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

<table>
<thead>
<tr>
<th>Weapon Type</th>
<th>Iteration 1</th>
<th>Iteration 2</th>
<th>Iteration 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical agent</td>
<td>329 (64%)</td>
<td>211 (72%)</td>
<td>108</td>
</tr>
<tr>
<td>TASER</td>
<td>1460 (69%)</td>
<td>536 (67%)</td>
<td>270</td>
</tr>
<tr>
<td>Compliance hold</td>
<td>64 (16%)</td>
<td>81 (63%)</td>
<td>35</td>
</tr>
<tr>
<td>Takedown</td>
<td>215 (41%)</td>
<td>166 (62%)</td>
<td>64</td>
</tr>
<tr>
<td>Empty hand strike</td>
<td>26 (28%)</td>
<td>63 (61%)</td>
<td>47</td>
</tr>
<tr>
<td>Impact weapon</td>
<td>32 (45%)</td>
<td>41 (51%)</td>
<td>43</td>
</tr>
<tr>
<td>Pepperball</td>
<td>4 (57%)</td>
<td>2 (67%)</td>
<td>0</td>
</tr>
<tr>
<td>12 gauge beanbag</td>
<td>2 (29%)</td>
<td>1 (50%)</td>
<td>2</td>
</tr>
<tr>
<td>K9</td>
<td>209 (69%)</td>
<td>74 (71%)</td>
<td>32</td>
</tr>
</tbody>
</table>
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 Staff

- Three full time grad students
- Three – five interns
- As many as ten service learning students
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
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.
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.
Despite labeling on canisters that claim that they are ECD safe, we continue to see flammable reactions.
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

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

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

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Percent (w/w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabre Red</td>
<td>1.2</td>
</tr>
<tr>
<td>Sabre Red Duplicate</td>
<td>1.1</td>
</tr>
<tr>
<td>Detection Limit</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Dates Analyzed: 06-17-09**

**Quality Control Summary**

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Sample Result</th>
<th>Duplicate Result</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl sulfoxide</td>
<td>1.15</td>
<td>1.10</td>
<td>4</td>
</tr>
<tr>
<td>QC Guidelines</td>
<td></td>
<td></td>
<td>NMT 25</td>
</tr>
</tbody>
</table>
# Material Safety Data Sheet

## SECTION 1 - CHEMICAL PRODUCT & COMPANY IDENTIFICATION

<table>
<thead>
<tr>
<th>Manufacturer/Name</th>
<th>SECURITY EQUIPMENT CORPORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>330 SUN VALLEY CIRCLE</td>
</tr>
<tr>
<td>City, State, Zip</td>
<td>FENTON, MO 63029</td>
</tr>
<tr>
<td>Chemical Name</td>
<td>Oleoresin Capsicum (Red Pepper)</td>
</tr>
<tr>
<td>Trade Name</td>
<td>SABRE Red (H2O Series)</td>
</tr>
<tr>
<td>Emergency Phone</td>
<td>800-325-0568</td>
</tr>
<tr>
<td>Other Data</td>
<td>636-343-0200</td>
</tr>
<tr>
<td>Fed Number</td>
<td>636-343-1318</td>
</tr>
</tbody>
</table>

## SECTION 2 - HAZARDOUS INGREDIENTS / IDENTITY

<table>
<thead>
<tr>
<th>Hazardous Component (Chemical &amp; common name)</th>
<th>Content</th>
<th>OSHA PEL</th>
<th>Carcinogen (Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleoresin Capsicum</td>
<td>10%</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Scoville Heat Units</td>
<td>2,000,000</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Major Capsaicinoids</td>
<td>1.33%</td>
<td>N/A</td>
<td>No</td>
</tr>
</tbody>
</table>

Capsaicin CAS #404-85-4
Nonhydrocapsaicin CAS #10436-84-5
Dryycapsaicin CAS #26788-35

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

## SECTION 3 - PHYSICAL & CHEMICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>370 Degrees F</td>
</tr>
<tr>
<td>Specific Gravity (H2O = 1)</td>
<td>1.0</td>
</tr>
<tr>
<td>Solubility in Water</td>
<td>Soluble</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>130 PSI</td>
</tr>
<tr>
<td>Appearance &amp; Odor</td>
<td>Red/Orange in color. Odor is pungent</td>
</tr>
</tbody>
</table>

## SECTION 4 - FIRE & EXPLOSION DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Auto-Ignition Temperature</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Special Fire Fighting Procedures</td>
<td>Halon, Carbon Dioxide, Dry Chemical or Water</td>
</tr>
<tr>
<td>Unusual Fire and Explosion Hazards</td>
<td>Smoke would be irritating to eyes and mucous membranes.</td>
</tr>
</tbody>
</table>

## SECTION 5 - PHYSICAL HAZARDS (REACTIVITY DATA)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>Conditions To Avoid</td>
<td>N/A</td>
</tr>
<tr>
<td>Incompatibility (Materials to Avoid)</td>
<td>N/A</td>
</tr>
<tr>
<td>Hazardous Decomposition Products</td>
<td>N/A</td>
</tr>
<tr>
<td>Physical Changes to Avoid</td>
<td>X</td>
</tr>
<tr>
<td>Unusual Fire and Explosion Hazards</td>
<td>X</td>
</tr>
<tr>
<td>Reaction with Water</td>
<td>X</td>
</tr>
</tbody>
</table>
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.

\[ R = 0.94 \]
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 CO2 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
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.

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

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

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

Performance

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

Charlie Mesloh, Ph.D.
Associate Professor / Director
Weapons and Equipment Research Institute
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Fort Myers, FL 33965
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cmesloh@fgcu.edu