
# Oversight and Testing of Law Enforcement Less Lethal Weapons

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# Funding Driving this Research

**Funded under numerous NIJ & BJA grants over the last five years**





Disclaimer: The views and opinions expressed herein do not necessarily state or reflect those of the Department of Justice, the National Institute of Justice or any other government agency.

# Initial NIJ Funding

- TASER v Stinger
- 5 Year Use of Force Study (OPD/OCSO)
- Infrared Beacon
- Alternatives to Highway Flares

# TASER v Stinger



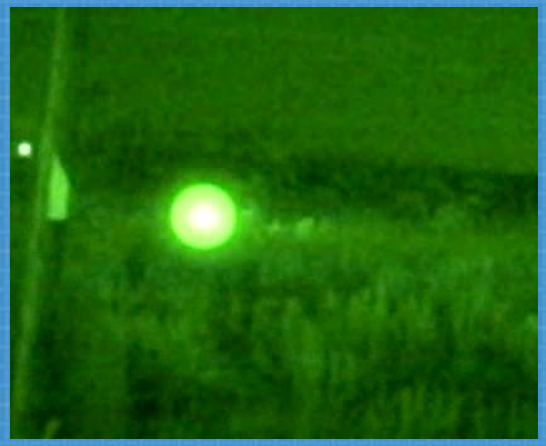
# Stinger Probe Malfunction

# Five Year Force Study

# Less Lethal Effectiveness

| | Iteration 1 | Iteration 2 | Iteration 3 |
|---|---|---|---|
| **Chemical agent** | 329 (64%) | 211 (72%) | 108 |
| **TASER** | 1460 (69%) | 536 (67%) | 270 |
| **Compliance hold** | 64 (16%) | 81 (63%) | 35 |
| **Takedown** | 215 (41%) | 166 (62%) | 64 |
| **Empty hand strike** | 26 (28%) | 63 (61%) | 47 |
| **Impact weapon** | 32 (45%) | 41 (51%) | 43 |
| **Pepperball** | 4 (57%) | 2 (67%) | 0 |
| **12 gauge beanbag** | 2 (29%) | 1 (50%) | 2 |
| **K9** | 209 (69%) | 74 (71%) | 32 |

# Infrared Beacon Study

# Police Canine Application

# Highway Flare Study

# Initial Outdoor Weapons Testing

# Weapons and Equipment Research Institute


- Initially funded by BJA
- 8,000 sq ft off-campus facility
- Classroom, armory, offices, training areas and indoor test range

# WERI Mission

- Conduct testing and evaluation of law enforcement products. Host training when possible.
- Provide technical support to agencies and manufacturers
- Provide data to the academic, law enforcement and legal communities
- Projects selected by official request, legal cases, or identified need.

# Weapons and Equipment Research Institute (WERI)

# WERI Test Range

# WERI Staff

- Three full time grad students
- Three – five interns
- As many as ten service learning students

# Service to Community

- Whenever possible, we provide whatever assistance to the law enforcement community as possible.
- This may take the form of productions with the Law Enforcement Training Network or assisting manufacturers in the evaluation of their products.

# LETN Production (03/04/10)

# Additional Product Testing

K9 vest for IR beacons

Yawaras


K9 video recording system

5-11 flashlight


MUVI video recorder

Flashcam

# Evaluating Training Methodologies

- We have begun preliminary data collection utilizing Airsoft as a supplemental firearms training tool.

# Firearms Comparison

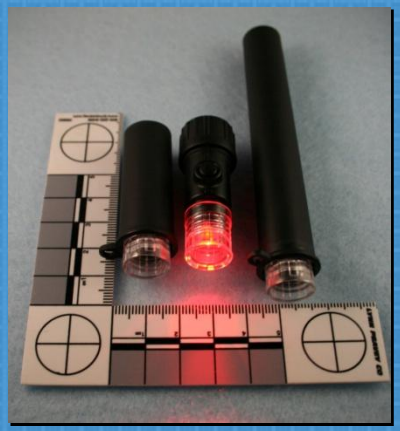
# AFIDs and DOJ

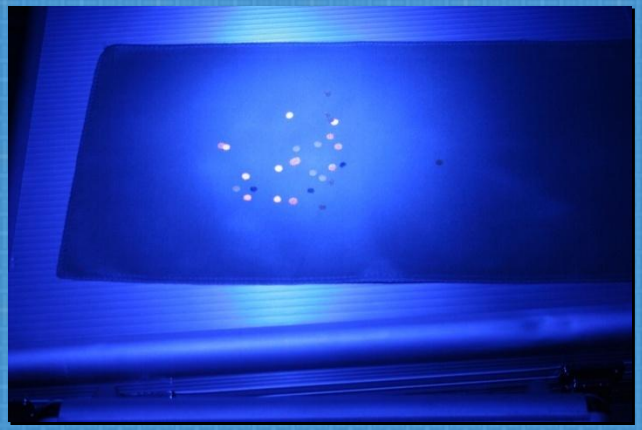
- Recently, the Department of Justice and a number of agencies have required the collection of a sample of TASER AFIDs at the scene of each deployment.
- They are difficult to locate without specialized forensic tools.

# TASER AFID Detection

AFIDs become luminescent under 510nm with orange light filter.

