 1/2" space between each tube
  - any multiple tube fountains with over 500 grams of pyrotechnic composition and without 1/2" space between each tube
  - any reloadable aerial shells over 1.75" diameter
  - display shells
  - any single-shot or reloadable aerial shell/mine/comet/tube with over 60 grams of pyrotechnic composition
  - any Roman candle or rocket with over 20 grams of pyrotechnic composition
  - any aerial salute with over 130 milligrams of explosive composition
- **Class 1.4G** (Minor Explosion Hazard Confined To Package:Pyrotechnics) **UN0336** Fireworks (Consumer or Common Fireworks) Most popular consumer fireworks sold in the US.
  - reloadable aerial shells 1.75" or less sold in a box with not more than 12 shells and one launching tube
  - single-shot aerial tubes
  - bottle rockets
  - skyrockets and missiles
  - ground spinners, pinwheels and helicopters
  - flares & fountains
  - Roman candles
  - smoke and novelty items
  - multi-shot aerial devices, or "cakes"
  - firecracker packs (see this link for various brand/label images)
  - sparklers
  - Catherine wheel
  - black snakes and strobes
  - mines
- **Class 1.4S** (Minor Explosion Hazard Confined To Package: Packed As To Not Hinder Nearby Firefighters) **UN0336** Fireworks (Consumer or Common Fireworks)
- **Class 1.4G** (Minor Explosion Hazard Confined To Package:Pyrotechnics) **UN0431** ARTICLES, PYROTECHNIC for technical purposes (Proximate Pyrotechnics)
- **Class 1.4S** (Minor Explosion Hazard Confined To Package: Packed As To Not Hinder Nearby Firefighters) **UN0432** ARTICLES, PYROTECHNIC for technical purposes (Proximate Pyrotechnics)

Fireworks tubes are made by rolling thick paper tightly around a former, such as a dowel. They can be made by hand, most firework factories use machinery to manufacture tubes. Whenever tubes are used in fireworks, at least one end is always plugged with clay to keep both chemicals and burning gases from escaping through that end. The tooling is always made of non-sparking materials such as aluminium or brass. Experts at handling explosives, called pyrotechnicians, add chemicals for special effects.

British fireworks classification

Britain has its own system of classifying fireworks.

- **Category 1** - indoor fireworks, for use in small areas.
- **Category 2** - garden fireworks; must be safely viewable from 5 metres and must not scatter debris beyond 3 metres.
- **Category 3** - display fireworks; must be safely viewable from 25 metres and must not scatter debris beyond 50 metres.
- **Category 4** - professional fireworks; these require a license to use.

Pyrotechnic compounds

Colors in fireworks are usually generated by ***pyrotechnic stars***–usually just called ***stars***–which produce intense light when ignited. Stars contain five basic types of ingredients.

- A **fuel** which allows the star to burn
- An **oxidizer**—a compound which produces (usually) oxygen to support the combustion of the fuel
- **Color**-producing chemicals
- A **binder** which holds the pellet together.
- A **Chlorine Donor** which provides chlorine to strengthen the color of the flame. Some times the oxidizer can serve this purpose.

Copper compounds glow green or blue-green in a flame.

Some of the more common color-producing compounds are tabulated here. The color of a compound in a firework will be the same as its color in a flame test (shown at right). Not all compounds that produce a colored flame are appropriate for coloring fireworks, however. Ideal colorants will produce a pure, intense color when present in moderate concentration.

Color	Metal	Example compounds
Red	Strontium (intense red)	$SrCO_3$ (strontium carbonate)
	Lithium (medium red)	Li_2CO_3 (lithium carbonate)
Orange	Calcium	$CaCl_2$ (calcium chloride)
Yellow	Sodium	$NaNO_3$ (sodium nitrate)
Green	Barium	$BaCl^+$ (barium chloride ions)
Blue	Copper halides	$CuCl_2$ (copper chloride), at low temperature
Purple	Potassium or Strontium + Copper	KNO_3 (Potassium Nitrate) or $SrCl^+ + CuCl^+$ (Strontium Chloride + Copper Chloride)
Gold	Charcoal, iron, or lampblack	
White	Titanium, aluminium, or magnesium powders	

The brightest stars, often called **Mag Stars**, are fueled by aluminium. Magnesium is rarely used in the fireworks Industry due to its lack of ability to form a protective oxide layer. Often an alloy of both metals called magnalium is used.

