The Nammo Green Ammunition Experience

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Lead Ammo Toxicity Debate

DON'T MOVE, or I'll fill you full of LEAD!!!

HAAAA!! I happen to know that the lead in bullets is in the METALLIC form! This chemical form of lead has an intrinsically low bioavailability and toxicity!!

YES, but EARP et al (1886) have recently reported that the gunpowder-assisted acceleration of this form of lead to 1000 ft/sec substantially enhances its ability to penetrate biological membranes, effectively making it a whole lot MORE toxic!!!

I don't believe I've read that paper...
General Objectives

- “Green” ammunition
- Environmental friendly
  - Groundwater
- Safe working environment
  - Non Toxic Primer
  - Non Toxic Projectile
- Transparent to users
  - Combat/Training ammo
  - Full military performance
- Same costs as lead core ammo
  - High-rate Production
## TIMELINE

### Nammo Non Toxic Ammo Program

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Swedish Requirement Established</td>
</tr>
<tr>
<td>1996</td>
<td>Swedish Specification Established</td>
</tr>
<tr>
<td>1995-1999</td>
<td>Design Trade Studies</td>
</tr>
<tr>
<td>1997-1999</td>
<td>Production Studies</td>
</tr>
<tr>
<td>1999</td>
<td>Initial Production to Sweden</td>
</tr>
<tr>
<td>1999-2002</td>
<td>Production Improvements</td>
</tr>
<tr>
<td>2001</td>
<td>Norway Adopts Nammo NT</td>
</tr>
<tr>
<td>2004</td>
<td>Finland Adopts Nammo NT</td>
</tr>
<tr>
<td>2004</td>
<td>NATO Qualification Approval</td>
</tr>
</tbody>
</table>
Specific “Green” Objectives

- External environment - Groundwater
  - No lead or heavy metals in the projectile
  - Outdoor range issue

- Safe working environment
  - Non toxic primer
    (no toxic gas/particle emissions)
  - Non toxic projectile
    (no toxic base oxidation emissions)
  - Indoor range issue
General Design Objectives

- Full Military (NATO) Performance:
  - Accuracy
  - Terminal Ballistics
    - Penetration
    - Wound Ballistics
  - Storage and Use Environments
    - -65°F to +125°F (-54°C to +52°C)
  - Function in all NATO weapons
  - Barrel erosion
  - Smoke, flash and fouling
  - Full training and combat interchangeability

- Cost Delta <15% more than lead ammunition
Evaluated Projectile Materials & Designs

- **Metal-Polymer Composite Core & Steel Tip + Gilding Metal Jacket**
  - High Cost
  - Penetration
  - Barrel Erosion
  - Copper Fouling

- **Solid Steel and Solid Brass**
  - Penetration
  - Barrel Erosion
  - Copper Fouling

- **Monolith Steel Core + Gilding Metal Jacket**
  - Penetration
  - Barrel Erosion

- **Copper Core & Steel Tip or Steel Core & Steel Tip + Gilding Metal Jacket**
  - Steel Core & Steel Tip selected
  - Lower cost
  - Minimal Copper exposure
Primer – Powder Optimization

Optimization of primer – powder system critical

Green Primer design considerations;
• High peak pressure
• More hot gases than hot particles
Nammo Green Ammunition Concept

5.56 mm & 7.62 mm NATO

- Non-Toxic Primer
- Optimized ignition train
- Adapted propellant
- Optimized Soft-steel core
- Hardened steel penetrator
- Ball HP
- Optimized gilding metal jacket
- Clad steel jacket
- Copper core
- Tracer
Nammo Green Ammunition Concept

9 mm NATO

- Non-Toxic Primer
- Adapted propellant
- Optimized ignition train
- Gilding metal jacket
- Clad steel jacket
- Copper core
- Ball
- Ball HP
- Copper core
**Norwegian Groundwater Study**

**Laboratory Study:** Relative change (%) in soaking of dissolved heavy metals when firing Nammo Green ammunition at Norwegian firing ranges in service.