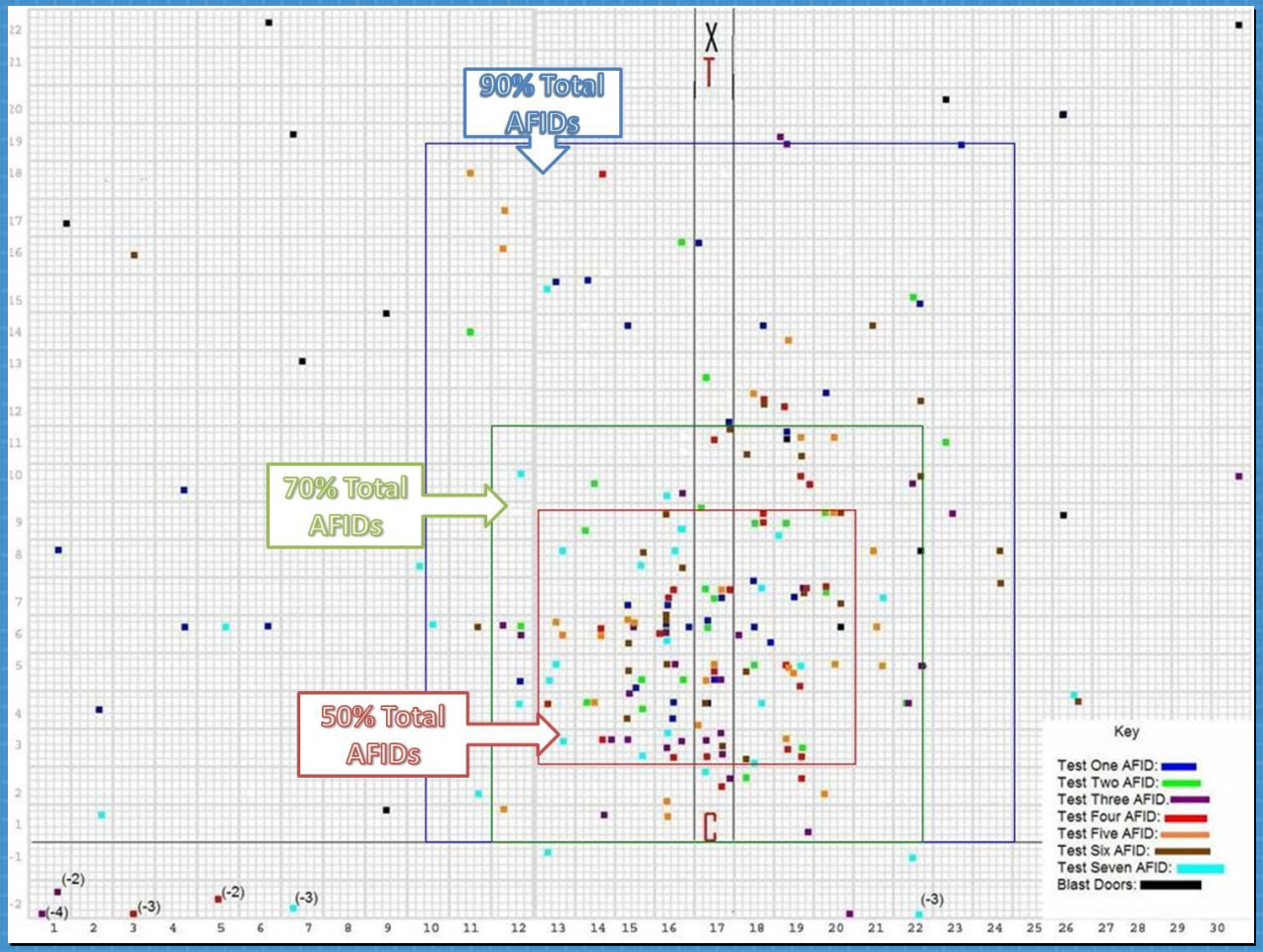
# Alternate Light Source Testing





- Product evaluation for Cejay Engineering to locate AFIDS

# AFID Distribution Pattern



# AFID Distribution Findings

- Unable to reconstruct shooting scene.
- Without ALS and orange goggles, finding AFIDS is almost impossible.
- Submitted for publication to Journal of Forensic Identification *The Distribution of Anti-Felon Identification Tags* on 01/08/10 by Lindsey Medley.

# Flammable OC and TASER

- Despite labeling on canisters that claim that they are ECD safe, we continue to see flammable reactions.

# FGCU Pepper Spray Research

**Driven by *Sweeny v. West Melbourne (FL)***

Officer was blamed for not using O.C. while holding suspect at gunpoint

# Blowback danger

- Misses also became a mist and created an additional risk of contamination.

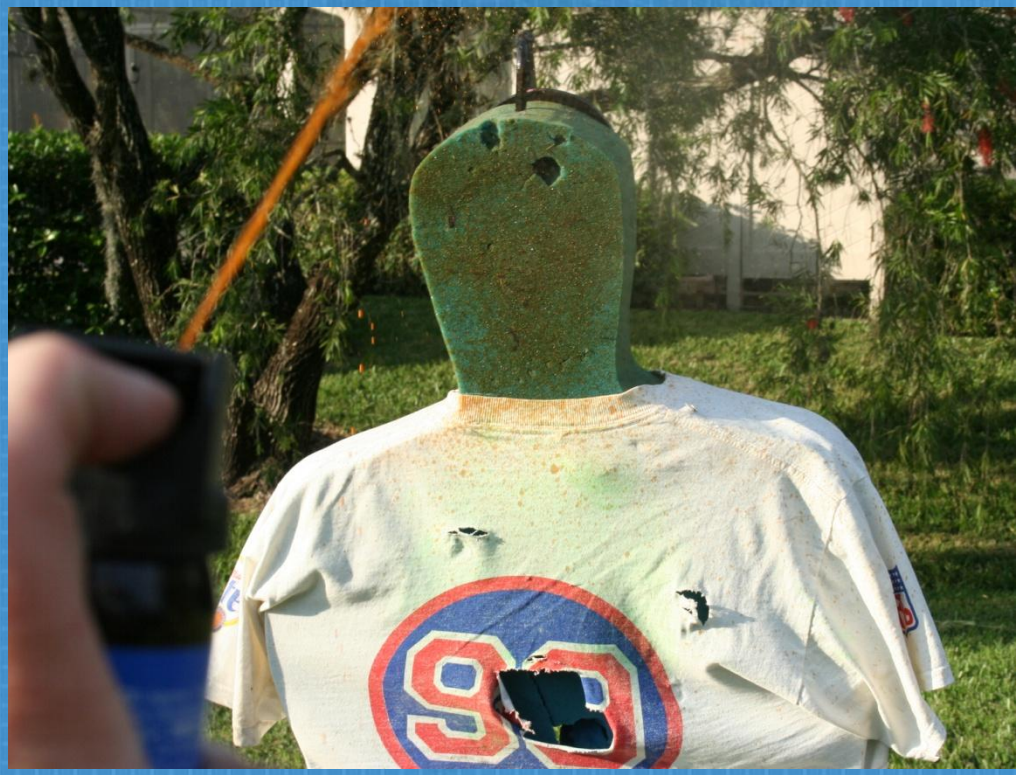
# Accuracy

Strong hand 90%

Weak hand 40%

No training in weak hand use could be located in any system.

# Strong vs Weak Hand Use



# Pepper spray comparisons

Table 1. Description and Performance of Pepper Sprays

| Brand | Size | Type | Liquid (oz) | Cost[1] | Shots | CPS[2] | 15' Drop | 18' Drop | 21' Drop |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MK-4 | Stream | 3.0 | 19.99 | 33 | 0.61 | 0.0 | 17.0 | nd |
| 2 | MK-3 | Stream | 1.5 | 15.99 | 12 | 1.33 | 0.0 | 18.0 | nd |
| 3 | MK-4 | Stream | 3.1 | 12.99 | 61 | 0.22 | 0.0 | 17.0 | nd |
| 4 | MK 3 | Stream | 1.5 | 11.99 | 28 | 0.43 | 0.0 | 34.0 | nd |
| 5 | MK-3 | Foam | 2.4 | 19.99 | 33 | 0.61 | 25.5 | nd | nd |
| 6 | MK-3 | Stream | 1.8 | 14.99 | 13 | 1.15 | 0.0 | 22.0 | 43.0 |
| 7 | MK-4 | Stream | 3.3 | 16.99 | 24 | 0.71 | 0.0 | 13.0 | 51.0 |
| 8 | MK-5 | Stream | 4.0 | 20.99 | 37 | 0.57 | 0.0 | 14.0 | 43.0 |
| 9 | MK-3 | Gel | 1.6 | 16.99 | 16 | 1.06 | 0.0 | 12.5 | 27.5 |

[1] Cost in dollars

[2] Cost per shot in dollars

nd = no data


Performance Evaluation of Chemical Agent Systems. Law Enforcement Executive Forum 9 (3) 2009

# Pepperspray

- Contents are a mystery and end-users must rely completely on factory literature.
- However, this information may not be accurate and is not regulated. This includes MSDS.
- Confirmed by FDA and OSHA

# Pepperspray Issues

**Bodycote**

**Florida Gulf Coast University**
**Job No: 115260**

Dimethyl Sulfoxide by Gas Chromatography/Mass Spectrometry

Sample was collected by spraying the contents of the canister into a 40 mL vial. A portion of the collected sample was weighed, diluted in methanol, and analyzed by GCMS. Results are reported as concentration in the collected sample.

| | |
|---|---|
| Column: | 30m x 0.32mm x 0.5µm DB-WAX (J&W) |
| Oven Temp: | 50 °C (hold 2 min) to 200 °C at 30 °C/min (bake 3 min post-run at 250 °C) |
| Carrier: | He, 2.0 mL/min constant flow |
| Injection: | 1 µL, split 1:10 |
| Inj Temp: | 200 °C |
| MS: | 35-160 amu; 2.94 scans/sec |

| Sample ID | Percent (w/w) |
|---|---|
| Sabre Red | 1.2 |
| Sabre Red Duplicate | 1.1 |
| Detection Limit | 0.1 |

Dates Analyzed: 06-17-09

Quality Control Summary

Sample ID: Sabre Red

| Analyte | Sample Result | Duplicate Result | RPD |
|---|---|---|---|
| Dimethyl sulfoxide | 1.15 | 1.10 | 4 |
| QC Guidelines | | | NMT 25 |

# Material Safety Data Sheet

**SABRE Red**

*Quick Identifier*

March 1, 2002

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910. 1200. Standard must be reviewed for specific requirements.

