Consumer Fireworks – An Overview

For Enforcement, Fire Service & Public Safety Officials.
Meet the Presenter...

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American Civilian Pyrotechnics Industry

- Legitimate “1.4” or Consumer Fireworks.
- PublicDisplays (“1.3” Fireworks)
- “Special Effects” – or Close Proximity Pyrotechnics
UN/DOT Classification System for Explosives - Fireworks

- **Division 1.4** - Explosive articles with no significant blast hazard - UN0336, Consumer Fireworks & UN0431 Articles Pyrotechnic
- **Division 1.3** - Explosives with a mass fire or minor explosion hazard - UN0335, Display Fireworks
- **Division 1.1** – Large color shells greater than 10” in diameter, and all salutes with >71 grams of flash powder - “1.1” means a mass explosion is possible
- Compatibility Group - G
UN Classifications

- Shipping cartons must have the proper DOT/UN orange label
- Vehicles must be placarded when greater than 1,000 lb (gross weight) of 1.4G products are on board, or any quantity of 1.3G or 1.1G in commerce
Basic Pyrotechnics

- Oxygen + Fuel = Heat
- Heat --- Light, Color, Motion
Pyrotechnic Effects

- Color
- Light (including “strobe” effect)
- Sparks (including “crackle” effect)
- Whistle
- “Bang” (Report)
- Propulsion
- Smoke
Requirements for a Pyro Device

- Produces the desired effect
- Safe to manufacture
- Stable (transportation, storage)
- Low hygroscopicity
- Low toxicity
- Moderate cost
Ignition Temperatures

- Paper - Fahrenheit 451°
- Black powder - 640° F
- Other fireworks compositions – ignite at T’s equal to or higher than black powder – thermal stability is not a problem with U.S.-approved consumer fireworks
Consumer Fireworks

- Various types of devices are permitted for sale and use in 49 states plus the District of Columbia (No, 2019: MA, last hold out)
- Sales periods vary from state to state
- Devices are intended for use by, or under the direct supervision, of a sober adult.
- They DO function by combustion – caution is needed
## DOT 1.4 Powder Limits

<table>
<thead>
<tr>
<th>Item</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firecracker</td>
<td>0.050 g</td>
</tr>
<tr>
<td>Aerial “report”</td>
<td>0.130 g</td>
</tr>
<tr>
<td>Roman candle</td>
<td>20 g</td>
</tr>
<tr>
<td>Sky rocket</td>
<td>20 g</td>
</tr>
<tr>
<td>Cone fountain</td>
<td>50 g</td>
</tr>
<tr>
<td>Mine, aerial shell</td>
<td>60 g</td>
</tr>
<tr>
<td>Cylindrical fountain</td>
<td>75 g</td>
</tr>
<tr>
<td>Multiple-tube item</td>
<td>200 g/500 g</td>
</tr>
</tbody>
</table>
Consumer Fireworks

- Regulated at the Federal level (CPSC) since 1976 – no Federal regulation prior to that except for a ban on big explosive devices
- States/local governments may impose additional limitations per state law
- The number of states permitting some or all types of “consumer fireworks” has risen steadily for the past 30 years.
CPSC regulations:

- Fuse must burn 3-9 seconds
- Bases must provide stability
- “Report” effect limited to 130 milligrams
- Labels must provide proper warning
- Performance must be proper - no “burnout” or “blowout”
- All of the applicable rules apply to consumer fireworks and novelties
Types of Consumer Fireworks

- Ground-based – device stays on the ground, emits sparks, various color flames, smoke, whistle, and non-explosive crackling effect
- Aerial – device rises into the air or propels effects into the air
- Firecrackers – explosive effect
- Novelties – limited amounts of composition with limited effect (smoke devices, party poppers, snappers, certain sparklers, “snakes”)
Ground-based items

- Fountains
- Ground spinners
- Wheels
- Crackling items
- Sparklers
- Firecracker (explosive)
- Novelties
“Fountain”

A typical ground-based sparkling device

An item may have multiple tubes, fused to light in sequence
Aerial items

- Sky rockets
- Missiles
- Aerial shells – preloaded in a launch tube or reloadable “kits” – they burst in the air
- Mines – propel star or a comet into the air
- Helicopter
- Roman candles
Mine, Comet

Diagram:
- Paper Cap
- Cardboard Disc
- Fuse
- Black Powder Propellant
- Base
- One or more stars (whistle, crackers, etc.)
Single vs. Multiple-tubes

- Many consumer fireworks (as well as display “cakes”) contain multiple tubes, fused to fire in sequence
- These can be either fountains or aerial items
Consumer Fireworks Today

- Vast majority are manufactured in China
- Chinese products must meet all DOT and CPSC requirements; certification is required
- CPSC performs import surveillance testing on Chinese shipments
- Importers are also expected to test shipments for compliance
AFSL Testing

- American Fireworks Standards Laboratory was founded in 1990 by a group of fireworks importers.
- Created additional standards for consumer fireworks - more flexible than the federal regulatory process. AFSL has worked very closely with China and CPSC.
- A voluntary testing program has been established - to check product before it leaves China. A majority of consumer fireworks are tested under the AFSL program.
Testing of Consumer Fireworks

- CPSC requires that importers have their products tested for compliance, by someone properly trained to do the testing.
- The AFSL program is recognized by CPSC as an acceptable testing program – and it has been in place since the early 1990’s.
- How do you know if product is AFSL-tested?—look for special stickers on shipping cartons.
Illegal Explosive Devices

The possible sale of Federally-outlawed illegal explosive devices is of particular concern, both to enforcers and the legitimate sparkler industry. These devices contain large quantities of explosive powder, and can cause very serious injuries, and possibly death.

