


Firework Displays & Safety 



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Just common sense innit? 


- Assessing Risk
- Regulations
- Knowledge of the subject
- "Morbid Imagination"




Before we move on...


Lack of common sense! 




Today's Topics 

- Regulations etc.
- Black Powder (gunpowder)
- Deflagration
- Firework Types
- Estimating Risk
- Planning an event
- Firing a show
- Demonstrations



Regulations etc.
Categories of Firework (BS7114) 


- **Category 1 ("indoor")**
 - fireworks are for use in extremely restricted areas.
- **Category 2 ("garden")**
 - fireworks are for use by the public in their gardens. Safely viewable from 5m, no debris beyond 3m.
- **Category 3 ("display")**
 - fireworks are for use by the public in larger displays. Safely viewable from 25m, no debris beyond 20m.
- **Category 4 ("professional")**
 - for sale only to *fireworks professionals*. They have few restrictions, default category for untested fireworks

Regulations etc.
UN Hazardous Materials – Class 1 

- **1.1** Mass Explosion Hazard
- **1.2** Nonmass explosion, fragment-producing
- **1.3** Mass fire, minor blast or fragment hazard
- **1.4** Moderate fire, no blast or fragment: a consumer firework is 1.4G or 1.4S
- **1.5** Explosive substance, very insensitive (with a mass explosion hazard)
- **1.6** Explosive article, extremely insensitive

Regulations etc. Firework Categories & Classes


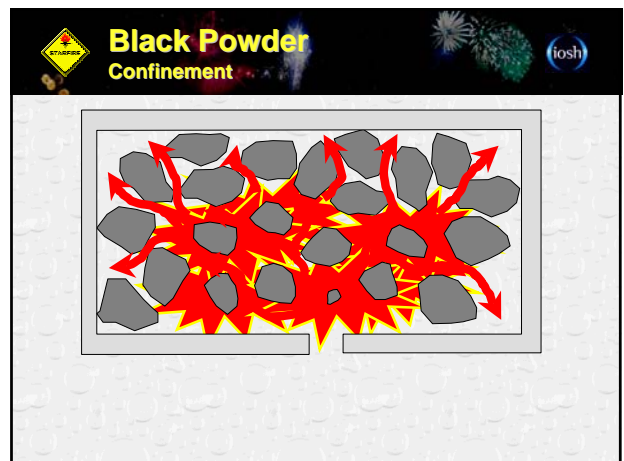
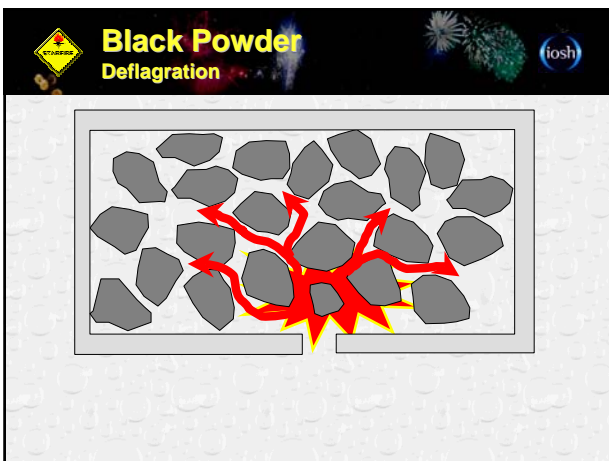
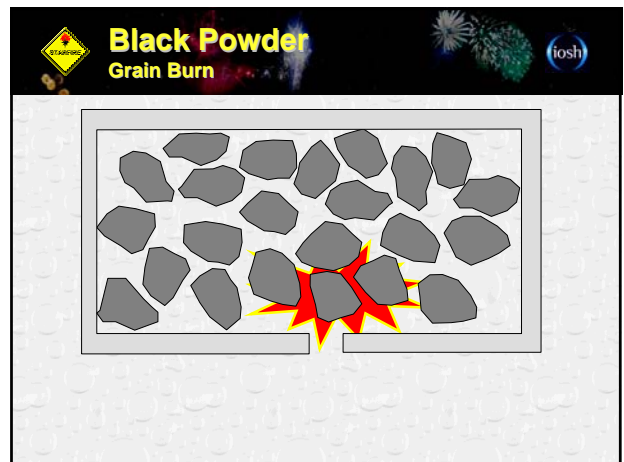
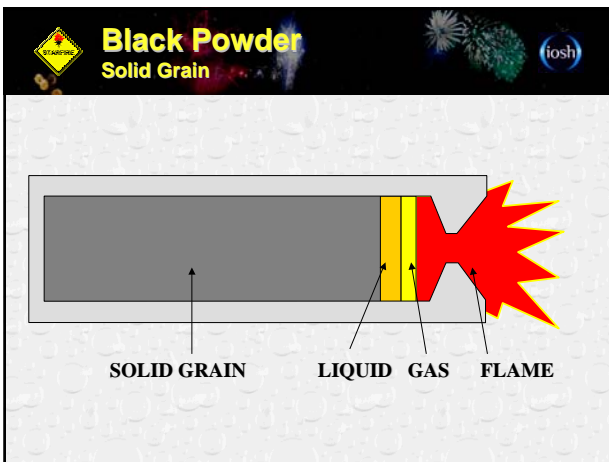
- Consumer Fireworks
 - Usually Cat.3
 - 1.4G
- Display Fireworks
 - Usually Cat.4
 - Mostly 1.3G
 - Large shells now 1.1G
 - (ADR)