Types of effects

Peony

A spherical break of colored stars. The peony is the most commonly seen shell type.

Chrysanthemum

A spherical break of colored stars, similar to a peony, but with stars that leave a visible trail of sparks.

Dahlia

Essentially the same as a peony shell, but with fewer and larger stars. These stars travel a longer-than-usual distance from the shell break before burning out. For instance, if a 3" peony shell is made with a star size designed for a 6" shell, it is then considered a dahlia. Some dahlia shells are cylindrical rather than spherical to allow for larger stars.

Willow

Similar to a **chrysanthemum**, but with long-burning silver or gold stars that produce a soft, dome-shaped weeping willow-like effect.

Palm

A shell containing a relative few large comet stars arranged in such a way as to burst with large arms or tendrils, producing a palm tree-like effect. Proper palm shells feature a thick rising tail that displays as the shell ascends, thereby simulating the tree trunk to further enhance the "palm tree" effect. One might also see a burst of color inside the palm burst (given by a small insert shell) to simulate coconuts.

A collection of palm-shell fireworks illuminating the beach of Tybee Island, Georgia

Ring

A shell with stars specially arranged so as to create a ring. Variations include smiley faces, hearts, and clovers.

Diadem

A type of **Peony** or **Chrysanthemum** with a center cluster of non-moving stars, normally of a contrasting color or effect. The name comes from the Latin word for "jewel".

Kamuro

A dense burst of glittering silver or gold stars which leave a heavy glitter trail. The name refers to a common Japanese hairstyle.

A typical kamuro effect

Crossette

A shell containing several large stars that travel a short distance before breaking apart into smaller stars with a loud crackling sound, creating a crisscrossing grid-like effect. Once limited to silver or gold effects, colored crossettes such as red, green, or white are now very common.

Spider

A shell containing a fast burning tailed or charcoal star that is burst very hard so that the stars travel in a straight and flat trajectory before burning out. This appears in the sky as a series of radial lines much like the legs of a spider.

Horsetail

Named for the shape of its break, this shell features heavy long-burning tailed stars that only travel a short distance from the shell burst before free-falling to the ground. Also known as a waterfall shell. Sometimes there is a glittering through the "waterfall."

Time Rain

An effect created by large, slow-burning stars within a shell that leave a trail of large glittering sparks behind and make a very loud sizzling noise. The "time" refers to the fact that these stars burn away gradually, as opposed to the standard brocade "rain" effect where a large amount of glitter material is released at once.

Multi-Break shells

A large shell containing several smaller shells of various sizes and types. The initial burst scatters the shells across the sky before they explode. Also called a bouquet shell. When a shell contains smaller shells of the same size and type, the effect is usually referred to as "Thousands". Very large bouquet shells (up to 48 inches) are frequently used in Japan.

A typical spider effect

Fish

Large inserts that propel themselves rapidly away from the shell burst, often looking like fish swimming away.

Salute

A shell containing a large quantity of flash powder rather than stars, producing a quick flash followed by a very loud report. Titanium may be added to the flash powder mix to produce a cloud of bright sparks around the flash. Salutes are commonly used in large quantities during finales to create intense noise and brightness. They are often cylindrical in shape to allow for a larger payload of flash powder, but ball shapes are common and cheaper as well. Salutes are also called Maroons.

Lampare

A shell containing a burst charge of flash powder that sits above a container of liquid fuel, usually diesel fuel or kerosene, to produce a fireball in the sky.

Mine

A mine (aka. pot-au-′feu) is a ground firework that expels stars and/or other garnitures into the sky. Shot from a mortar like a shell, a mine consists of a canister with the lift charge on the bottom with the effects placed on top. Mines can project small reports, serpents, small shells, as well as just stars. Although mines up to 12 inches in diameter appear on occasion, they are usually between 3 and 5 inches in diameter.

Roman Candle

A Roman candle is a long tube containing several large stars which fire intermittently at a regular interval. These are commonly arranged in fan shapes or crisscrossing shapes, at a closer proximity to the audience. Some larger Roman candles contain small shells (bombettes) rather than stars.