<table>
<thead>
<tr>
<th></th>
<th>Lead</th>
<th>Copper</th>
<th>Antimony</th>
<th>Zinc</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range A</strong></td>
<td>-35%</td>
<td>5%</td>
<td>-37%</td>
<td>-24%</td>
<td>2800%</td>
</tr>
<tr>
<td><strong>Range B</strong></td>
<td>-86%</td>
<td>17%</td>
<td>-93%</td>
<td>-75%</td>
<td>2100%</td>
</tr>
<tr>
<td>(wetland)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Range C</strong></td>
<td>-17%</td>
<td>-31%</td>
<td>-75%</td>
<td>-13%</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>-46%</strong></td>
<td><strong>-3%</strong></td>
<td><strong>-68%</strong></td>
<td><strong>-37%</strong></td>
<td><strong>1636%</strong></td>
</tr>
</tbody>
</table>
Green Accuracy

7.62 mm BNT 9 HP

Lot 01-CG-05 (5/12/05)
30 rounds @ 550 m

- Std. Dev. Hor. 5.5 cm
- Std. Dev. Vert. 6.2 cm
- NATO Req. Std Dev < 20 cm
- Mean Radius 7.6 cm
- US Req. MR < 6" (15.2 cm)
# NATO Test Target - Penetration

<table>
<thead>
<tr>
<th>Nammo Cartridge</th>
<th>Nammo BNT-HP Penetration</th>
<th>Standard Ball Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.56 mm BNT 4 High Performance</td>
<td>3.5 mm NATO plate @ 620 m @ 0º obliquity</td>
<td>3.5 mm NATO plate @ 550-600 m @ 0º obliquity</td>
</tr>
<tr>
<td>7.62 mm BNT 9 High Performance</td>
<td>3.5 mm NATO plate @ 950 m @ 0º obliquity</td>
<td>3.5 mm NATO plate @ 550-600 m @ 0º obliquity</td>
</tr>
<tr>
<td>9 mm BNT 7 High Performance</td>
<td>3 mm mild steel @ 70 m @ 0º obliquity</td>
<td>3 mm mild steel @ 5-10 m @ 0º obliquity</td>
</tr>
</tbody>
</table>
Test Target – 10 % Gelatin

7.62 mm Ball M80
Tumbling starts @ 6” (15 cm)

7.62 mm BNT 9 HP
Tumbling starts @ 5” (12.5 cm)
Real Target - Building
Test Target - Concrete

125 mm (5’’)
1999 Vintage
Concrete Block

7.62 mm Ball M80
23 rounds
Two bursts

7.62 mm BNT 9 HP
10 rounds
One bursts

Green Performance
Green Performance

Real Targets - Trucks
Test Target – Medium Truck

NATO Medium Truck
STANAG 4498

Material: Mild steel

1.2mm  1mm  1mm  3.2mm

Truck Door Skin Front & Back
Kevlar 24 Layers
Ballistic Soap

Green Performance
Target Effect – Medium Truck

7.62 mm Ball M80

7.62 mm BNT 9 HP

27 cm (10.5”)

Green Performance
# Nammo Green Ammunition

## NATO Qualification Status

<table>
<thead>
<tr>
<th>Nammo Cartridge</th>
<th>Specification</th>
<th>NATO QA Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.56 mm TNT 4</td>
<td>STANAG 4172</td>
<td>In progress</td>
</tr>
<tr>
<td>9 mm BNT 7 High Performance</td>
<td>STANAG 4090</td>
<td>In progress</td>
</tr>
</tbody>
</table>
Nammo Green Ammunition Family

In Production:
- 5.56 mm Ball Non Toxic 4 High Performance
- 5.56 mm Tracer Non Toxic 4
- 5.56 mm Ball Non Toxic 3 Short Range
- 7.62 mm Ball Non Toxic 9 High Performance
- 7.62 mm Tracer Non Toxic 9
- 7.62 mm Ball Non Toxic 6 Short Range
- 9 mm Ball Non Toxic 7 High Performance
- 9 mm Ball Non Toxic 7

Under development:
- 5.56 mm Dim Tracer Non Toxic 4
- 7.62 mm Dim Tracer Non Toxic 9
... and Finally
... and Finally

..so far 300 tons less lead polluting the environment and creating health hazards

Thank you for your attention!

Any questions?