

### Introduction

For occasions of delight, celebration or triumph, a fireworks display says it all. They can attract large crowds, and involve some displays can be massive. In Hyde Park, England, at the end of World War I, some 2,000 rockets were fired at once in the grand finale.

No event seems to preclude an excuse for a fireworks display. For example, the Earl of Sheffield provided one in 1893, at a party to honour the arrival of the Australian cricket team – one of the most expensive private displays on record. Unfortunately there was no need for one back in Australia, on the team's return.

### Gunpowder

Fireworks came with the discovery of gunpowder, sometime before AD 1,000 in China. This mixture of saltpetre (potassium nitrate), charcoal and sulphur, is considered to be one of the most important discoveries of mankind. When the knowledge of gunpowder arrived in Europe about AD 1,250, it revolutionized the nature of warfare, making possible the invention of the canon and musket.

More important, it began to be used in blasting rock, making possible huge engineering projects, as well as releasing coal and minerals locked in the earth, leading to the age of iron and steel.



Until mineral sources of saltpetre were found, the manufacture of those early gunpowders was limited. The only source of nitrate to prepare saltpetre came from leachings of vegetable and animal refuse, and sweepings from slaughterhouses that were mixed with lime, old mortar, earth and ashes. It was sheltered from rain but kept moist with runnings from stables and urine. The stench coming from such piles made saltpetre men *hated and abhorred by the rest of the community*.

Those early gunpowders did not travel well either. The continual bouncing tended to make the heavier saltpetre separate and sink to the bottom, so that it had to be mixed again on the field of battle? Even then it was not all that reliable.

It was found that grinding freshly mixed powder in a mortar and pestle for several hours, produced a far more effective product which burned immediately in a puff of smoke. To prepare this kind of powder, water-powdered mills with some grinding stones weighing up to 7 tons were constructed all over Europe. Even so we are told gunpowder workers kept a *continual Eye upon Heaven*.



### Fireworks

The fireworks industry throughout most of its history has remained secretive, with recipes and formulae being handed down from father to son. It still remains this way today, with the manufacturing techniques remaining basically unchanged.

Fireworks are usually prepared by hand, with the main precautions being required for static electricity and sparks. Floors are coated with a conductive paint, all equipment including presses are electrically grounded, only cotton clothes are worn, and non-ferrous hand tools used: either wood, brass or aluminium.

Oxidizers and fuel are stored separately, and bulk storages operated by one person. Buildings are constructed separate from each other, and have either an intentionally weak roof or wall.

### Fireworks displays

Pre-19th century fireworks displays consisted mainly of noise and rockets, with only a choice of two colours:

orange and gold produced from charcoal and iron filings. Today various metals or metallic salts (Table 1) are added to produce some spectacular coloured effects.

Colour	Metals
Red	Strontium
Orange	Iron
Yellow	Sodium
Green	Barium
Blue	Copper
White	Aluminium or Magnesium

**Table 1: Colours from metals or their salts used in fireworks**

Fireworks can burn at temperatures up to 3600 degrees C, however these temperatures are far too high for most colour effects, and so the pyrotechnician has to ensure colour components burn at much lower temperatures.

This is particularly true of the blue colour from copper. This elusive colour has only been found in recent times. Today, many experts judge the quality of a display by the richness of the blue colour.

Most displays such as the one conducted here in Perth on Australia day, are fired from mortars, in which a firing charge propels the firework to the right altitude before it is set off. The whole show is timed and synchronised, so that no-one needs go near them as they are fired.

### Incidents

Most fire works are either banned or strictly controlled here in Australia, and so, incidents are relatively few. This is not so true of overseas, where they still injure or kill from fire or explosion.

In America, it has been said that nearly as many people have died celebrating independence day, as those who died fighting in it. Even today, *fireworks cause more fires in the United States on July 4 of a typical year than all other causes of fire on the same day combined.*

However they do not allow one cracker that was available about century ago – it was about half a metre long and filled with gun powder. It was said to have made the leaves on trees shiver for at least an acre around.

There are also continuing major incidents in manufacturing and storage premises world-wide:

1. In 1985, an explosion at a fireworks manufacturer in Jennings, Oklahoma, USA destroyed most of the site 20 buildings, killing 21 and injuring 5.
2. In 1987, one woman was killed and 5 injured when a fireworks factory exploded in Caserta, Italy. Several buildings were destroyed.

3. In 1988, one person was killed and 2 injured in Peterborough, England, from an explosion in a fireworks factory, which destroyed a neighbouring workshop and vehicles.

4. In 1989, more than 1.5 tons of fireworks exploded in the main fire station injuring 49 people in Mexico City, Mexico. Prior to this 62 people had died in a huge fire sparked by fireworks. They had just been banned and taken into custody at the fire station.

5. In 1990, a series of 4 explosions at a fireworks factory Candelaria, Philippines killed 10 people and injured 19.

6. In 1991, in Kuala Lumpur, Malaysia, explosions and fire at a fireworks factory killed 41 people and injured 60. The fire burned an adjacent chemical installation, 3 furniture factories, a food-processing plant, a saw-mill and 50 houses.

8. In 1992, a fireworks shop exploded in Jaria, Bihar, India, killing 25 people and injuring 100 others.

Fireworks must be respected and best left to the professionals to handle in large public displays.

But even then, things can go wrong. One display was all set-up ready to go, when a lightning strike sent the whole lot off at once.

Then there was another one where it rained, and not one went off.

### Carmel, Western Australia

On the 6<sup>th</sup> March, 2002, about 1.5 tonne of fireworks were involved at Carmel, WA. A carton of fireworks ignited while being shifted. Two employees escaped while fire spread into other storage magazines. There were two explosions, in which one caused widespread off-site damage to neighbouring houses.

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