Cake

A cake is a cluster of small tubes linked by fuse, that fire small aerial effects at a rapid pace. Tube diameters can range in size from ¼ inch to 4 inches, and can sometimes have over 1,000 shots. These are often used in large quantities as part of a show's finale. The variety of effects within individual cakes is often such that they defy descriptive titles and are instead given cryptic names such as "Bermuda Triangle", "Pyro Glyphics", "Waco Wakeup", and "Poisonous Spider", to name a few. Others are simply quantities of 2.5"-4" shells fused together in single-shot tubes.

Laws and politics

Safety of consumer fireworks in USA

Availability and use of consumer fireworks are hotly debated topics. Critics and safety advocates point to the numerous injuries and accidental fires that are attributed to fireworks as justification for banning or at least severely restricting access to fireworks. Complaints about excessive noise created by fireworks and the large amounts of debris and fallout left over after shooting are also used to support this position. There are numerous incidents of consumer fireworks being used in a manner that is supposedly disrespectful of the communities and neighborhoods where the users live.

Meanwhile, those who support more liberal firework laws look at the same statistics as the critics and conclude that, when used properly, consumer fireworks are a safer form of recreation than riding bicycles or playing soccer.[7]

The Consumer Product Safety Commission has guidelines concerning the standard of consumer fireworks sold in the US. Together with US Customs, they are very proactive in enforcing these rules, intercepting imported fireworks that don't comply and issuing recalls on unacceptable consumer fireworks that are found to have "slipped through". Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) is the federal agency that regulates explosives, including Display Fireworks in the US.

Many states in the United States have laws which further restrict access to and use of consumer fireworks, and some of these states vigorously enforce them. Each year, there are many raids on individuals suspected of illegally possessing fireworks.

In 1998, a non-profit organization called American Fireworks Safety Laboratory (AFSL) was established to develop a voluntary fireworks standard for the US to which members would adhere.[8]

The U.S. Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) as well as the U.S. Consumer Product Safety Commission (CPSC) have general jurisdiction over what types of fireworks may be legally sold in the United States. The federal law is only the minimum standard however, and each state is free to enact laws that are more stringent if they so choose. Citing concerns over fireworks safety, some states, such as California, have enacted legislation restricting fireworks usage to devices that do not leave the ground, such as fountains, while states such as New York , Massachusetts, and Delaware ban all consumer fireworks completely. Arizona and Maine allows only sparklers. On the other hand, states such as South Carolina and Tennessee allow most or all legal consumer fireworks to be sold and used throughout the year. New Mexico in some cases, will not allow fireworks from individual residents if the fireworks are said to detonate over 5 feet (1.5 m) in height.

Pennsylvania is somewhere in between. The law only allows fireworks that don't leave the ground to be sold and used by residents. Yet residents from out of state and Pennsylvania residents with a permit can buy any consumer fireworks from an outlet.

Differences in legislation among states have led many fireworks dealers to set up shop along state borders in order to attract customers from neighboring states where fireworks are restricted. Some Native American tribes on reservation lands show similar behavior, often selling fireworks that are not legal for sale outside of the reservation.

The type of fireworks sold in the United States vary widely, from fireworks which are legal under federal law, all the way to illegal explosive devices/professional fireworks that are sold on the black market. Both the illicit manufacture and diversion of illegal explosives to the consumer market have become a growing problem in recent years.

Safety of display fireworks in USA

Federal, state, and local authorities govern the use of display fireworks in the United States. At the federal level, the National Fire Protection Association (NFPA) sets forth a set of laws which give the minimum standards of display fireworks use and safety in the USA. Both state and local jurisdictions can further add restrictions on the use and safety requirements of display fireworks. Typically, these jurisdictions will require a licensed operator to discharge the show. Although requirements vary from state to state, licensed operators and their crew are typically required to have hours of extensive training in the safe use of display fireworks.

These laws govern the way a licensed operator must set up and fire his display. These laws can include, but are not limited to, distance from the audience, maximum size shell, firing location requirements, electrical firing system requirements, and the minimum safety gear to be worn by the fireworks crew. The above mentioned laws are explained in the NFPA 1123 fireworks code.

