Insensitive Munitions (IM) Testing:
25mm Target Practice, Discarding Sabot with Trace (TPDS-T), M910 Cartridge using ECL® Propellant
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Presented by:
Mica Mc Ghee-Bey

Propulsion Manufacturing Technology & Producibility Branch
Energetics Producibility & Manufacturing Technology Division
RDECOM-ARDEC, Picatinny Arsenal, NJ

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- **Co-Authors**
  - **RDECOM-ARDEC**
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    - Mr. Chester Topolski
    - Mr. Bishara Elmasri
  - **Nitrochemie Wimmis**
    - Mr. Kurt Ryf
    - Mr. Beat Vogelsanger
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Outline

- Overview
- System Description
- Objective
- Why ECL?
- Test Results
  - Ballistics
  - Engineering IM
- Conclusion
- Planned Effort
The U.S. Army is increasingly stressing the necessity of Insensitive Munitions (IM) compliance to provide a more cost effective, efficient means of transporting, storing and handling munitions.

PEO Ammunition strategy plan adopted an IM initiative to bring medium and large caliber munitions into IM compliance.

Existing medium and large caliber munitions do not meet Insensitive Munitions (IM) requirements.

Develop and investigate IM technologies (less sensitive propellant, cartridge case and ammo can venting concepts) to enhance munitions survivability when subjected to extreme environments and unplanned stimuli.

- IM improvements over the existing designs to enhance the survivability of logistical and tactical combat systems
- Does not degrade the performance of the systems
- Minimize injury to personnel

Developed solutions will be demonstrated for IM enhancement using the 25mm APDS-T, M910 cartridge.
The 25mm M910 Target Practice, Discarding Sabot with Trace (TPDS-T), M910 cartridge is a limited range munitions ballistically matched to the service cartridge, 25mm Armor Piercing Discarding Sabot with Tracer (APDS-T), M791 cartridge.

- Maximum range is less than 8000 meters
- The M910 is fired in lieu of the M791 from the M242 25mm autogun turret mounted on the M2/M3 Bradley Fighting Vehicle System during live fire gunner training and qualification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length (max)</td>
<td>223 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>419 g</td>
</tr>
<tr>
<td>Projectile Mass</td>
<td>98.8 g</td>
</tr>
<tr>
<td>Propellant Weight</td>
<td>98.5 g</td>
</tr>
<tr>
<td>Muzzle Velocity</td>
<td>1520 m/s</td>
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<tr>
<td>Chamber Pressure @ Ambient</td>
<td>454 MPa</td>
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<tr>
<td>Trace Time</td>
<td>4.0 sec</td>
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<tr>
<td>Dispersion</td>
<td>0.40 x 0.40 mr</td>
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</tbody>
</table>
- Develop and investigate IM technologies to enhance munitions (System Level) survivability when subjected to extreme environments and unplanned stimuli
  - Less sensitive propellant to mitigate fragment impact deficiency
  - Cartridge case venting
  - Ammo can venting
Main Benefits of new ECL® propellants compared to current nitroglycerine-base propellant solutions:

- **Improved performance potential** due to
  - High energy density and thermal conversion
  - Tunable force level, favorable thermodynamic features

- **Improved dispersion, consistency and repeatability**
  - Improved accuracy and precision

- **Direct incorporation of muzzle flash suppressants**
  - Eliminate added flash suppressant granules

- **Higher cook-off resistance**

- **Less sensitive propellant – Enhanced IM characteristics**
  - No reaction to bullet impact

- **NG-free (safety) / non-toxic "green" formulation**
  - Avoidance of critical migration problems (plasticizers)

- **Much higher service life in A1 climatic zones due to:**
  - Improved chemical and ballistic stability
  - Improved compatibility

- **Provides equal to or better chemical and ballistic performance and stability when compared to currently fielded NG-containing propellants**
83% of Akardite in ECL present after 25 days at 71°C

More than 90% of DPA in ball powder depleted after 25 days aging at 71°C
Performance Test Results

Radford Summary of Results - M910 FM4201 at 97.5 grams

<table>
<thead>
<tr>
<th>Temp, °C</th>
<th>Pressure, MPa</th>
<th>Press, Std Dev</th>
<th>Velocity, m/s</th>
<th>Vel, Std Dev</th>
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<tbody>
<tr>
<td>-54</td>
<td>342.9</td>
<td>15.3</td>
<td>1498.9</td>
<td>11.70</td>
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<tr>
<td>21</td>
<td>382.5</td>
<td>7.6</td>
<td>1530.7</td>
<td>6.70</td>
</tr>
<tr>
<td>71</td>
<td>388.3</td>
<td>6.9</td>
<td>1527.4</td>
<td>5.40</td>
</tr>
</tbody>
</table>

Nitrochemie Summary of Results - M910 FM4201 @ 98.0 grams

<table>
<thead>
<tr>
<th>Temp, °C</th>
<th>Pressure, MPa</th>
<th>Press, Std Dev</th>
<th>Velocity, m/s</th>
<th>Vel, Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>-54</td>
<td>353.5</td>
<td>13.6</td>
<td>1501</td>
<td>11</td>
</tr>
<tr>
<td>21</td>
<td>379.6</td>
<td>12.8</td>
<td>1528</td>
<td>11</td>
</tr>
<tr>
<td>71</td>
<td>379.7</td>
<td>10.3</td>
<td>1520</td>
<td>10</td>
</tr>
</tbody>
</table>
Dispersion Test Results

Dispersion (distance = 50m)
ECL FM 4201

Two type of penetrations:
- Projectile
- Pusher plate

Dispersion in Target Area (50m)
Muzzle Flash Signature

At 21°C

At 71°C

At -54°C
**Fragment Impact (STANAG 4496)**

- Impact of cylindrical steel fragment at 2'530 m/s (alternatively 1'830 m/s)
- Impact normal to surface of test item
- Assessment of Reaction Type
- Swiss setup uses alternative velocity (1'830 m/s)

**Test Setup**

- Steel Cylinder 18.6 g
- 2'530 m/s or 1'830 m/s

**Diagram**

- 23 mm Powder Gun
- Sabot Cage
- Safety Aperture
- Velocity Measurement
- Test Item
ECL FM 4201 in 35mm steel cartridge
ECL FM 4201 in 35mm steel tube
Engineering IM SCO Test
Test Setup

Slow Heating (STANAG 4382)

- Heating Rate: 3.3°C / h
- Assessment of Cook-Off Temperature and Reaction Type

Measured temperature during Slow Cook-off #1

Test available at armasuisse
Engineering IM SCO Test
Test Setup (Cont’d)
Results IM engineering tests

Slow cook-off SCO, 1st run 200807, 06/17/2008
Propellant: FM 4201 in 35mm steel cartridge,

Autoignition: 130.6°C
Fragmentation: III

Temperature vs Time Graph
Results IM engineering tests

Slow cook-off SCO, 2nd run 200808, 06/19/2008
Propellant: FM 4201 in 35mm steel cartridge,

Autoignition: 131.3 °C
Fragmentation: III

Graph showing temperature over time.
ECL Provides:

- Enhanced IM characteristics
- Provides equal to or better chemical and ballistic performance and stability when compared to currently fielded NG-containing propellants
- Improved ballistic performance with flat tunable temperature
- Increases stability / service life
Finalize the design of:
- cartridge case venting
- ammo can (PA125) with vent windows

L/A/P M910 cartridges with ECL propellant

Conduct abbreviated ballistic performance tests per MIL-PRF-70775B

Conduct full scale IM tests per MIL-STD-2105C

Conduct abbreviated safety/environmental tests