Black Powder (Gunpowder) Introduction

Used for:

- Propellant (small grain – e.g. Gun)
- Propellant (large grain – e.g. Rocket)
- Explosive (burst charge)
- Fuses, delays etc.

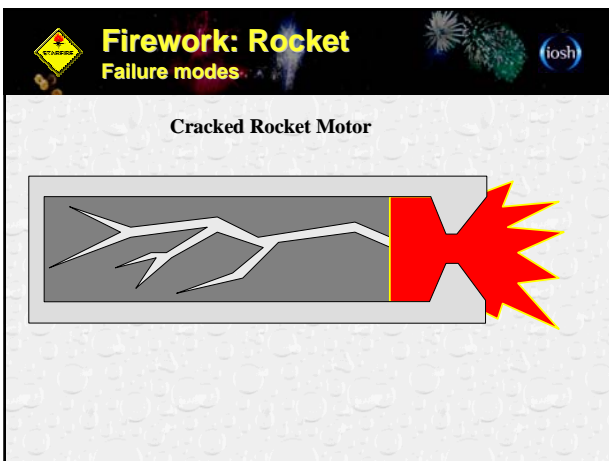
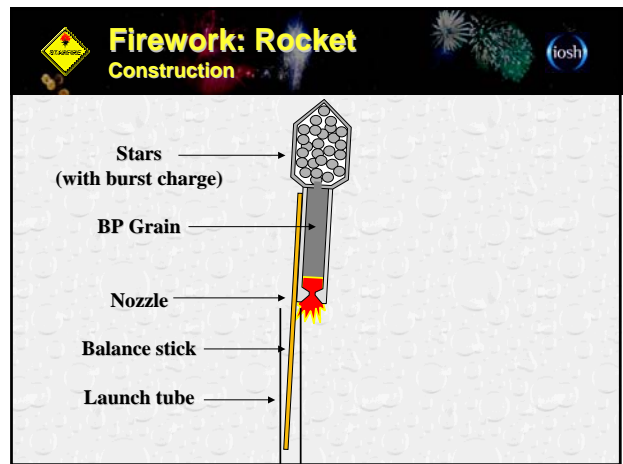



Black Powder
Confinement Failure!

3,000 C
50,000psi

“Flash”

- Perchlorate and atomised Aluminium
- Loud reports
- “Hard Break” shells and rockets
- High Brisance
- ‘explodes’ with little confinement
- >10g = 1.1G



Firework: Rocket

Effect of wind

“CofG”

wind

wind

Angling away from wind – make it worse!