Safety of commercial and display fireworks in Canada

Fireworks safety is considered to be extremely important in Canada. The use, storage and sale of commercial-grade fireworks in Canada is licensed by Natural Resources Canada's Explosive Regulatory Division (ERD). Unlike their consumer counterpart, commercial-grade fireworks function differently, and come in a wide range of sizes from 50 mm (2 inches) up to 300 mm (12 inches) or more in diameter. Commercial grade fireworks require handling permits issued by the Explosive Regulatory Division. Since commercial-grade fireworks are shells which are loaded into separate mortars by hand, there is danger in every stage of the setup.[9] Setup of these fireworks involves the placement and securing of mortars on wooden or wire racks; loading of the shells; and if electronically firing, wiring and testing. The mortars are generally made of FRE (Fiber-Reinforced Epoxy) or HDPE (High-Density Polyethelene), some older mortars are made of Sheet Steel, but have been banned by most countries due to

the problem of shrapnel produced during a misfire.

Setup of mortars in Canada for an oblong firing site require that a mortar be configured at an angle of 10 to 15 degrees down-range with a safety distance of at least 200 meters down-range and 100 meters surrounding the mortars, plus distance adjustments for wind speed and direction. In June of 2007, the ERD approved circular firing sites for use with vertically fired mortars with a safety distance of at least 175 meter radius, plus distance adjustments for wind speed and direction. [10]

Loading of shells is a delicate process, and must be done with caution, and a loader must ensure not only the mortar is clean, but also make sure that no part of their body is directly over the mortar in case of a premature fire. Wiring the shells is a painstaking process; whether the shells are being fired manually or electronically, any "chain fusing" or wiring of electrical ignitors, care must be taken to prevent the fuse (an electrical match, often incorrectly called a squib) from igniting. If the setup is wired electrically, the electrical matches are usually plugged into a "firing rail" or "breakout box" which runs back to the main firing board; from there, the Firing Board is simply hooked up to a car battery, and can proceed with firing the show when ready.

Since commercial-grade fireworks are so much larger and more powerful, setup and firing crews are always under great pressure to ensure they safely set up, fire, and clean up after a show.

Safety of Consumer Fireworks In Britain

Safety of Consumer Fireworks in England, Scotland and Wales is always a widely discussed topic around Bonfire Night, November 5th. The most common injuries are burns from hand-held fireworks such as sparklers. There are also injuries due to people being hit by projectiles fired from fireworks, although these can usually be explained by people setting up fireworks incorrectly. Other issues include the dangers of falling rocket sticks, especially from larger rockets containing metal motors. "Shock" adverts have been used for many years in an attempt to restrict injuries from fireworks, especially targeted at young people. The vast majority of fireworks are "Category 3," all of which state that spectator must be at least 25 metres away when the firework is fired. This is a safety concern as few people have access to that amount of private space.

Safety of commercial and display fireworks in Britain

In the UK, responsibility for the safety of firework displays is shared between the Health and Safety Executive, fire brigades and local authorities. Currently, there is no national system of licencing for fireworks operators, but in order to purchase display fireworks, operators must have licenced explosives storage and public liability insurance. All reputable companies are members of either the Explosives Industry Group (EIG) of the Confederation of British Industry or the British Pyrotechnics Association (BPA).

Pollution

Fireworks produce smoke and dust that may contain residues of heavy metals, sulfur-coal compounds and some low concentration toxic chemicals. These by-products of fireworks combustion will vary depending on the mix of ingredients of a particular firework. (The color green, for instance, may be produced by adding the various compounds and salts of Barium, some of which are toxic, and some of which are not.) Some fisherman have noticed and reported to environmental authorities that firework residues can hurt fish and other waterlife because some may contain toxic compounds such as antimony sulfide. This is a subject of much debate due to the fact that large-scale pollution from other sources makes it difficult to measure the amount of pollution that comes specifically from fireworks. The possible toxicity of any fallout may also be affected by the amount of gunpowder used, type of oxidizer, colors produced and launch method.

Pollutants from fireworks raise concerns because of potential health risks associated with hazardous by-products. For most people the effects of exposure to low levels of toxins from many sources over long periods are unknown. For persons with asthma or multiple chemical sensitivity the smoke from fireworks may aggravate existing health problems. Environmental pollution is also a concern because heavy metals and other chemicals from fireworks may contaminate water supplies and because fireworks combustion gases might contribute to such things as acid rain which can cause vegetation and even property damage. However, gunpowder smoke and the solid residues are basic, and as such the net effect of fireworks on acid rain is debatable. The carbon used in fireworks is produced from wood and does not lead to more carbon dioxide in the air. What is not disputed is that most consumer fireworks leave behind a considerable amount of solid debris, including both readily biodegradable components as well as nondegradable plastic items. Concerns over pollution, consumer safety, and debris have restricted the sale and use of consumer fireworks in many countries. Professional displays, on the other hand, remain popular around the world.

