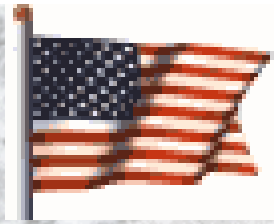
Insensitive Munitions Maturity - A Systems Perspective



"IM — are we there yet ?"

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Outline

- System-level IM — what, why & how
- IM Technology — where are we now
- IM Signatures & Assessments
- Technology Challenges for the Way Ahead

IM in The New World Order

NAVSEA
NAVAL SEA SYSTEMS COMMAND

Innovation & Methodologies

Globalization & Applicability

Transformation
- Capabilities based
- Top down — Not bottom up
- No Stovepipes

Joint Operations
- Top down capabilities
- Born Joint

IM

M&S Design Tools
- Total Weapon System Performance
- Weapon System / Platform Integration

Interoperability & SeaBasing

System-level Solutions

IM S&T / Demonstrations
Integrated Concepts & Technologies
System Design Tools
Predictive Methods
Decision Systems
Decision Aids
Sensors
Shielding
Active Intervention
Dynamic Energy Management
Synthesis, Formulation & Processing

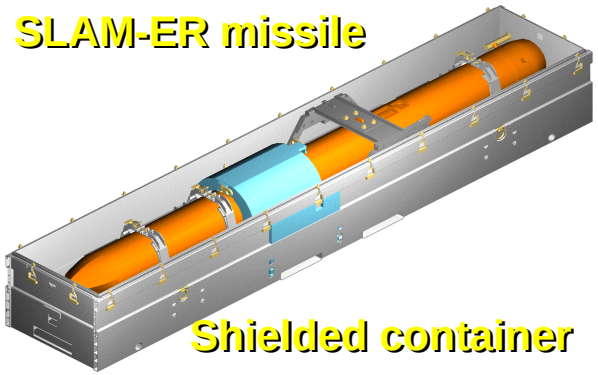
INTEGRATED

- Platforms
- Combat Systems
- Weapon Systems
- Propulsion Systems
- Ordnance Systems
- Energetic Materials

System-level IM Solutions

SLAM-ER

- NIMIC award for *novel container design*
- Reduced handling & storage requirements for improved logistics
- SD solution: Al plates + pumice-filled shielding



Integrated IM Technologies:

– Newer explosive fills
PBXN-112 (SLAM-ER)
AFX-757 (JASSM)

– Case venting with stress risers

– Vented fuze boosters

– Improved shielding for ballistic protection during PHS&T

JASSM

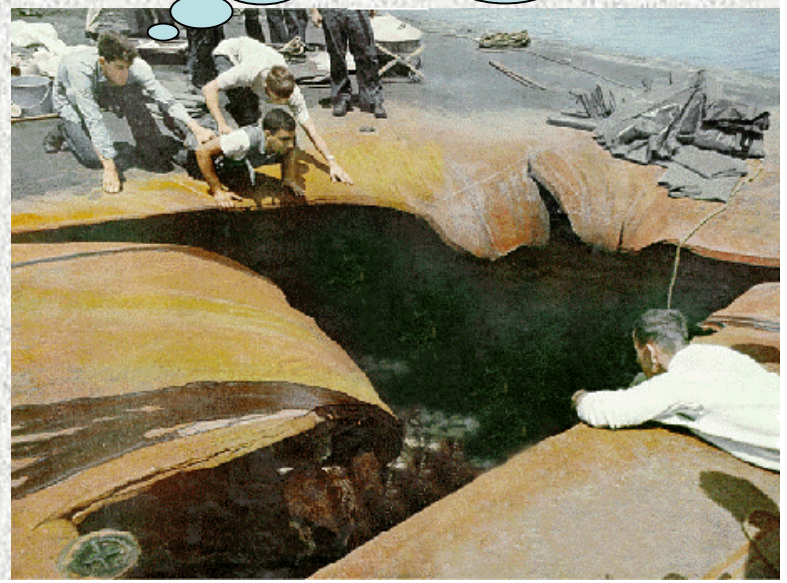
- Awarded for "*the most significant advance in IM technology in the NIMIC nations over the past two years*" in 2001
- Met all IM requirements and DoD's Hazard Class 1.2.3
- Reduced handling & storage requirements for improved logistics
- Only 2000lb class weapon to be IM certified

Historical perspective on IM

IM is a daunting task !

