A Review of The Insensitive Munitions Design Technology Workshop

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TSO Munitions Systems
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25-28 April 2005
40th GARM Annual Symposium
Contents

• Introduction:
  – MSIAC
  – Insensitive Munitions
• Workshop Outline
• Summary Of Final Output
  – Key Factors
  – General IM Technology Status
• Conclusion
MSIAC (formerly NIMIC): a NATO Project funded by its member Nations

Answers to Technical Inquiries

50,000+ reports, journals, references, STANAGS; POC’s

Range of munition safety related topics

Topics of interest, reviews, tutorials

Example: Short courses for Finnish services

Reaction mechanisms, testing, implementation…

E-groups, Open website, secure website
Insensitive Munitions: Why?

- Bien Hoa AF Base – 1965
- Da Nang ASP – 1969
- Camp Doha – 1991
- Roseville, CA – 1973

Killed: 251/99 (if IM)
Injured: 985/226 (if IM)

Insensitive Munitions: Recent Headlines

Allied Munitions Storage in Afghanistan - 2003


155-mm Harbour Stowage in the Al Jubayl
Insensitive Munitions: Recent Headlines

32 killed, 70 injured

Spin Boldak, Afghanistan, 28/06/02 – Attack

6-14 killed, > 50 injured

Zaafaraniya, Iraq, 26/04/03 – Attack

Fallujah, Iraq
19/10/03 – RPG Attack

USAF Base, Kirkuk, Iraq
02/06/04 – Rocket Attack
Tests and Reaction Levels

**Threats**
- Shaped Charge Weapon Attack
- Detonation in Magazine, Store, Aircraft or Vehicle
- Magazine, Store, Aircraft or Vehicle Fuel Fire
- Fire in Adjacent Magazine, Store, or Vehicle
- Small Arms Attack
- Fragmenting Munitions Attack

**Tests**
- Shaped Charge Jet Impact
- Sympathetic Reaction
- Fast Cookoff
- Slow Cookoff
- Bullet Impact
- Fragment Impact

**Responses**
- Type I Detonation
- Type II Partial detonation
- Type III Explosion
- Type IV Deflagration
- Type V Burning

Responses: More Severe → Less Severe
The NIMIC IM Design Technology workshop was held between 29th September and 2nd October 2003 at the Royal Military College of Science, Shrivenham, UK.

The UK DOSG provided sponsorship.

92 Participants.

Key Factors
Common & Specific

General IM Technology Status
Payload
Delivery Systems: Rocket Motors & Gun Propellant Charges
Auxiliary Explosive Devices
Packaging
System Integration

MSIAC Limited Presentation:
IM SoA version 1.4 – Compendium of 29 “IM” Systems
Common Key Factors (1)

Material Properties

- Heat transfer rate.
- Attenuation of impacting bullets, frags, shock wave.
- Frag projection.

Casing

Confinement (Venting)

- Shock attenuation
- Confinement (Venting)

Configuration

Thermal

Impact
Common Key Factors (2)

Explosiveness

Energetic Material

Sensitiveness

DDT/BVR Tendency.

Auto-ignition Temperature (Booster vs Main Charge).

Chemical Stability.

DDT/BVR Tendency.

Ignitability (mechanical properties, shock sensitivity, extinguishability etc.).

Thermal

Impact
Specific Key Factors

- Propellant
- Packaging
- System Integration

Charge Configuration

Spatial Configuration

Mech. properties of degraded architecture

Propellant Cd vs Web.

Propagation (SR).

Venting systems.

DDT Tendency (Depends on geometry, bed density & distribution).

Thermal
Impact

Barriers.
Payload: IM Technology Status

**Technology**
- Explosives: Cast & Pressed Cast PBX (RDX, HMX, NTO, Al, AP)
- Design/Mitigation: Intumescent paint, venting, internal liners

**Technology deployment:** HIGH

**Shortfalls**
- Explosives with lower shock sensitiveness

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<table>
<thead>
<tr>
<th>Payload Type</th>
<th>FCO</th>
<th>SCO</th>
<th>BI</th>
<th>FI</th>
<th>SR</th>
<th>SCJ</th>
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<td>Penetrators</td>
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<td>V</td>
<td>PC</td>
<td>P</td>
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<tr>
<td>Fragmenting Warheads</td>
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<td>V</td>
<td>IV/V</td>
<td>IV/V</td>
<td>F/Pc</td>
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<tr>
<td>Shaped Charge</td>
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<td>V</td>
<td>V</td>
<td>I/IV</td>
<td>PC</td>
<td>F</td>
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</table>

C=In Container/Stowage Configuration

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• **Technology**
  – Explosives: Cast & Pressed PBX (RDX, HMX), Melt-cast (DNAN, Wax, NTO/TNT)
  – Design/Mitigation: Cook-off resistant boosters, Fusible fuze adaptors (Guns & Mortar Ammunition)

• **Technology deployment:**
  – Guns/Mortar = LOW; Submunitions = MEDIUM;

• **Shortfalls**
  – FI/SCJ resistant explosives
  – Guns/Mortar: Lower cost explosive filling (process/EM).
### Technology

- **Propellant:** Less sensitive nitrate esters, reduce/eliminate sensitive nitramines, unfilled EMCDB
- **Mitigation:** Case deconfinement (CFRP, SSL, KOA, Bonded end closures, Shear pins, Shape memory metal joints), Preferential insulation

### Technology deployment: MEDIUM

### Shortfalls

- FI low shock sensitivity propellant with suitable performance
- SCO mitigation devices
- SCJ mitigation.
Delivery Systems: IM Technology Status

- **Technology**
  - Propellant: HTPE/Butyl-NENA binder, Partial replacement of AP with AN, Eliminate nitramines
  - Mitigation: Case deconfinement (CFRP, SSL, KOA, Bonded end closures, TIVS), Preferential insulation

- **Technology deployment:**
  - Reduced Smoke = HIGH
  - High Performance = LOW

- **Shortfalls**
  - SCO mitigation devices
  - BI, FI & SCJ mitigation.
Delivery Systems: IM Technology Status

- **Technology**
  - Propellant: Composite propellant (LOVA, LOVA/CAB)
  - Mitigation: Fusible parts in container, Combustible case
- **Technology deployment**: LOW
- **Shortfalls**
  - Low cost-lightweight packaging materials
  - Progression of next generation LOVA type propellants
  - SCJ mitigation
  - Reduced vulnerability high performance propellants (esp. direct fire).
Packaging: IM Technology Status

- Considerable progress in IM technology; wide range of materials available
- Technology deployment: HIGH
- Shortfalls
  - Suitable lightweight inexpensive materials (for low cost munitions)
  - Assessment of candidate materials
  - Materials to mitigate SCJ.

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<th>SCJ</th>
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<td>P</td>
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Technology is sufficiently mature for the design of IM compliant (or near compliant) solutions for most munition types.

Acceptable technical risks
Acceptable costs
Acceptable performance

Many munitions have been introduced into service that are IM compliant (or near compliant).
Questions?

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  - Secure Website: [https://msiac.hq.nato.int](https://msiac.hq.nato.int)