## SECTION 1 - CHEMICAL PRODUCT & COMPANY IDENTIFICATION

| | | | |
|---|---|---|---|
| *Manufacturer's Name:* | SECURITY EQUIPMENT CORPORATION | *Emergency Phone Number:* | 800-325-9568 |
| *Address:* | 330 SUN VALLEY CIRCLE | *Other Calls:* | 636-343-0200 |
| *City, State, Zip* | FENTON, MO 63026 | *Fax Number:* | 636-343-1318 |
| *Chemical Name:* | Oleoresin Capsicum (Red Pepper) | | |
| *Trade Name:* | SABRE Red (H2O Series) | | |

## SECTION 2 - HAZARDOUS INGREDIENTS / IDENTITY

| Hazardous Component(s) (chemical & common name(s)) | Content(s) | OSHA PEL | Carcinogen (Yes / No) |
|---|---|---|---|
| Oleoresin Capsicum: | 10% | N/A | No |
| Scoville Heat Units | 2,000,000 | N/A | No |
| Major Capsaicinoids | 1.33% | N/A | No |
| Capsaicin CAS #404-86-4 | | | |
| Nordihydrocapsaicin CAS #19408-84-5 | | | |
| Dihydrocapsaicin CAS #28789-35 | | | |

Other ingredients are trade secrets as defined in Hazard Communications ACT 29 CFR 1910.1200 Para 1 (1) end Apendix D to CFR 1910.1200.

## SECTION 3 - PHYSICAL & CHEMICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| *Boiling Point:* | *370 Degrees F* | *Specific Gravity (H20 = 1)* | 1.0 |
| *Solubility in Water:* | Soluble | *Vapor Pressure:* | 130 PSI |
| *Appearance & Odor:* | Red/Orange in color. Odor is pungent | | |

## SECTION 4 - FIRE & EXPLOSION DATA

| | | | |
|---|---|---|---|
| *Flash Point:* | Not Applicable | | |
| *Auto-Ignition Temperature:* | Not Applicable | *Extinguishing Media:* | Halon, Carbon Dioxide, Dry Chemical or Water |
| *Special Fire Fighting Procedures:* | Wear respirator or self-contained breathing apparatus. | | |
| *Unusual Fire and Explosion Hazards:* | Smoke would be irritating to eyes and mucous membranes. | | |

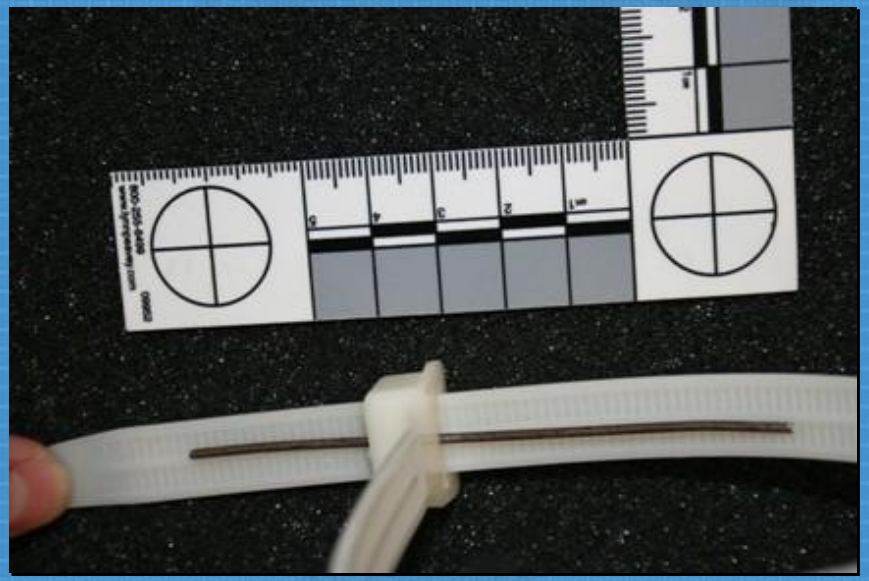
## SECTION 5 - PHYSICAL HAZARDS (REACTIVITY DATA)

| | | | | | |
|---|---|---|---|---|---|
| *Stability* | Unstable | | *Conditions To Avoid* | *Incompatibility (Materials To Avoid)* | N/A |
| | Stable | X | | | |
| *Hazardous Polymerization:* | May Occur | | | *Hazardous Decomposition Products:* | N/A |
| | Will Not Occur | X | *Conditions To Avoid* | | |

# Disposable Restraints

- Requested by TWG to examine products currently in the market.
- Five of seven products failed most basic testing
- Copy can be requested by Brian Montgomery.
- Video also available

# Easily Defeated

# Hosted Pepperball Instructor

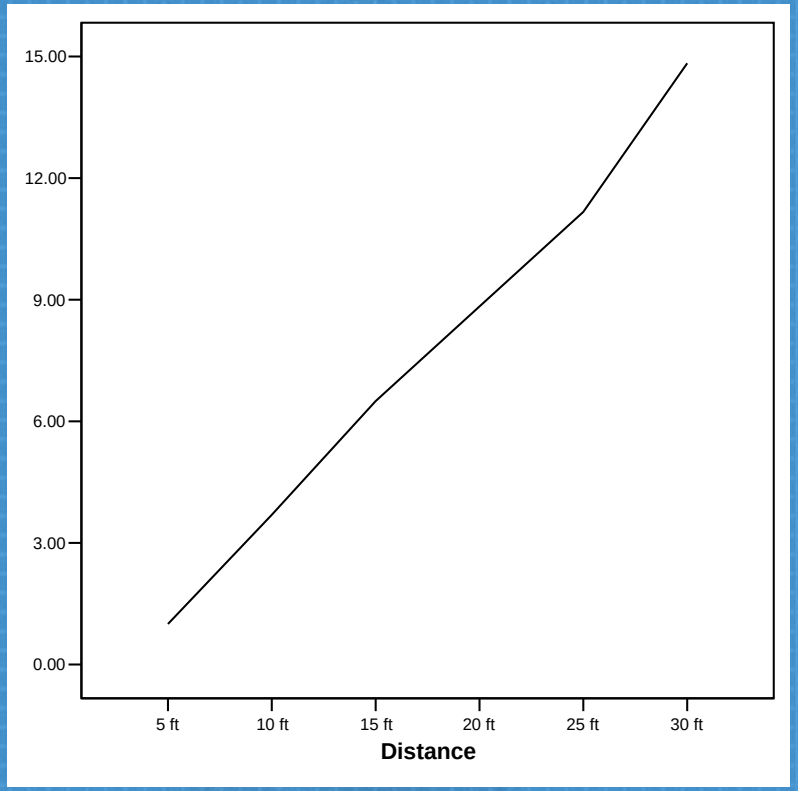
# Pepperball

Factory literature shows accurate to 30 feet.

Does not “drop” and tends to “float”

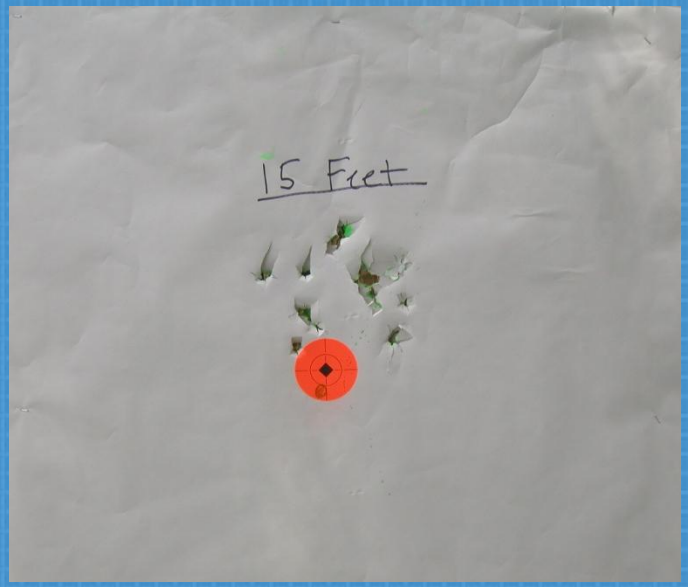
1 ½ in difference in P.O.A. to P.O.I for every five feet.