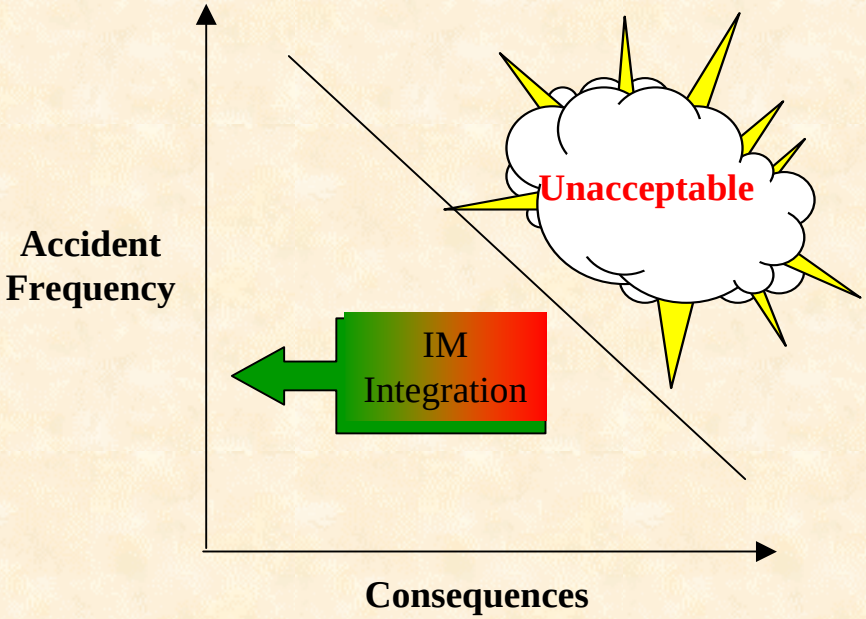
Navy's *original* goal was to be fully IM compliant by *1995*

Hmmm … was this a Type I, Type II or Type III reaction ?



In the early 1980's we underestimated the scope & magnitude of problems related to IM & the challenges ahead.

IM in a safety context ??



- In the 1980's & 90's IM focused on new energetic materials and reducing the consequences of events from specific unplanned stimuli
- Improved safety involved *risk management* — reducing accident frequency and consequences (collateral damage)

