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Supporting Munitions Safety

Munitions Safety Information Analysis Center

A Review of The Insensitive Munitions Design Technology Workshop

By Pascal Marchandin (MSIAC)

TSO Munitions Systems

Co-author: Ian J. Powell

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Munitions Safety Information Analysis Center (MSIAC)

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MSIAC (formerly NIMIC): a NATO Project funded by its member Nations

Answers to Technical Inquiries	50,000+ reports, journals, references, STANAGS; POC's
Software & Databases	Range of munition safety related topics
Technical Reports	Topics of interest, reviews, tutorials
Focused Training	Example: Short courses for Finnish services
Workshops & Tech. Meetings	Reaction mechanisms, testing, implementation…
Internet	E-groups, Open website, secure website

Insensitive Munitions: Why?

4 US Navy Aircraft Carrier Accidents: 1966 - 1981

Bien Hoa AF Base – 1965

Da Nang ASP – 1969

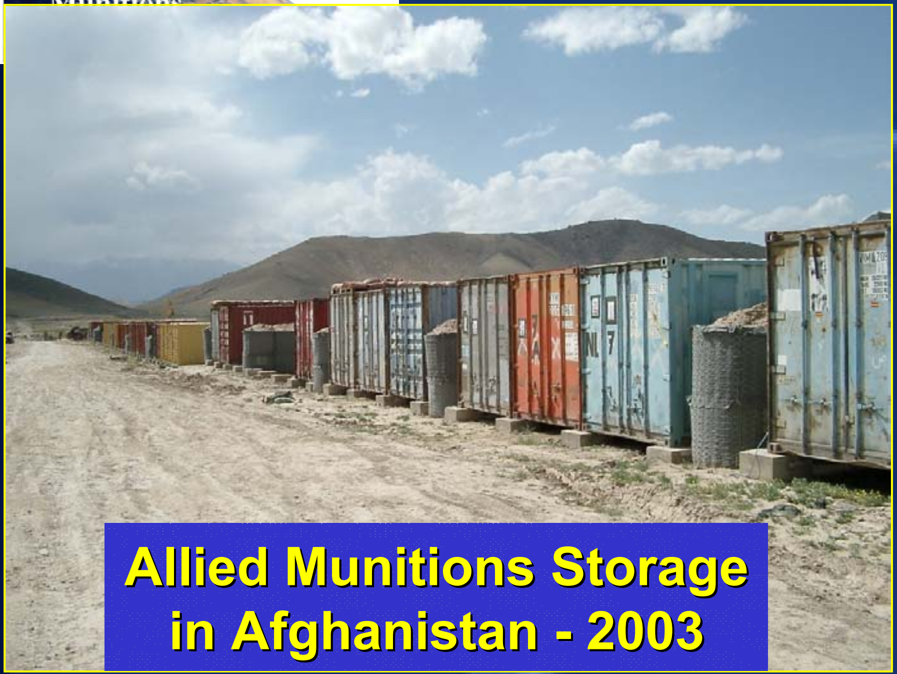
Killed: 251/99 (if IM)
Injured: 985/226 (if IM)

Roseville, CA 1973

Camp Doha – 1991

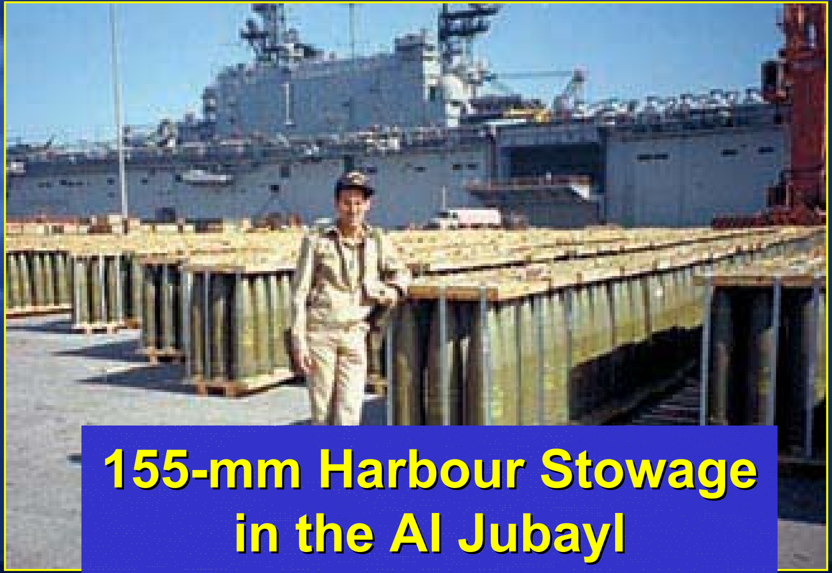
IM Cost savings: US$ 2,340 M (FY-2004)

