Munitions Safety Information Analysis Center

New and Evolving Insensitive Munitions Threats

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NIMIC/Pilot MSIAC
Outline

• **Introduction**

• **Evolving IM Threats**
  – Bullet Impact
  – Shaped Charge Jet Impact

• **Emerging IM Threats**
  – EFP Warheads
  – Electromagnetic Threats
  – Thermobaric Warheads
  – Terrorist Specific Threats:
    ➢ Improvised Explosive Devices

• **Conclusion and Recommendations**
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<th>Stimuli</th>
<th>Test Procedures</th>
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<td>Fast Cook-off (FCO) or Fast Heating (FH)</td>
<td>STANAG 4240 Edition 2</td>
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<td>Slow Cook-off (SCO) or Slow Heating (SH)</td>
<td>STANAG 4382 Edition 2</td>
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<td>Mechanical Threats</td>
<td>Bullet Impact (BI)</td>
<td>STANAG 4241 Edition 2</td>
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<td>Fragment Impact (FI)</td>
<td>STANAG 4496 Edition 1</td>
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<td>Shaped Charged Jet Impact (SCJI)</td>
<td>STANAG 4526 Edition 1</td>
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<tr>
<td>Combined Threats</td>
<td>Sympathetic Reaction (SR)</td>
<td>STANAG 4396 Edition 2</td>
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</table>
1985
Sniper/Hunting rifles
7.62-mm to 7.92-mm

IM and HC
Specified Stimuli:
12.7x99 AP M2 bullet

20-mm RHA @ 500 m

2005
Sniper/Anti-material rifles:
12.7-mm to 20-mm

Available bullets:
- 12.7x99 API M8
- 12.7x99 MP
- 12.7x99 SLAP
- 14.5x114 API

20 to 64 mm RHA @ 500 m
### Bullet Threats: IM Assessment

#### 1985

- **12.7-mm AP M2 Bullet**
- **Reaction Mechanisms:**
  - DDT
  - BVR
  - Bore Effects (3)

#### 2005

- **New bullets**
- **Reaction Mechanisms:**
  - Same as before +
    - Incendiary effects (API)
    - Explosive and incendiary effects (MP)
- **Armor Penetration**
  - SLAP
  - AP M2
- **Bore Effects (3)**
  - Less venting (SLAP)?

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**Diagram:**
- **Penetration**
- **Delayed Action**
- **Blast Fragmentation Incendiary**
Shaped Charge Threats

MK-118 Rockeye
50-mm Shaped Charge

IM Threat Stimuli
STANAG 4526

RPG-7 (all versions):
Availability: 40+ Nations
Iraq: 272 RPG attacks in Sept. 2004

190-mm RHA @ standoff

Shaped Charge caliber: 70.5 to 85 mm
RPG 7V HE: RDX/Wax

330-mm RHA @ standoff
Shaped Charge Threats: IM Assessment

• **Recommendations:**
  - Selection of a new shaped charge representative of RPG threats for AUR tests (same SC to be used for spall impact)
  - Use small-scale and modeling to predict the AUR response (prediction of SDT and BSDT using validated models)
  - Assessment of the risk level
    - ALARP Principle
Explosively Formed Penetrators (EFP)

• **New Generation of munitions (started to enter into service in middle 90’s)**
  - Artillery sub-munitions (BONUS, SADARM, SMArt, etc.)
  - Air-delivered sub-munitions (BLU-108)
  - Top-attack anti-tank missiles (e.g., Predator missile)

• **Main threat characteristics**
  - EFP charge: calibre between 130 and 145 mm
  - EFP projectile:
    - Mass: 400+ grams
    - Velocity: 2000+ m/s
    - Material: e.g., Tantalum

• **Availability:**
  - Limited to a few Nations, but…
EFP: IM Assessment

• **EFP impact: not covered by any IM test**
  - French Heavy Fragment Impact:
    - too light (250 grams) and too slow (2000 m/s)
    - Other issue: high density material (penetrator)