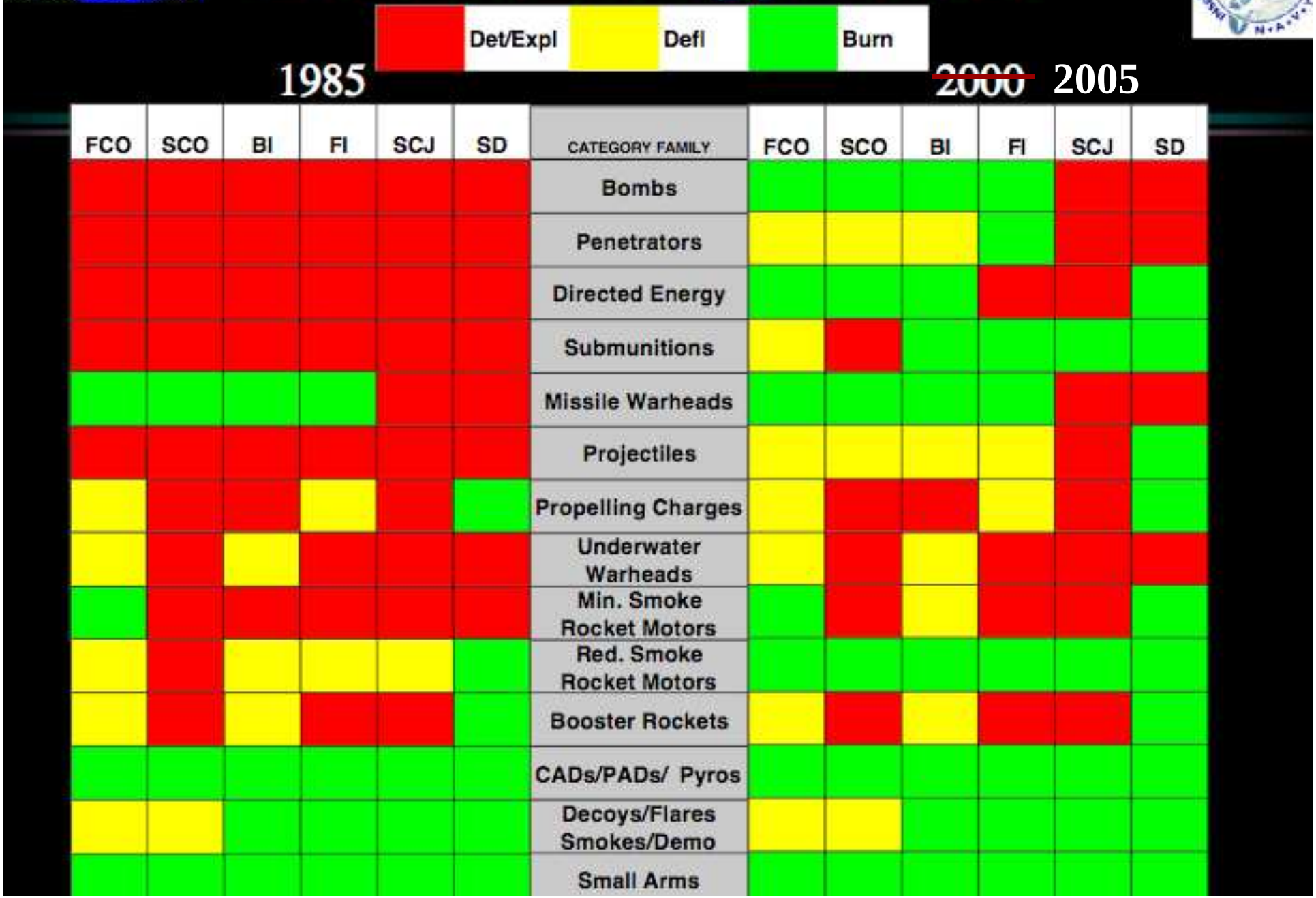
- Newer bombs are intrinsically safer.
- Reduced risk to personnel and equipment.
- No gains from Hazard Classification standpoint.

MK 83 & H6

BLU-110 & PBXN-109

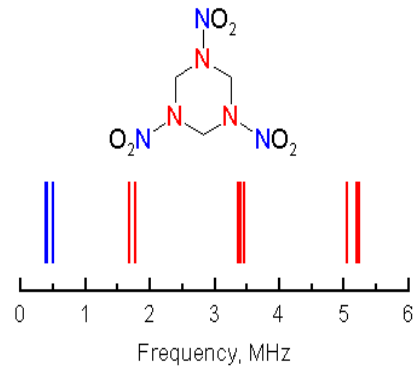
Huge IM improvement but results not as good as they can be !

IM Technology Status



Maturity of Technology

Energetic Materials — *We've come a long way in 20+ yrs !!*



Maturity

8-9 • **Explosive molecules**
- **TATB, NTO**
- **RDX & RS-RDX**
- **HMX, CL-20**

8-9 • **Explosive formulations**
- **Internal & external blast — PBXN-109, PBXW-126, PBXIH-135**
- **Metal accelerating — PBXN-110, PBXIH-18, PBXC-304, AFX-757, PAX-2A, + many others**
- **Boosters — PBXN-9, PBXW-11, PBXW-16, + others**
- **Underwater — PBXN-103 + derivatives w/ AP & Al oxidizers & nitrimine additives**

5-6 • **Propellant formulations —**
- **LOVA based propellants for gun system applications**
- **HTPE & HTCE propellants for solid rocket applications with various combinations of AP, Bi_2O_3, AN or other oxidizers.**

Maturity of Technology

Will we continue to advance the SOTA enough in the next 20 yrs ?