Fireworks: Gerbs

“Fountains”

Solid or compressed grain

Kimbolton 7lb Gerb

“Fountain with sparks”

Fireworks: Cakes

“Multi-shot Battery”

Crackle Red

Explosive (flash)

Red Flare (delay)

Propellant (BP)

Fuse

Fireworks: Cakes

“Multi-shot Battery”

DISPLAY FIREWORK. ROMAN CANDLE BATTERY.
 WARNINGS: DO NOT HOLD.
 SPECTATORS MUST BE AT LEAST 25 METRES AWAY.
 INSTRUCTIONS: Insert upright in soft ground. Ensure firework will be orange fuse cover to expose fuse. Straighten fuse if

Fireworks: Candles

“Roman Candle”

Fuse

Delay

Felt wad

- Multi-shot
- 19mm – 65mm +
- Sidewall can fail
- Stake, Board or Box

Fireworks: Shells

Introduction

- 3” , 4” and 5”
(75,100,125mm)
- 6” and up 1.1G

Fireworks: Shells Construction

Labels in diagram: MAIN FUSE, TIME-DELAY FUSE, FAST-ACTING SLOW FUSE, BURST CHARGE, LIFT CHARGE, TIME-DELAY FUSE, 50m burst, ~100m/sec, ~300mph.

Fireworks: Shells Failure Modes

- No Lift (or zero delay)
 - “Flowerpot”
 - “detonation” →
- Poor Lift
 - Low Break (going up)
- Long or failed delay
 - Low Break (coming down)
 - “Black Shell”

Causes: Malfunction, Jam, Loading error

Fireworks: Shells Calculating Distances

- Rule of thumb:
 - 25m + 10m per shell inch
- Other Variables:
 - Mortar angle
 - Wind speed & direction
 - Shell spin
 - Mortar type (esp. steel)
- Note:
 - Normal safety distances do NOT account for disrupted racks

4" Shell

Fireworks: Shells Calculating Distances

4" Shell – 100m burst diameter, burst at 6m, 230m from launch
Mortar fallen to 75 degrees from vertical

Run SHELLCALC

Fireworks: Fuse & Igniters

- PIC Green / Brown
- WASAG
- Pipe Match (“green”)
- Electric matches (“dets”)

PPE

- Clothing
- Hard Hat
- Eye protection
- Ear protection (or not)
- Gloves (or not)

Don't forget: Torch and Several lighters!

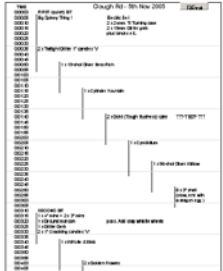
A Firework Show Planning the Event

- Site Visits
 - Safety Distances
 - Roads, Buildings, Airports
- Responsibilities
 - Event Organiser
 - Marshalling requirements
 - Notification: Police, Fire, CAA
(and any other affected parties)
- Budget etc.
- Method Statement
- Risk Assessment




A Firework Show Planning the Display

- Check material (if possible)
- Firing Order
- Equipment Requirements
 - Racks, boxes, boards etc.
- Material Preparation
 - Fusing
 - Waterproofing
- Transport
 - ADR



A Firework Show Site Setup

- Event Organiser
- Safety Distances
- Wind Direction
- Perimeters and Marshalling
- Layout in firing order
- Site fusing / wiring



Drop Zone

Shells
Large Cakes
Candles
Small Cakes
Set Pieces

Audience

A Firework Show Site Setup



Driffield Showground – 24th June 2006

A Firework Show Site Setup



Hull University Union – May 2004

A Firework Show Firing the Display

- Firing Order
- “Gaffer”
- Walk-thru
- Decision to fire
- Keep lookout
- Check for ‘duds’
- Clearing Up





More Information:



www.hse.gov.uk



www.eig.org.uk



www.bpa-fmg.org.uk



Firework Safety

www.dti.gov.uk/fireworks/

Lots of links at Fireworks magazine site:



www.fireworks.co.uk

- Training courses
www.kimboltonfireworks.co.uk
www.fantasticfireworks.biz



Outdoor Demonstrations



- Example equipment
- Types of fuse
- Black Powder and confinement
- Fire Fighting