Spread directly related to distance.

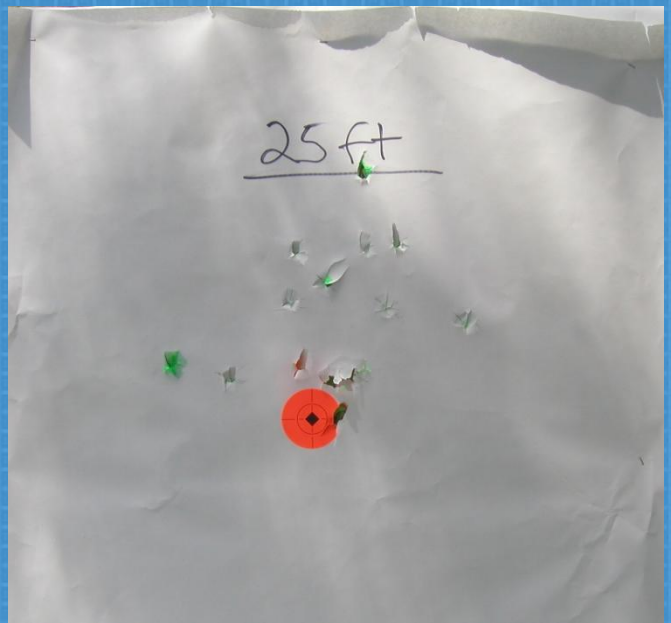



R = .94

# Float Pattern








# Velocity

# Pepperball velocity

- Very consistent
- Accuracy issues appear related to projectile itself
- Number of projectiles found to have defects that would impact accuracy

# Pepperball Projectiles

# Initial Tests of SA-8 Pistol

- Pepperball's new product
- Utilizes detachable magazine that contains CO2 and eight projectiles

# Initial Observations

- Multiple misfeeds and jams
- Double loading caused projectiles to break in barrel
- Unknown failure caused $CO_2$ bottle to break and release

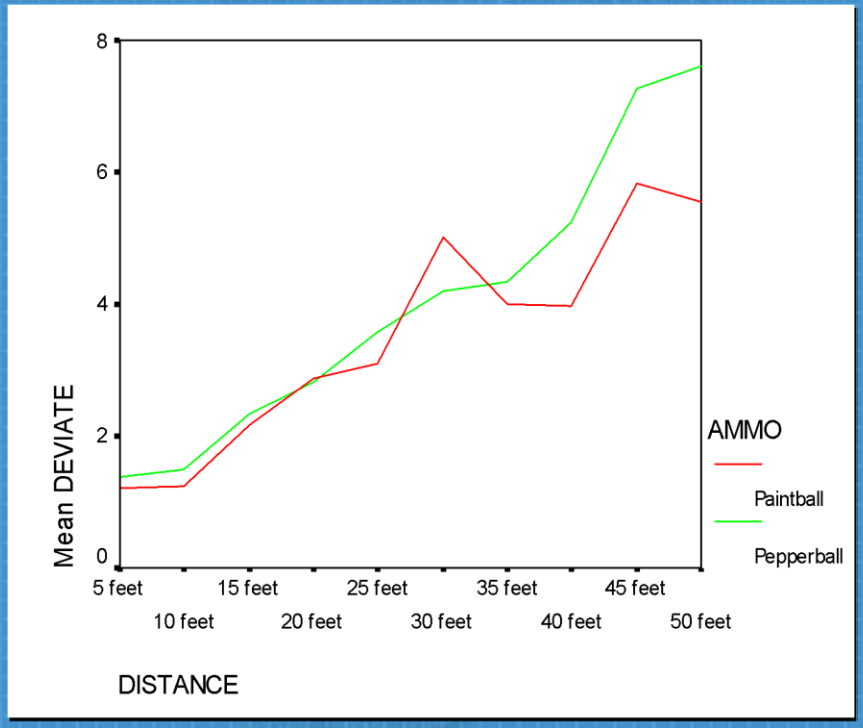
# Pepperball SA-8

# Pepperball Cloud Dynamics

- Dictated by environmental conditions
- High humidity causes cloud to remain close to ground and in tight concentration
- Low humidity causes it to rise and spread out.
- Directly impacted by wind.

# Pepperball Training

- We did find that you could use off-the-shelf paintballs and get similar results for training.
- That was a cost savings of $.63 per shot.



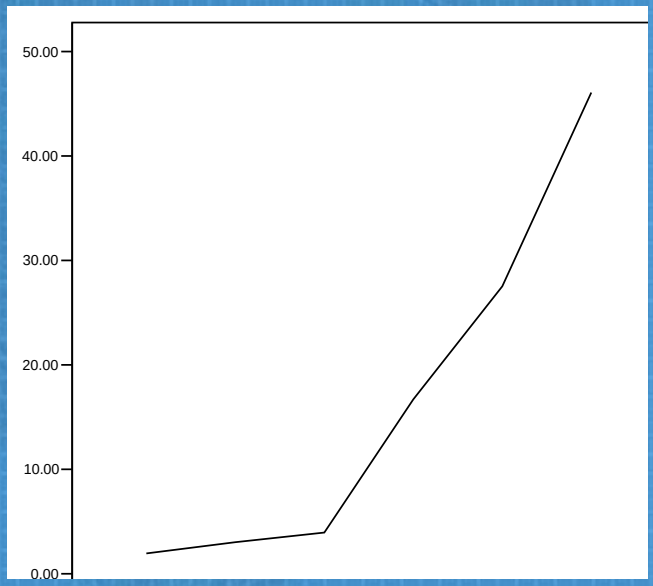
# Hosted FN303 Armorer Instructor School

# FN303

Factory sights set at 30 yds

Ability to accurately hit at 60 yds but can extend beyond 100 yds

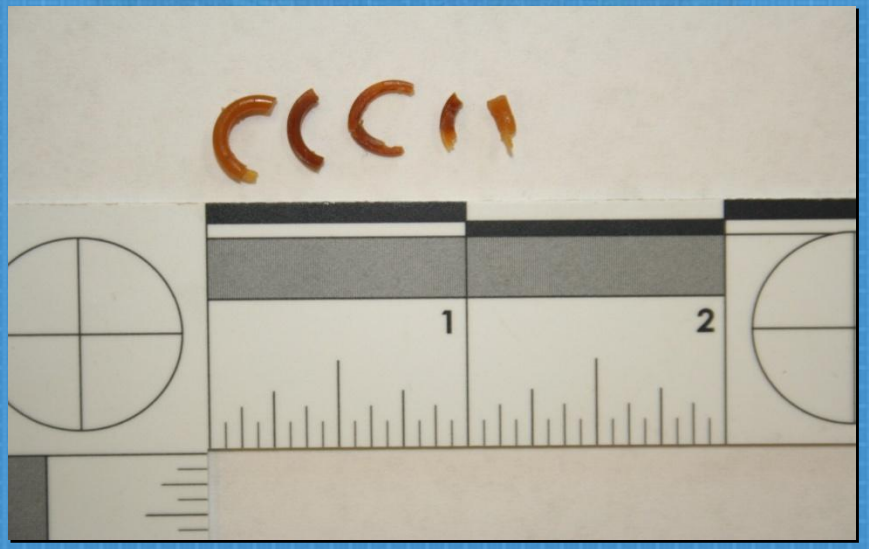
Consistent drop rate of 13.7 inches for every ten yards beyond.