Maturity

6-7 • **Venting systems**

- case designs — stress risers, laminate structures & composites, vented boosters
- thermal sensors — PIT, TIVS, vent plugs

6-7 • **Shock & impact protection**

- creative application of *new* materials
- shielding system designs for weapons, containers, magazines, vehicles (including ships)

5-6 • **Logistics & stowage**

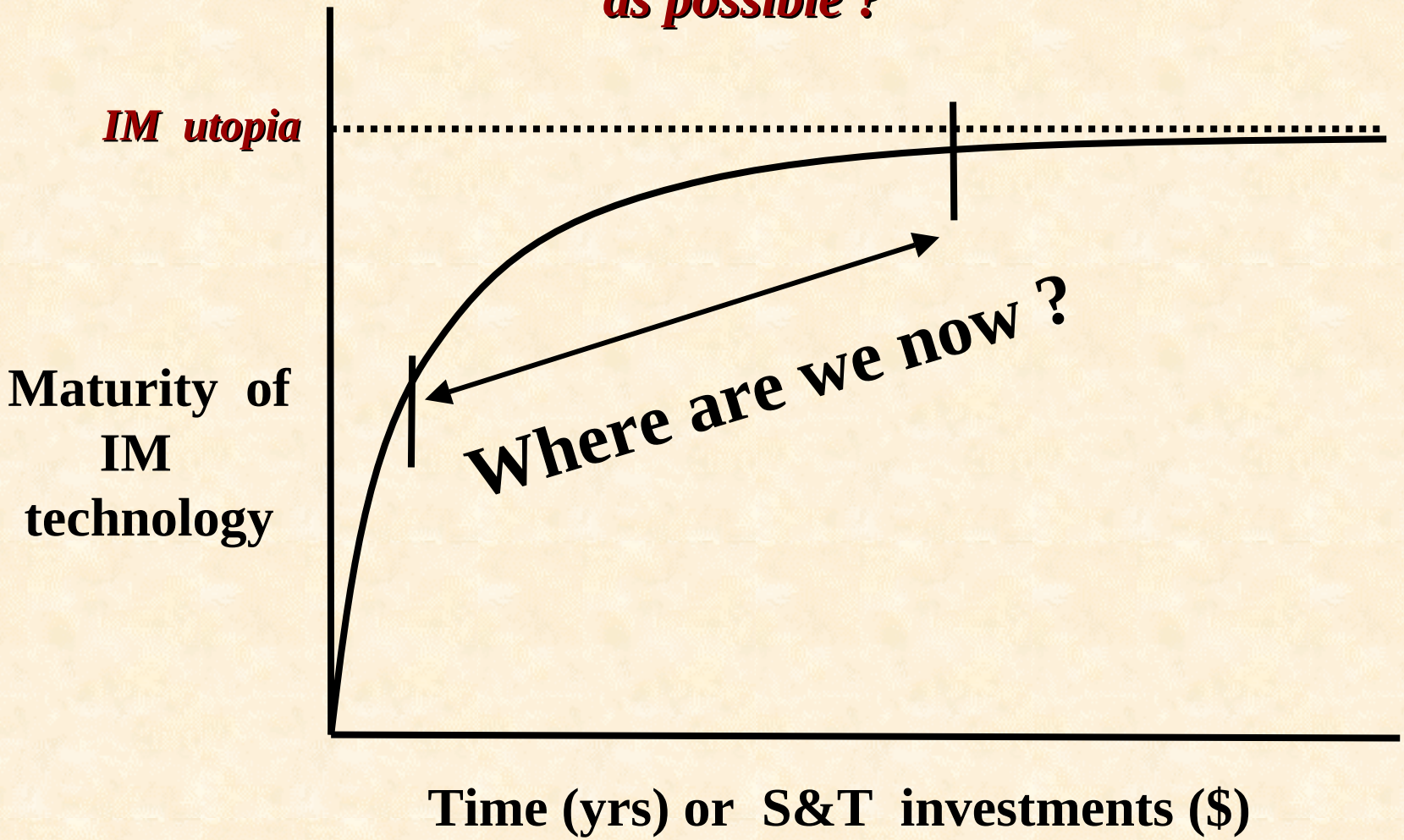
- improved handling procedures with greater emphasis on lower HC compliance
- magazine & platform design

4-5 • **Design tools & methodology**

- M&S (old) — 1-D codes for FI and SD
- M&S (new) — 1-D & 3-D codes, low & near shock initiation, cook-off
- Evolving — design process to assess & evaluate new technology

Maturity level of IM technology

Have we advanced the state-of-the-art in IM technology as much as possible ?