Typical names - M-80’s, M-100’s, Blockbusters, Quarter-sticks, Ash Cans.

Usually, these devices have NO warning label, nor do they have manufacturer’s ID on each item.
Important - Stability of Fireworks

- Fireworks compositions permitted in the U.S. are **stable** in transportation and storage - they will NOT spontaneously ignite
- The chemical compositions are controlled by DOT and CPSC (for 1.4g)
- Where fires have occurred, arson or malicious actions have been involved
Emergency Response

- 1.4G fireworks - will burn (possibly vigorously) but will not mass explode. Sprinklers should be effective.

- 1.3G & 1.1G display fireworks will be quite violent if a fire reaches them - a mass explosion is possible. Evacuate - quickly - if a fire approaches a 1.3 magazine or a truck containing 1.3G products
Pyrotechnic Fires

- **DON’T** try to suffocate a pyrotechnic or explosive fire - it contains its own oxygen. Confining the heat will accelerate the fire and can lead to an explosion.

- To effectively fight this type of fire, you must get the material back below its ignition temperature.

- Allowing the material to burn may be the best strategy to use.
NFPA Codes

- **NFPA 1124** - Code for the Manufacture, Transportation and Storage of Fireworks
- **NFPA 1123** - Code for Fireworks Display
- **NFPA 1126** - Standard for the Use of Pyrotechnics before a Proximate Audience
NFPA 1124 – Retail provisions

The NFPA has deleted requirements for the retail sale of consumer fireworks from NFPA 1124.

Use the version of 1124 effective in 2013 if you wish to have the former requirements apply in your area.

Primary debate between industry and NFPA – sprinkler requirements continues…
NFPA 1124 Also Required:

- “Covered Fuse”
- Flame Breaks
- Packaging
- Containment of aerial devices
- Standards and testing were needed to clarify these requirements, and to see effect of sprinklers on a consumer fireworks fire
Consumer Fireworks Testing Plan

- Funding to perform a series of fire tests was provided by the American Fireworks Standards Laboratory (AFSL)

- Purpose was to validate the effectiveness of provisions recently added to NFPA 1124 – when the requirements were applied as an integrated system
TEST SETUP

- Two 16-ft long x 6-ft tall gondolas, 4 ft isle width
- Full range of consumer fireworks used in merchandising the gondolas
Products for Tests 1-9

- A full range of consumer fireworks was used
- 76 shipping cartons per test/approx. 2,000 lb gross wt.
- Products were represented %-wise based on testing conducted in China by the AFSL
Product Breakdown, Tests 1-9 – 76 Cases

- Assortments (full “Class C” & “Safe & Sane”) 22 cs.
- Mine/Shell Devices (single & multiple tube) 20
- Reloadable Shell Kits 6
- Roman Candles 3
- Fountains, wheels 7
- Rockets, helicopters, missiles 7
- Firecrackers 3
- Novelties (snaps, smoke, poppers) 8

TOTAL 76 cartons
TEST SETUP (Sprinkler System)

- Sprinkler system (set at 17 feet)
  - 10 x 10 ft grid
  - Heads were Viking VK100, standard response, 165 °F element, 1/2-in. orifice (k=5.6)
  - Design density of 0.2 gpm/ft²
TEST SETUP (Instrumentation)

- Instrumentation
  - Thermocouple trees
  - Thermocouples in gondolas
  - Heat flux measurements at the target shelves
  - CO measurements
  - VIS and IR video
TEST MATRIX

- Twelve tests
  * Nine with display gondolas
  * Three with palletized displays
Set Up (Ignition point)
RESULTS (After Test #1 – NFPA measures not in place)
Test 6 RESULTS (All measures used)

- 2 min 20 s after ignition of the first device before other devices became involved
- 3 min 40 s to involve target gondola,
- 3 min 45 s before 1st sprinkler activates
- 12 min no visibility and no sparks or reports
- 25 min manually extinguish smolder where sprinklers could not reach
- Post-test – minimal amount of devices on floor, many devices were unburned and intact, four sprinkler heads activated
RESULTS (After Test #6)
RESULTS (Back side, test #6, post-test)
RESULTS (Test #1 – no measures taken)

American Fireworks Standards Laboratory
SwRI Project No. 01.13626.01.001
Test Date: October 17, 2007
Test ID: 07-290FRW01

Test 1 - No Fuse Covers, No Sprinklers, No Containment Bins
Thermocouple Tree B

![Graph showing temperature over time for different thermocouple readings.](image)
RESULTS – Test 6 (All measures employed)

Test 6 - Fuse Covers, Sprinklers, Shelf to Shelf Bins, Metal Flame Breaks Perpendicular and at Shelf Backs
Thermocouple Tree B

American Fireworks Standards Laboratory
SwRI Project No. 01.13626.01.001
Test Date: November 1, 2007
Test ID: 07-305FWR06
CONCLUSIONS(1) (from SWRI Report)

- Fuse covers meeting the proposed test methods and “pass” criteria significantly decrease the ability to start a fire.
- The fuse covers significantly decrease the growth of a fire during the early stages.
- The containment bins helped contain the aerial devices, decreasing the fire spread.
- Metal flame breaks were effective at decreasing the spread of fire.
So: Be careful out there, and
Thanks for your attention!

If I can ever provide information, refer you to
someone to call for information, or give an
opinion, please feel free contact to contact me:
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