Others argue that alleged concern over pollution from fireworks constitutes a red herring, since the amount of contamination

from fireworks is minuscule in comparison to emissions from sources such as the burning of fossil fuels. In the US some states and local governments restrict the use of fireworks in accordance with the Clean Air Act which allows laws relating to the prevention and control of outdoor air pollution to be enacted. Few governmental entities, by contrast, effectively limit pollution from burning fossil fuels such as diesel fuel or coal. Coal fueled electricity generation alone is a much greater source of heavy metal contamination in the environment than fireworks.

Misconceptions on fireworks chemistry

Many journalists and websites misrepresent the chemical content of fireworks. This may be due to outdated information, a lack of research, or due to the potential for the rapid proliferation of factual inaccuracies on the Internet. Many of the chemicals used in the manufacture of fireworks are non-toxic, while many more have some degree of toxicity, can cause skin sensitivity, or exist in dust form and are thereby inhalation hazards. Still others are poisons if directly ingested or inhaled.

Some reports on fireworks incorrectly contend that fireworks contain chemicals such as radioactive barium, in effect creating radioactive fallout. Radioactive substances such as the isotopes of barium have no application in fireworks and are simply not used. Elemental lead, rubidium, and cadmium also are not used in fireworks, and their compounds see little if any use. Other reports contend that fireworks contain arsenic, dioxins, or other extremely poisonous chemicals, when in fact such chemicals are not used in modern-day fireworks. Such reports are simply false and are easily debunked with the use of common chemistry or pyrotechny texts, but this does little to stop the spread of these common inaccuracies.[11]

Laws governing consumer fireworks

United States

In the United States, the laws governing consumer fireworks vary widely from state to state, or from county to county. It is common for consumers to cross state and county lines in order to purchase types of fireworks which are outlawed in their home-jurisdictions. Fireworks laws in urban areas typically limit sales or use by dates or seasons. Municipalities may have stricter laws than their counties or states do.

The American Pyrotechnic Association maintains a directory of state laws pertaining to fireworks.

Five states (Delaware, Massachusetts, New Jersey, New York, and Rhode Island) ban the sale of all consumer fireworks including novelties and sparklers by the general public.

One state (Arizona) permits residents to purchase and use only novelties.

Four states (Illinois, Iowa, Maine, and Vermont) permit residents to purchase and use only wire or wood stick sparklers and other novelties.

Nineteen states (California, Colorado, Connecticut, Florida, Georgia, Kentucky, Idaho, Maryland, Michigan, Minnesota, Nebraska, North Carolina, Oregon, Pennsylvania, Utah, Virginia, Wisconsin, West Virginia, and the District of Columbia) allow residents to purchase and use non-aerial and non-explosive fireworks like novelties, fountains and sparklers.

For example: California has very specific requirements for the types of consumer fireworks that can be sold to and used by residents. Even then each city can and often does place restrictions on sale and use.

Another example: In Minnesota only consumer fireworks that do not explode or fly through the air are now permitted to be sold to and used by residents. In Nebraska the sale and use of all consumer fireworks are prohibited in Omaha, while in Lincoln there is a two day selling period and in other parts of the state all of the permitted types can be sold and used by residents.

Twenty states — Alabama, Alaska, Arkansas, Indiana, Kansas, Louisiana, Mississippi, Missouri, Montana, New Hampshire, New Mexico, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Washington and Wyoming — permit the sale of all or most types of consumer fireworks to residents. Many of these states have selling seasons around Independence Day and/or Christmas and New Year's Eve. Some of these states also allow local laws or regulations to further restrict the types permitted or the selling seasons.

For example: Missouri permits all types of consumer fireworks to be sold to residents with two selling seasons; June 20–July 10 and December 20–January 2. South Carolina permits all types of consumer fireworks except small rockets less than ½” in diameter and 3” long to be sold and used by residents year round.

Two states (Hawaii and Nevada) allow each county to establish their own regulations.

For example, Clark County, Nevada, where Las Vegas is located, allows residents to purchase and use only non-explosive and non-aerial consumer fireworks during Independence Day, while other counties permit all types of consumer fireworks.