The IM quest continues …

Why aren't we there after 20+ yrs of IM investments & what else must be done ?

- **Vast majority of investments & resources in the early years were applied to *energetic material* development & upgrades as *the* IM solution.**

- **IM is a *system* problem that requires *system* solutions. Most cases of IM compliance, past & future, combine many technologies & many parts of the total weapon system.**

Additionally,

- **There's been little S&T emphasis in IM phenomenology — the how & why.**

For the great leap forward …

Culture must change to achieve true IM-ness !

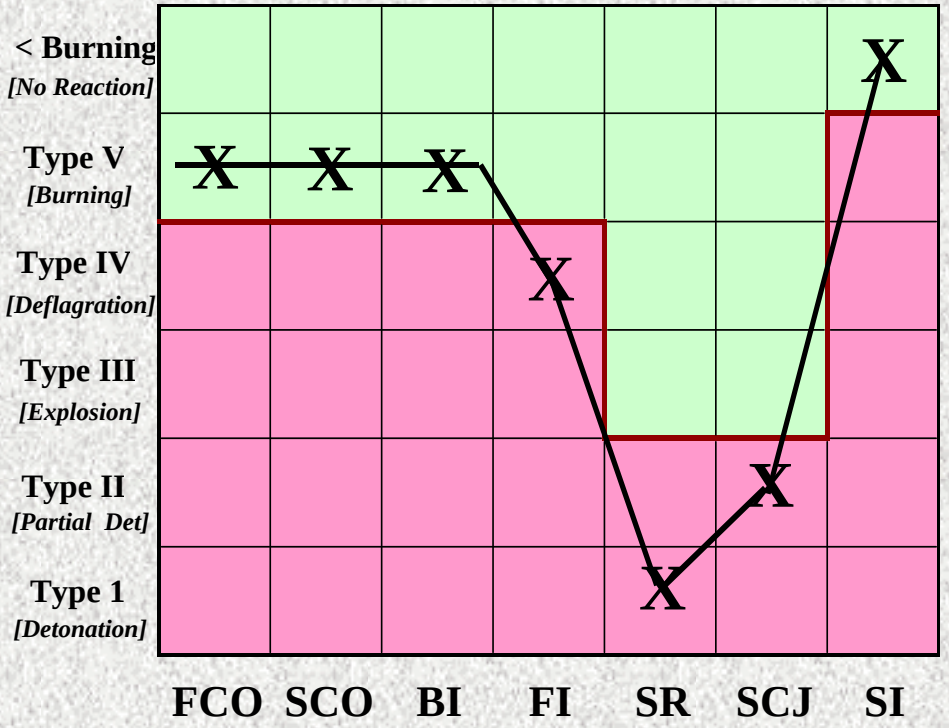
IM-ness & IM Signatures

Can these signatures be acceptable for IM-ness ?

IM "stoplight" summary

Item tested	Test	FCO	SCO	BI	FI	SR
All-up round	PBXN-109	Defl.	Defl.	Defl.	Det.	PASS
Warhead	PBXN-109	Burn	Burn	Burn	Det.	PASS
Prop. slot-based	Det.	Defl.	Defl.	Defl.	Defl.	PASS

IM signature
AOP-39



Meaningless displays without life-cycle relevance!

Violent Reactions

— Life cycle implications —

Unacceptable

SR event

Type I (detonation)

?

Acceptable

SR event

Type III (explosion)

- **High Shock event (supersonic decomposition of energetic fill)**
- **High blast overpressure**
- **Large ground crater**
- **Extensive case fragmentation**
- ***Lethal*** **fragments**

- **Mild Shock event (rapid burning of energetic fill)**
- **Lower blast overpressure**
- **Minor ground craters**
- **Case fragmentation (brittle fracture) with large fragments at high velocities**
- ***Lethal*** **fragments**

Both have BAD consequences !!