Insensitive Munitions: Recent Headlines



Allied Munitions Storage in Afghanistan - 2003

US Aircraft Carrier Deck: Armed Aircraft - 2003



155-mm Harbour Stowage in the Al Jubayl

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Insensitive Munitions: Recent Headlines

32 killed, 70 injured

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

Fallujah, Iraq
19/10/03 – RPG Attack

6-14 killed, > 50 injured

Zaafaraniya, Iraq, 26/04/03 – Attack

USAF Base, Kirkuk, Iraq
02/06/04 – Rocket Attack

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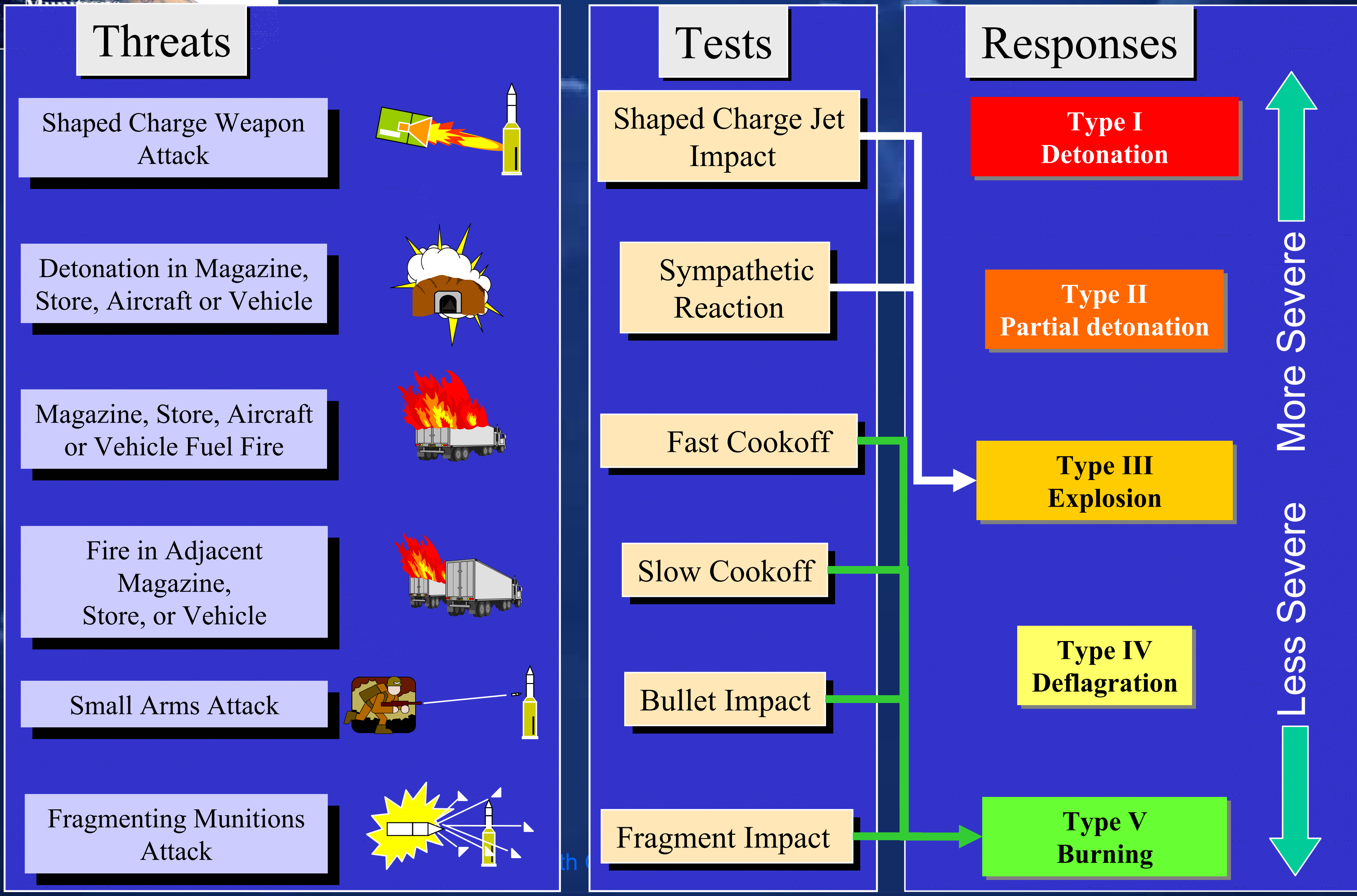
Tests and Reaction Levels



NIMIC IMDT Workshop

- 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.

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IMDT Workshop Final Output

MSIAC Restricted Document L-101:
Report on the State of the Art of IM Design Technology

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 ← **Casing** → **Configuration**

Heat transfer rate.