R = .96

Evaluation of the FN 303 Less Lethal Projectile. Journal of Testing and Evaluation 34 (6)

# FN303 Unpredictable Velocity



# Impact Weapon Research

# Baton selection

- No established system
- This is contrary to almost every sport, which has a specific methodology to “fit” the equipment to the individual user
- Baseball bat, golf club, cricket bat

# Baton Data

| | Features | | | Force | |
|---|---|---|---|---|---|
| | Length Closed | Length Open | Weight | Mean | Median |
| Wood | n/a | 26.25 | 346g | 13.38 | 13.75 |
| Composite thick | n/a | 26.50 | 566g | 14.50 | 14.25 |
| Composite thin | n/a | 25.75 | 378g | 12.63 | 12.25 |
| Expandable 1 | 6.25 | 15.25 | 242g | 8.63 | 9.00 |
| Expandable 2 | 6.25 | 15.50 | 380g | 8.13 | 8.50 |
| Expandable 3ab | 10.25 | 21.75 | 658g | 13.25 | 12.25 |
| Expandable 4a | 9.50 | 22.25 | 538g | 13.25 | 12.50 |
| Expandable 5b | 8.00 | 20.50 | 504g | 11.00 | 10.50 |
| Expandable 6b | 10.00 | 25.75 | 598g | 13.13 | 13.75 |
| Expandable 7 | 9.75 | 26.00 | 576g | 13.38 | 13.25 |
| Expandable 8 | 8.50 | 20.50 | 450g | 10.75 | 10.25 |
| Expandable 9 | 9.25 | 20.25 | 574g | 14.75 | 14.50 |
| Expandable 10 | 10.25 | 21.00 | 634g | 14.13 | 14.25 |
| RCB 1 | 9.50 | 24.00 | 702g | 16.25 | 17.25 |
| RCB 2 | 10.50 | 26.00 | 760g | 16.13 | 16.25 |

(A=Enlarged Striking Tip; B=Enlarged End Cap)

A Pilot Study of Kinetic Energy Transfer Based Upon Police Baton Designs. Law Enforcement Executive Forum 9 (1) (2009)

# Bent expandable baton

- Damaged after single strike on punching bag
- Shows lack of consistency in manufacturing and materials.

# Impact munitions

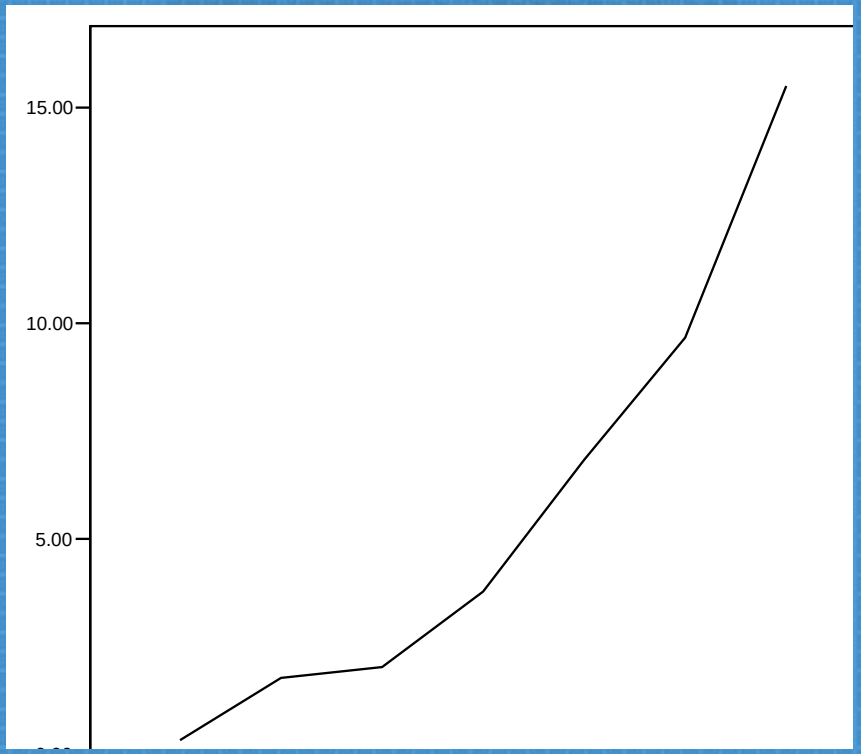
- Fired from shotgun, 37mm, and 40mm launchers
- Greatest variation in products, consistency, and quality



- Fired from standard shotgun
- Primarily impact
- Some chemical agent delivery payloads possible

# 12 gauge beanbag

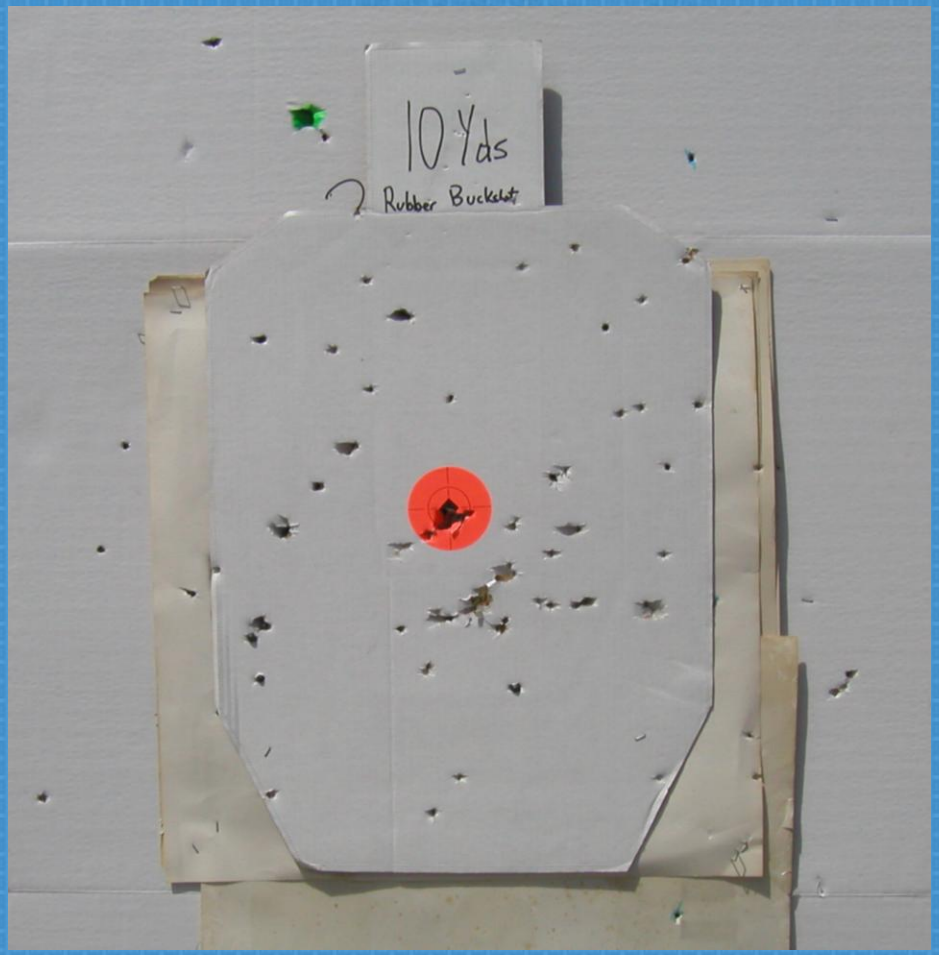
- Spread of projectiles is relatively constant.
- Drop is not a factor until 40 ft.
- At 70’, drop may be as much as a foot.




R = .91

# 12 Rubber Buckshot Pattern

- At ten yards, pattern is so inconsistent that it cannot accurately target an individual.
- Much more likely to strike the face or head.