Many states have stores with all types of consumer fireworks that sell to non-residents with the provision they are to remove the purchased fireworks from that state. This is why there are so many stores selling fireworks in states like Pennsylvania, Ohio, Florida, Missouri, New Hampshire, Nevada and Wisconsin with all types of consumer fireworks, even though residents are limited or prohibited from buying or using those very same consumer fireworks unless they have the appropriate licenses and/or permits.

Many Native American Tribes have consumer fireworks stores on reservation lands that are exempt from state and local authority. However, they are not exempt from federal law.

Because some states restrict the in-state use of fireworks by purchasers, large fireworks stores, like this one near Richmond, Indiana, are sometimes located on state borders.

Other countries

In the United Kingdom fireworks cannot be sold to people under the age of 18 and are not permitted to be set off between 11pm and 7am with exceptions only for New Year, Bonfire Night (5 November), the Chinese New Year and Diwali.[12] The legal NEC (Net Explosive Content) of a UK Firework available to the public is 2 Kilos- 4 times the legal amount in the USA. Jumping Jacks, Strings of Firecrackers, Shell Firing tubes, Bangers and Mini-Rockets were all banned during the 1990s. In 2004 single shot Air Bombs and Bottle Rockets were banned, and rocket sizes were limited. From March 2008 any firework with over 5% flashpowder per tube will be classified 1.3G. The aim of these measures was to eliminate "pocket money" fireworks, and to limit the disruptive effects of loud bangs.

Fireworks in New Zealand are available from the 2nd-5th November, and may be purchased only by those 18 years of age and older (up from 14 years pre-2007). Despite the restriction on when fireworks may be sold, there is no restriction regarding when fireworks may be used. The types of fireworks available to the public are multi-shot "cakes", Roman candles, single shot shooters, ground and wall spinners, fountains, cones, sparklers, and various novelties, such as smoke bombs and Pharaoh's serpents. Skyrockets, and other fireworks where the firework itself flies, are specifically banned, as well as bangers and firecrackers. It is worth noting also that sparklers may not be bought by themselves, available only in larger packets containing other fireworks. This is because of the popularity of sparkler bombs. However, several retailers get around this rule by including a single cheap non-sparkler firework (i.e a fountain) in cheap sparkler assortment packages. These rules are for the 2007 Guy Fawkes season. [2]

In Bergen, Norway, fireworks can only be purchased by people 18 or older. Class 1.3G professional display fireworks are for sale, and only be fired between 6PM and 2AM on the celebration day.

Fireworks in New Zealand

In Tasmania, Australia, Type 1 fireworks are permitted to be sold to the public. For anything that has a large explosion or gets airborne, users need to register for a Type 2 Licence. The Australian Capital Territory allows fireworks to be sold to residents 18 years or older during the week leading up to the Queen's Birthday long weekend for personal purposes. A similar allowance is made in the Northern Territory in the days leading up to Northern Territory Day (July 1). The types of fireworks allowed for sale is restricted to quieter fireworks, which can only be used during the long weekend and only at the address provided to the seller.

In the Netherlands, fireworks cannot be sold to anyone under the age of 16.[13]

In Iceland, the Icelandic law states that anyone may purchase and use fireworks during a certain period around New Year's Eve. Most places that sell fireworks in Iceland make their own rules about age of buyers, usually it is around 16. The people of Reykjavík spend enormous sums of money on fireworks, most of which are fired as midnight approaches on December 31. As a result, every New Year's Eve the city is lit up with fireworks displays.

Ecuador, and indeed, most of South America, sells essentially all types of imaginable fireworks.

See also

- Flame test
- Solid-fuel rocket

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12. ^ Statutory Instrument 2004 No. 1836 The Fireworks Regulations 2004, United Kingdom.
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External links

- The Fireworks Channel: Internet Videos and DVD Documentaries of International Fireworks
- online fireworks shops
- Three articles on fireworks photography from the New York Institute of Photography
- The Pyrotechnics Guild International, an independent worldwide nonprofit organization of amateur and professional fireworks enthusiasts.
- The Fireworks Alliance, a not-for-profit charitable organization dedicated to keeping fireworks legal and preserving the tradition of fireworks for all Americans.
- Illegal Explosive Devices
- About.com The Chemistry of Firework Colors
- Natural Resources Canada's Explosive Regulatory Division - Information and Licensing in Canada.
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