Attenuation of impacting bullets, frags, shock wave. Frag projection.

Thermal

Impact

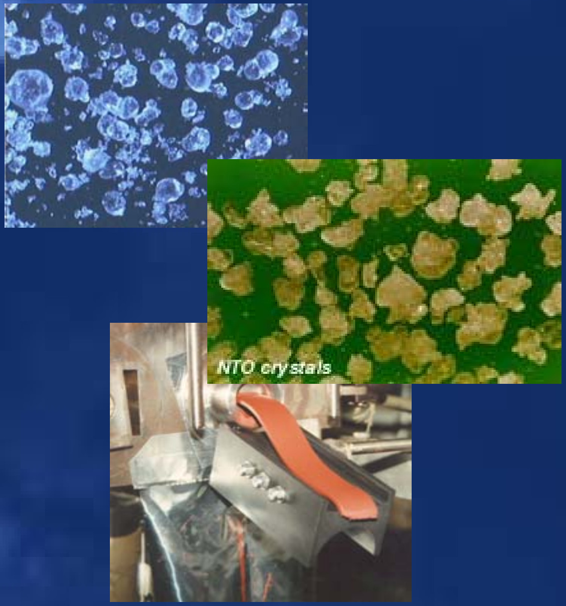
Confinement (Venting).

Confinement (Venting). Shock attenuation (Case thickness).

Common Key Factors (2)

Energetic Material

Explosiveness	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

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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.

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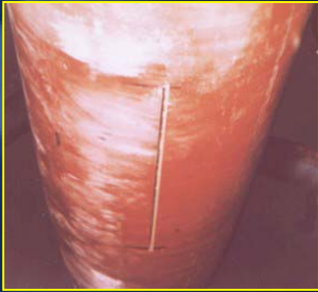
Payload: IM Technology Status

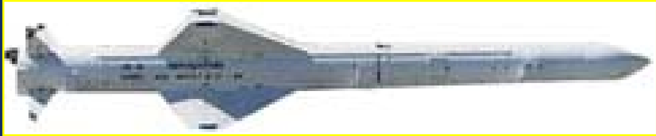


Payload Type	FCO	SCO	BI	FI	SR	SCJ
Penetrators	V	V	V	V	P^C	P
Fragmenting Warheads	V	V	IV/V	IV/V	F/P^C	F
Shaped Charge	V	V	V	I/IV	P^C	F

C=In Container/Stowage Configuration

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

- **Technology deployment: HIGH**



- **Shortfalls**
  - Explosives with lower shock sensitiveness

Payload: IM Technology Status(2)

Payload Type	FCO	SCO	BI	FI	SR	SCJ
Guns & Mortar Ammunition	IV/V	IV/V	V	III/V	P^C	P^C
Submunitions	IV/V	III/V	IV/V	IV/V*	P^C	F

*In carrier shell; C=In Container

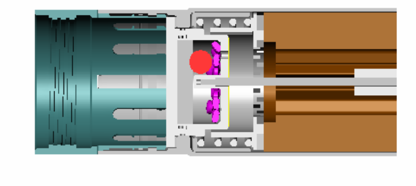
- **Technology**
  - Explosives: Cast & Pressed PBX (RDX, HMX), Melt-cast (DNAN, Wax, NTO/TNT)
  - Design/Mitigation: Cook-off resistant boosters, Fusible fuze adaptors (Guns & Mortar Ammunition)
- **Technology deployment:**
  - Guns/Mortar = LOW; Submunitions = MEDIUM;
- **Shortfalls**
  - FI/SCJ resistant explosives
  - Guns/Mortar: Lower cost explosive filling (process/EM).

Delivery Systems: IM Technology Status

Rocket Motor Type	FCO	SCO	BI	FI	SR	SCJ
Minimum Smoke	V	III/V	IV/V	I/III	P^{C}	F

C = In Container

- **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

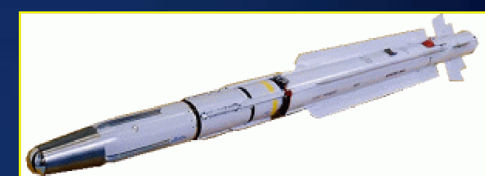


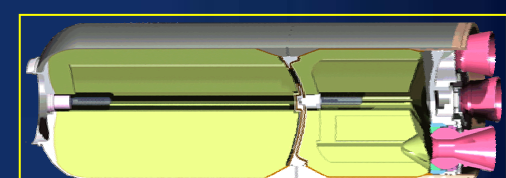
- **Technology deployment: MEDIUM**
- **Shortfalls**
  - FI low shock sensitivity propellant with suitable performance
  - SCO mitigation devices
  - SCJ mitigation.