Violent Reactions

— Life cycle implications —

Structural failure from HE *detonation*

Structural failure from propellant *burn*

Both have BAD consequences !!

Sympathetic Reaction Testing

— Life cycle implications —

- **Sympathetic reaction testing (STANAG 4396) requires donor initiation in the "*design mode.*"**

Is this a realistic scenario ?

- **Consider the following:**
  - **Built-in safeguards virtually eliminate design mode initiation of "donor" munitions.**
  - **SCJ attack that causes asymetric initiation of the 1st munition — propagation occurs.**
  - **B/F attack can be successfully mitigated in many munitions.**

THA must identify most credible threats as SR event stimuli

IM Standard of Excellence

Is striving for a "less violent" reaction good enough?

- **Can sub-detonation reactions still propagate ? They're certainly very hazardous! Type III reactions produce significant *collateral damage*!**
- **In some instances burning reactions may *not* be acceptable, especially for shipboard firefighters! New HC 1.1 propellants may burn *less violently* than some HC 1.3 propellants.**
- **Do these less violent reactions still propagate into hazardous events ?**
- **AOP-39 cites Types I - V and *No Reaction* responses. We must continue to assess the applicability of these reaction levels.**
- **Future IM S&T investments should address these related issues.**

Don't be complacent with acceptance of present IM standards !

In the interim …

What are the risks in deploying non-compliant weapons?

- **Everything must be considered & evaluated on a case-by-case basis.**
- **Make operational risk assessment a requirement for non-compliant items that obtain IM waivers for S^3 !**
- **This "risk tolerance level" will give a true measure of IM-ness & level of acceptability.**

How much IM-ness is needed for their survivability ?

Technology Challenges

What are the technology challenges for the acquisition and S&T communities in the years ahead?

- **Aged munitions assessments — weapon IM-ness can change with age (don't we all !).**
- **Reaction propagation — detonations are NOT the only bad actor !**
- **Combined effects assessments — can these be mitigated ?**
- **Minimum acceptable reactions — burning NOT acceptable on all platforms ?**
- **Maturity of design tools & methodologies — near & far term applicability of M&S, especially for *large propulsion systems.***
- **Risk assessments MUST be part of the IM compliance process.**

New IM Hazards

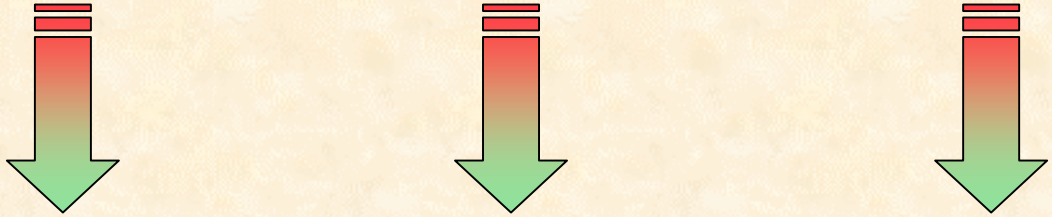
Will we reevaluate our IM certification processes for new IM hazards ?

- **Changing nature of warfare !**
  - **Global war on terror including urban warfare**
  - **Multi-national forces & weapons interoperability**
  - **Enhanced public awareness of fatal incidents**
  - **Reduced public tolerance for inadvertent casualties**

- **New threats & hazards will emerge !**
  - **Shaped charge jets (real threat now!)**
  - **Electromagnetic pulse — on the horizon ?**
  - **Chemical contamination ?**
  - **Radiation effects (dirty bombs) ?**

The Way Ahead

- **Redefine IM — set the bar higher !**
  - **Consider AOP-39's *No Reaction* as a future IM standard where its most appropriate.**
- **Emphasize *S&T* to a greater extent in future investments !**
- **Reinvigorate IM *Phenomenology* investigations**
  - **How things work and how they respond to stimuli.**
  - **How we can change their response.**
- **Develop the capability to predict IM responses to enable the design of platform-integrated systems based upon safe, minimal risk *insensitive munitions*.**



Institutionalize a system-level Design Approach!