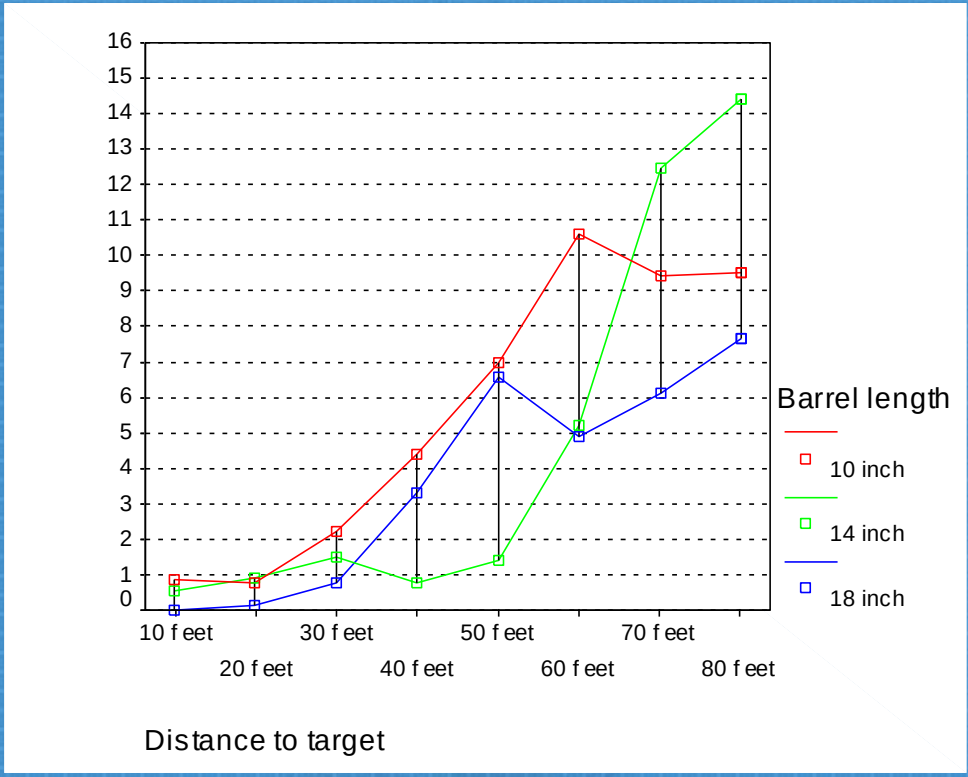
# Modular Shotgun Study

- Measured the effect of barrel length on beanbag accuracy
- 10 in, 14 in, 18 in barrels
- 480 projectiles fired

Modular 12 Gauge Shotgun Bean Bag Accuracy Study. Journal of Testing and Evaluation 36 (5). (2008)

# Performance

- 10 in barrel accurate to 50 feet.
- 14 in barrel accurate to 60 feet
- 18 in barrel accurate to 80 feet and beyond.



# 12 Gauge Beanbag Velocity

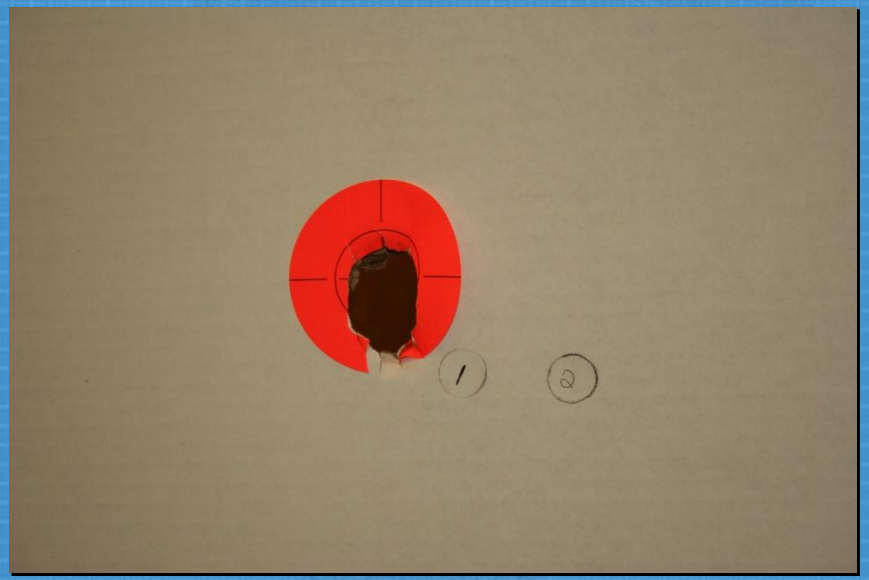
- The vast majority of beanbags travel at the advertised velocity of approximately 280 f.p.s.
- However, in one case, we measured a beanbag travelling at 861 f.p.s., which is approximately the speed of a .45 acp bullet.

# Unable to Explain Velocity

- We weighed shells and projectiles and found little variance.
- Manufacturer was unable to explain how this was possible


# Other Beanbag Testing

- Goal was to determine distance weapon was fired based on bruise from wadding.
- We were not successful as wadding has unusual flight characteristics.



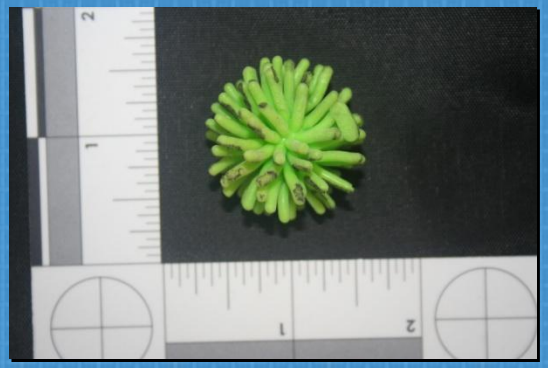
# Emerging Ammunition

- One company was marketing itself to corrections and claimed that their product would reduce the size of cell extraction team to two members.
- One officer would fire the projectiles through the food port until compliance was gained. It was suggested that a bandolier of twenty shells should be sufficient.

# Testing of Lightfield Ammunition

- A local agency brought a sample to test and evaluate to our facility.
- The marketing ploy was that a jury would view these soft rubber projectiles in a positive light.
- Each of their products' velocities were twice their advertised rate.

# Lightfield Ammunition



1198 f.p.s.

1327 f.p.s.

1021 f.p.s.

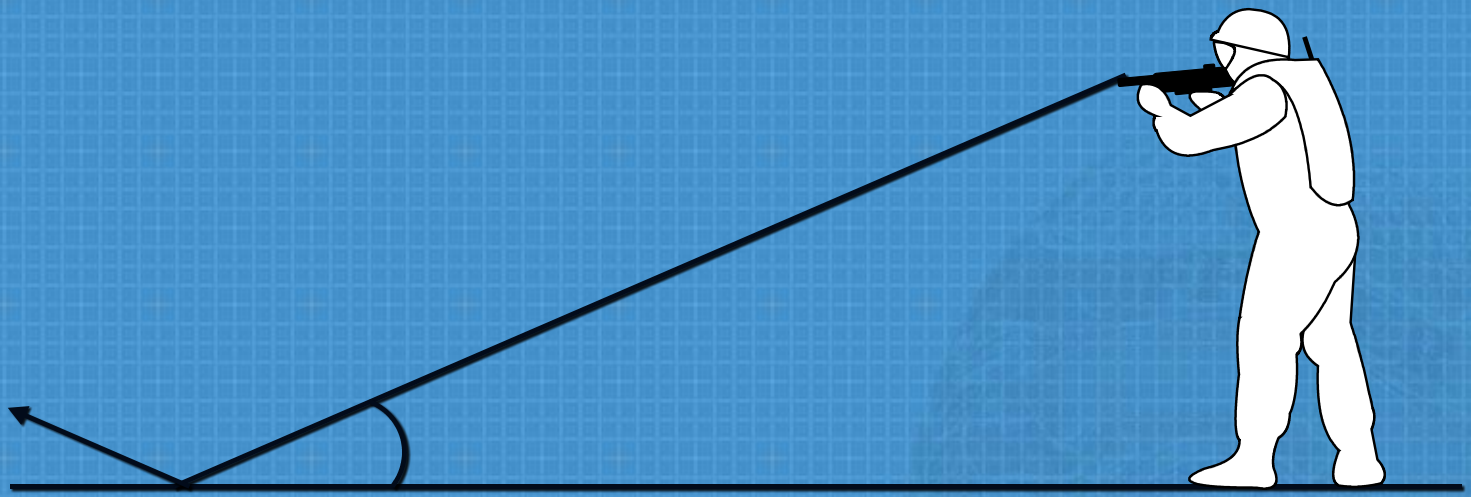
921 f.p.s.