• **Proposal: EFP IM Assessment = SCJI approach**
  - Response Goal: type III
  - Response assessed by Small-scale Testing and Modeling (SDT mechanism)
## Intentional Electromagnetic Interference (IEMI) Threats

### Higher Frequency

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Radar/EW/EMI</th>
<th>HEMP</th>
<th>Lightning</th>
<th>HPM(^+) (NB)</th>
<th>HPM (WB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical frequency</td>
<td>200 kHz to 35 GHz (\text{DC to 100 MHz}^*) (\text{DC to 10 MHz}^**) (100 \text{ MHz to } 5 \text{ GHz})</td>
<td>(100 \text{ MHz to } 3 \text{ GHz})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical peak power density ((W/cm^2))</td>
<td>Up to 10 (at 10 m) (650 \text{ (CONUS-wide)}) (\text{Up to 750 (at 1 km)}^#) (\text{Up to } 10^4 \text{ (at 1 km)}) (\text{~1 MV})</td>
<td>(\text{~1 MV})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range-electric field product ((\text{Volts}))</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
</tr>
<tr>
<td>Typical pulse-width</td>
<td>10 ns to CW (\text{Hundreds of nano-seconds to seconds}) (500 \text{ ns to } 100 \text{ ms}) (10 \text{ ns to } 1 \text{ ms}) (0.3 \text{ ns})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
<td>(\text{~})</td>
</tr>
<tr>
<td>System effect</td>
<td>Interference, degradation, or mission upset (\text{Upset and damage}) (\text{Upset and damage}) (\text{Upset and damage})</td>
<td>(\text{Upset and damage})</td>
<td>(\text{Upset and damage})</td>
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<td>(\text{Upset and damage})</td>
</tr>
</tbody>
</table>

\(\text{Factor 10+}\)

\(\text{Very Short pulse}\)
IEMI: IM Assessment

- **Probability of the threat:**
  - HPM bombs available in Russia (China?)
  - RF weapons in development
  - Terrorist-type solutions

- **Recommendation:**
  - Development of IEMI THA
  - Assessment of current munitions electronics, ESAD and EEDs
  - Development of international standardized test procedures
Thermobaric Threats

• Thermobaric munitions
  – Individual weapons (RPO-A, RShG-1, 40mm CTG)
  – Artillery ammunition (Buratino, Uragan, etc)
  – Guided missiles (AGM-114 TBX, AT-14)
  – Bombs (e.g., BLU-118)

• Probability
  – RPO-A widely available ($ 2,000)
    ➢ Congo, Sri-Lanka, Afghanistan, etc.

• Thermobaric warheads: enhanced thermal and blast effects (see Duncan Watt presentation)
Thermobaric Threats: IM Assessment

- **Thermobaric induced stimuli:**
  - Munition crushed and punctured, low velocity debris impacts caused by the building collapse
    - see following slides
  - Ignition of combustible materials and sustained fire
    - Cook-off threats covered by FCO
  - The ignition and the sustained burning of ordnance by incendiary pellets
    - Internal ignition of Energetic Mat. by incendiary pellets

- **Recommendations**
  - Test program to assess TBX / incendiary pellets effects on IM
Terrorist Threats

- **Terrorist threats:**
  - RPGs attacks (e.g., Iraq, Oct. 03 – Ammo Truck)
  - Lobbed rockets, mortar attacks - Examples
    - June 2002, Afghanistan
    - June 2004, Iraq (2 on ammunition)
    - July 2004, Afghanistan
  - IEDs - An IED can be almost anything with any type of explosive material and initiator.
    - Package type IED
    - Vehicle Borne-IED (VIEDs)
    - Suicide Bomb IED
Terrorist Threats and IM Stimuli

- **RPGs, Lobbed Rockets, Mortars:** IM threats (FI, SCJI)

- **IEDs:**
  - Package-type and Suicide bomb IEDs: IM Threats (FI, SR, Blast) – high probability (Iraq: 826 attacks in Sept. 04)
  - VIEDs: not covered – medium probability (Iraq: 40 attacks in Sept. 04)