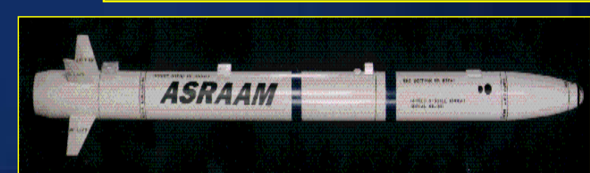
Delivery Systems: IM Technology Status

Rocket Motor Type	FCO	SCO	BI	FI	SR	SCJ
Reduced Smoke	V	IV	V	IV/V	P	NA
High Performance	IV/V	I/III	III/IV	III/IV	P	F

- **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

Delivery System	FCO	SCO	BI	FI	SR	SCJ
Gun Propellant Charge System	V	IV/V	IV/V	III/V	P	P^C

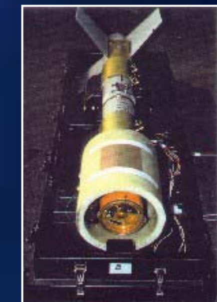
C = In Container

- **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

Type	FCO	SCO	BI	FI	SR	SCJ
Propelling Charges	V	IV/V	IV/V	III/V	P	NA
High Value Munitions	NA	NA	V	V	P	NA



- **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.

Conclusions

Technology is **sufficiently mature** for the design of IM compliant (or near compliant) solutions for most munition types

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Acceptable technical risks
Acceptable costs
Acceptable performance

↓

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

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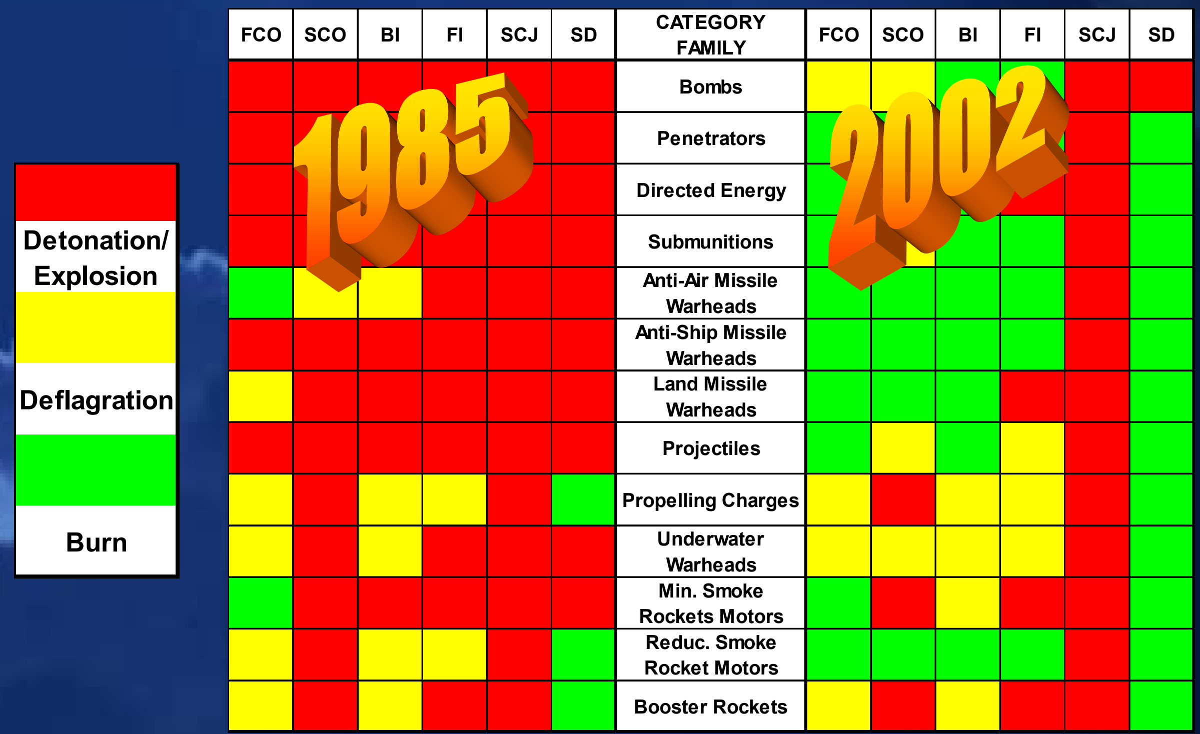

Questions?

- **Contacting MSIAC:**
  - Address: MSIAC / NATO HQ
    B-1110 Brussels, Belgium
  - Phone: +32.(0)2.707.54.16
  - Fax: +32.(0)2.707.53.63
  - Email: MSIAC@hq.nato.int
  - Website: http://hq.nato.int/related/msiac
  - Secure Website: https://msiac.hq.nato.int