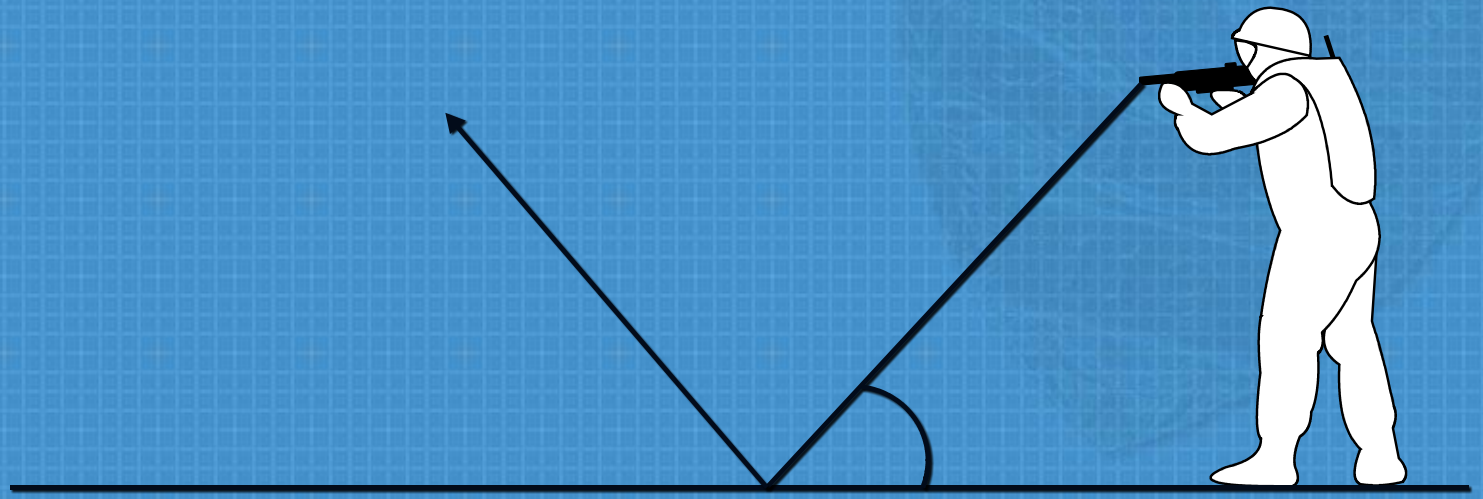
# 37mm Beanbag Issues

- Mistakes in ordering or shipping may deliver a product that looks similar on the outside but has a vastly different payload.


# SKIP FIRED MUNITIONS

- The brief training on skip fired munitions suggests aiming six to eight feet in front of the suspect.
- This does not take into consideration the composition (wood, rubber, foam, etc.) of the projectile which has its own ricochet rate.
- The angle that the weapon is fired also has a direct impact on projectile trajectory





# Baton Rounds

# Skip-Fired Munitions




# Target

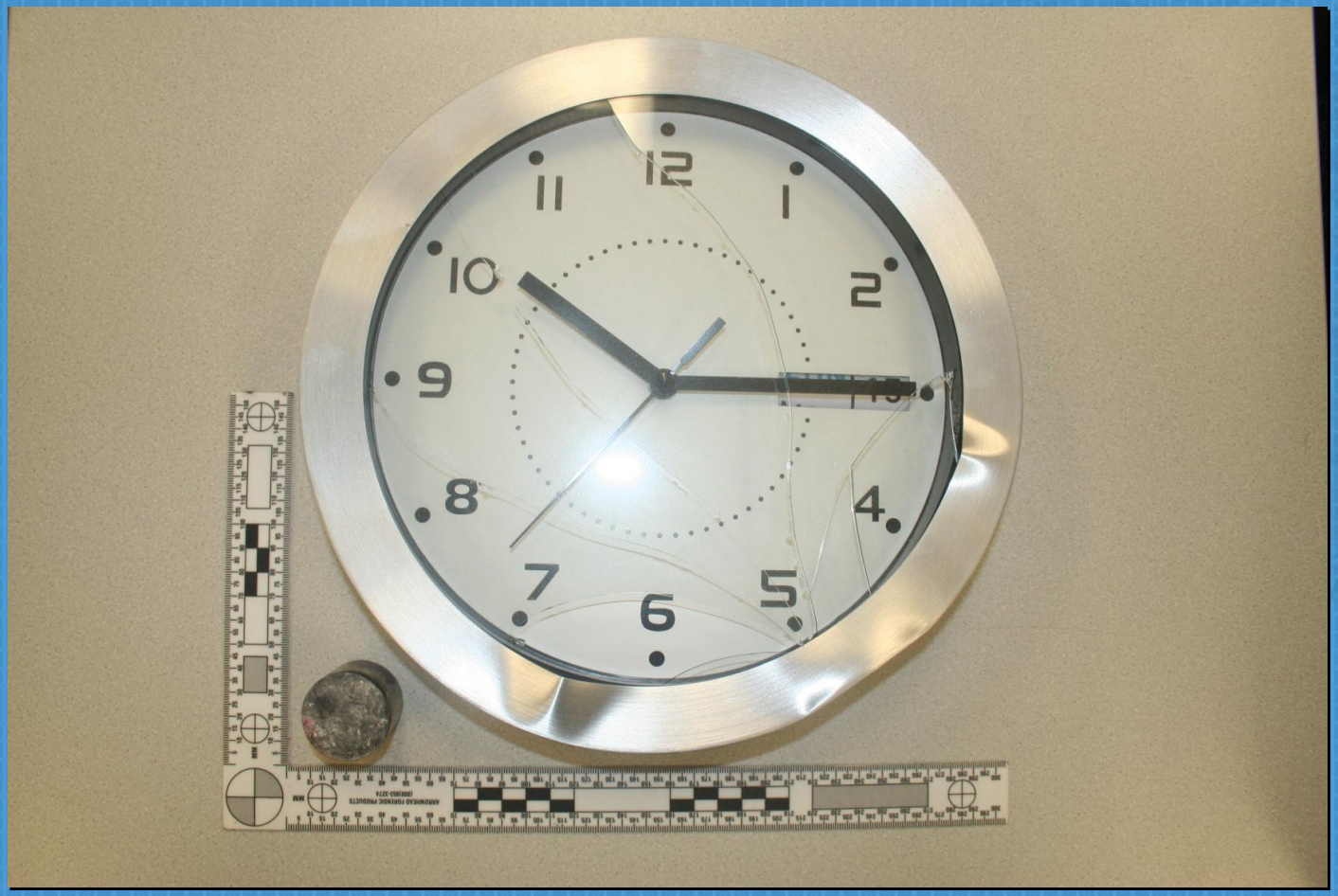
# Malfunctions

- Initially, safety glasses and hearing protection were standard.
- As seriousness of malfunctions increased, the level of protection was upgraded to riot gear.

# Protection increased

Projectile consistency was so poor that no predictive model could be created without placing researchers at extreme risk.

# Near Miss Wake-Up Call



# Projectile Performance

- On a clean concrete floor, projectiles ricocheted in an erratic and unpredictable manner.
- When we added dirt and gravel, one projectile ricocheted straight up and struck a 20 ft high ceiling.
- Actual street deployments are likely to meet with similar unpredictable results.

# New Protective Suit on Order


- It is hoped that with additional protection for the research team, data can be collected in a manner that has the ability to predict the behavior of these projectiles.