<table>
<thead>
<tr>
<th>ATF</th>
<th>Vehicle Description</th>
<th>Maximum Explosives Capacity</th>
<th>Lethal Air Blast Range</th>
<th>Minimum Evacuation Distance</th>
<th>Falling Glass Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Compact Sedan" /></td>
<td>Compact Sedan</td>
<td>500 pounds 227 Kilos (In Trunk)</td>
<td>100 Feet 30 Meters</td>
<td>1,500 Feet 457 Meters</td>
<td>1,250 Feet 381 Meters</td>
</tr>
<tr>
<td><img src="image" alt="Full Size Sedan" /></td>
<td>Full Size Sedan</td>
<td>1,000 Pounds 455 Kilos (In Trunk)</td>
<td>125 Feet 38 Meters</td>
<td>1,750 Feet 534 Meters</td>
<td>1,750 Feet 534 Meters</td>
</tr>
<tr>
<td><img src="image" alt="Passenger Van or Cargo Van" /></td>
<td>Passenger Van or Cargo Van</td>
<td>4,000 Pounds 1,818 Kilos</td>
<td>200 Feet 61 Meters</td>
<td>2,750 Feet 838 Meters</td>
<td>2,750 Feet 838 Meters</td>
</tr>
<tr>
<td><img src="image" alt="Small Box Van (14 Ft. box)" /></td>
<td>Small Box Van (14 Ft. box)</td>
<td>10,000 Pounds 4,548 Kilos</td>
<td>300 Feet 91 Meters</td>
<td>3,750 Feet 1,143 Meters</td>
<td>3,750 Feet 1,143 Meters</td>
</tr>
<tr>
<td><img src="image" alt="Box Van or Water/Fuel Truck" /></td>
<td>Box Van or Water/Fuel Truck</td>
<td>30,000 Pounds 13,636 Kilos</td>
<td>450 Feet 137 Meters</td>
<td>6,500 Feet 1,982 Meters</td>
<td>6,500 Feet 1,982 Meters</td>
</tr>
<tr>
<td><img src="image" alt="Semi-Trailer" /></td>
<td>Semi-Trailer</td>
<td>60,000 Pounds 27,273 Kilos</td>
<td>600 Feet 183 Meters</td>
<td>7,000 Feet 2,134 Meters</td>
<td>7,000 Feet 2,134 Meters</td>
</tr>
</tbody>
</table>
VIEDs: Consequences and IM Assessment

• **Consequences:**
  - The projection of complete munitions and/or munitions containers impacting different surfaces (e.g., spigot)
  - The crush of munitions by elements from destroyed/damaged building structures, projected materials, etc.
  - Large low-velocity fragments (sizes, density, hardness and shapes)

• **IM Assessment:**
  - AUR test can not represent the threat spectrum (Drop or spigot tests, corner plate tests, etc.)
  - Use SSTM to assess the sensitivity of munitions, for example
    - Susan Impact, Steven Test, ELVIS Approach
    - Sensitivity Groups Approach?
Recommendations

• **Traditional IM threats remain**
  - Cook-off, sympathetic reaction, high-velocity light fragments

• **Some IM threats have evolved**
  - Bullets with additional effects
  - Shaped charge jet: RPG instead of sub-munitions

• **Some existing threats never really considered**
  - Projection of complete munitions, Crush, puncture of munitions case and impact by large low-velocity fragments
    - Susan test, Steven Test, ELVIS, etc could be of interest for the IM Assessment
    - The Hazard Classification community is investigating the concept of Sensitivity Groups
Recommendations and Conclusions

- Some emerging threats to be considered:
  - Intentional EM Interference
  - Thermobaric munitions effects
  - Explosively-Formed Penetrators

- STANAG 4439 Edition 2
- AOP-39 Edition 2

In preparation
Questions?

Job Opportunity in NIMIC/MSIAC

Munitions Systems

Located in Brussels, Belgium

Submission Deadline: 30th November 2004

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