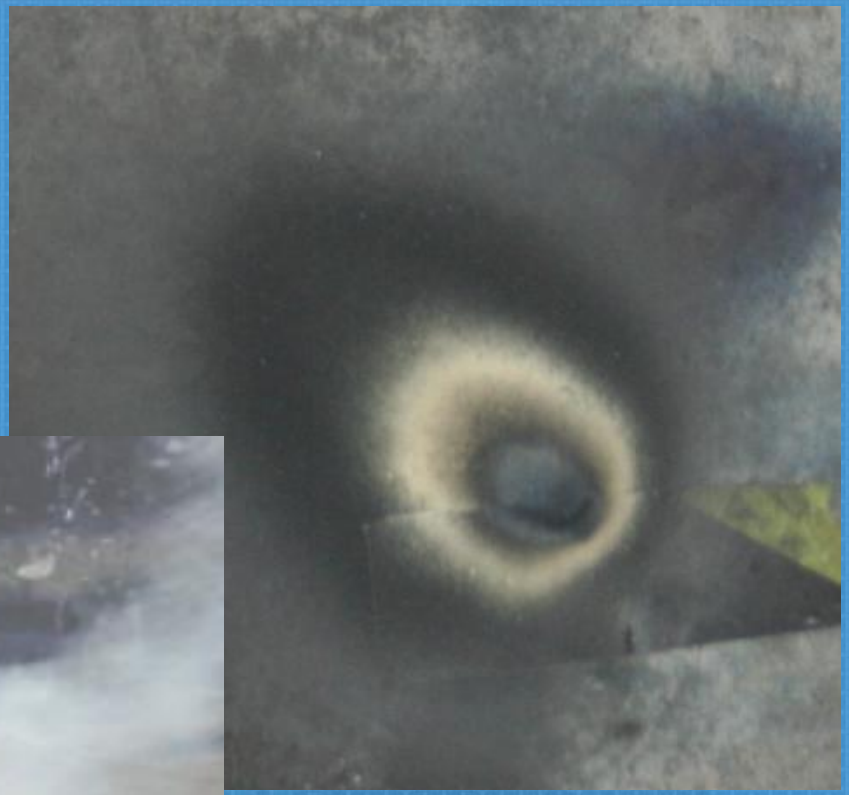
# Chemical munitions

- Broad spectrum of produced
- Launched or hand thrown
- Pyrotechnic or non-pyrotechnic
- Quality control is least reliable in this area and is most unpredictable.
- Majority are “duds” but others react violently. 50-70% do not perform as advertised.

# 37mm Muzzle Blast


# Thrown & Launched Grenades

# Grenades: Failed to Deploy Properly



# Grenades: Failed to Deploy Properly


ANTANEOUS
BLAST
ERT POWDER

# Other Launched Gas Munitions Issues

- Not as accurate as impact munitions
- These missiles need to be given a large margin for error and this projectile exploded on impact
- Secondary fires are a real threat

# How we handle a dud

# Deactivation

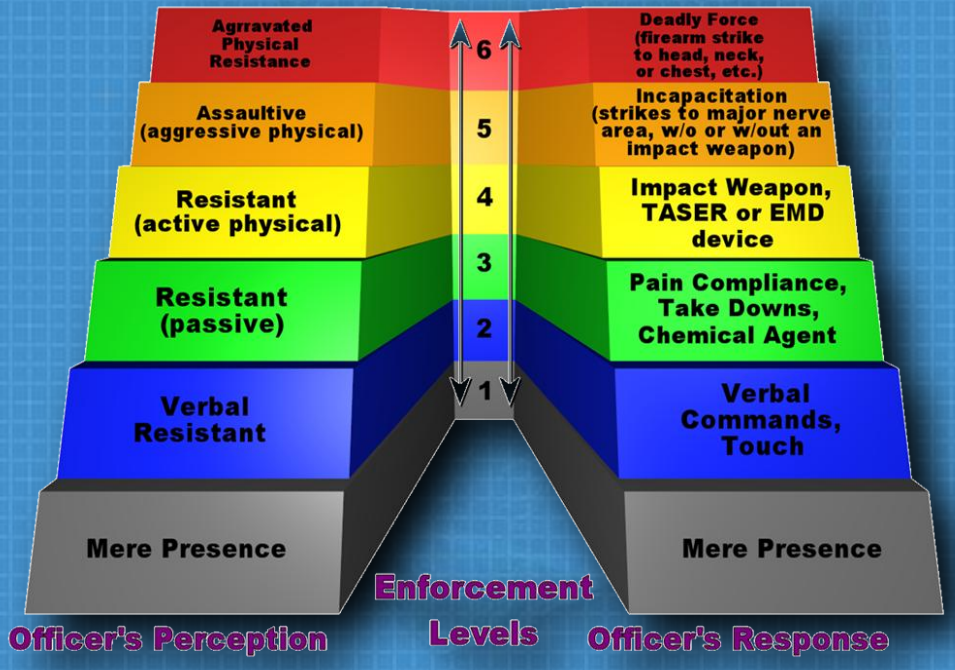
# Evaluating unexploded ordinance

# Dangerous pressure overload

HOW NOT TO HANDLE UNEXPLODED ORDINANCE

# Primary Issues

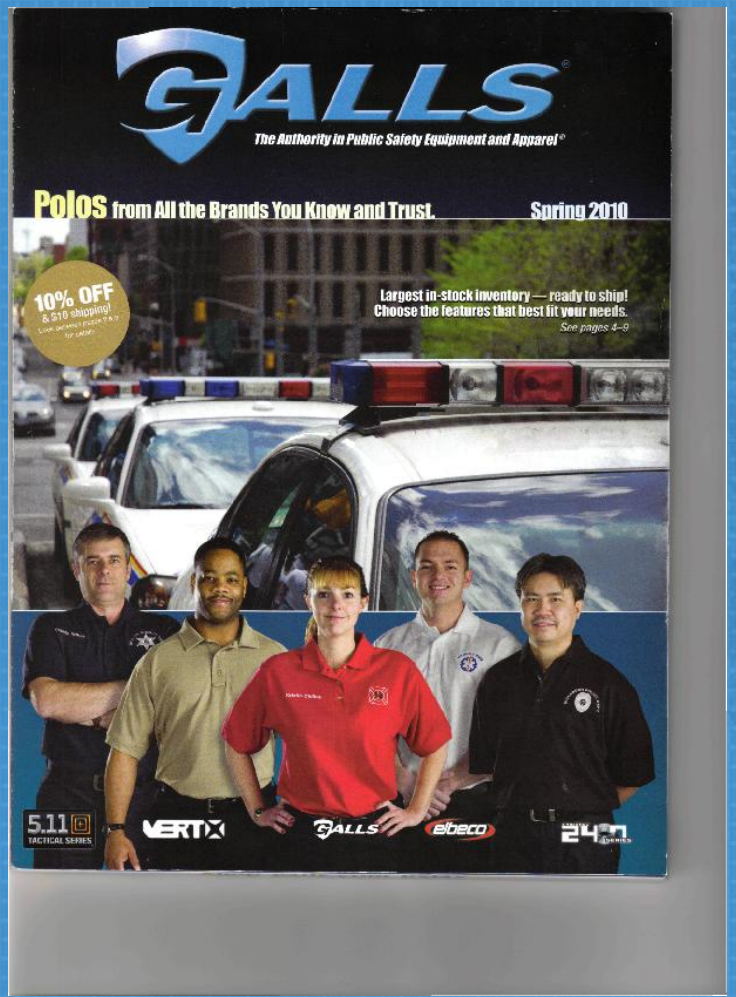
- Lack of regulation of the less lethal industry and changes occur only after civil litigation
- Academia views each type of weapon as if all are identical.

# Conclusions

- No established standards in the industry and we have no idea the extent of the problem.
- No method of disseminating what findings we do have as officers do not access NCJRS or NIJ websites.
- Agencies have one source of information: the vendors.

# Primary Source of Info



# Our Upcoming Study

- First semi-auto shotgun designed by Marines to fire less lethal munitions
- Five different brands to be tested

# Questions?

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