U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – ARMAMENTS CENTER

IM Technologies & Implementation of New Designs

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IM requirements are set forth in U.S. Code, Title 10, Subtitle A, Part IV, Chapter 141, Section 2389

The Secretary of Defense shall ensure, to the extent practicable, that Insensitive Munitions under development or procurement are safe throughout development and fielding when subject to unplanned stimuli.

NATO

Allied Ordnance Publication (AOP) “GUIDANCE ON THE ASSESSMENT AND DEVELOPMENT OF INSENSITIVE MUNITIONS”, AOP-39 Ed D V1 Nov. 2018.

Technological advances in the design of explosive ordnance are making possible the development of a range of munitions termed Insensitive Munitions (IM) or Munitions á Risques Atténués (MURAT) which are less dangerous than previous weapons when subjected to accidental and combat stimuli. Such munitions remain effective in their intended application, and are less sensitive than their predecessors to extreme but credible environments such as heat, shock or impact.

Introduction of IM into service is intended to enhance the survivability of logistic and tactical combat systems, minimize the risk of injury to personnel, and provide more cost effective and efficient transport, storage, and handling of munitions.

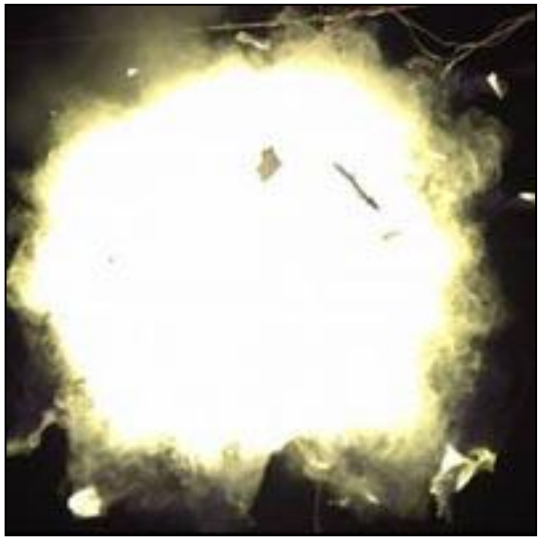
THE CHALLENGE

Boiler Explosion at Hays Manufacturing Co. Erie, Pa.

https://commons.wikimedia.org/wiki

- IM munitions require suppression of chemical energy release or release in a less violent manner.
- Violent reactions can occur with any poorly designed munition, and the violence is not limited to systems containing energetics.
- The challenge facing modern munitions engineers is to improve performance while maintaining or increasing safety.

IM TECHNOLOGIES ARE FOCUSED ON TWO AREAS OF IMPROVEMENT



Suppressing the release of the chemical energy:

- Less Shock Sensitive
- Larger Critical Diameter
- Self Extinguishing
  - Some materials require higher than atmospheric pressure to burn unaided
- Barriers between Munitions
- Armor

Releasing the chemical energy in a less violent manner:

- Venting
- Select Materials with Lower Burning Rates at Higher Pressure
- Less of the Energetic Material

IM IMPROVEMENT EXAMPLES

- Carbon Composite Rocket Motor Systems
- Package Venting
- Improved Fragmentation
- New Energetics
- Torpedo Explosives
- Integrated Technologies

Reactions	Detonation/ Partial Detonation	Explosion	Deflagration/ Propulsion	Burn	No Sustained Reaction
	Type I/II	Type III	Type IV	Type V	Type VI
					

Standard IM Scores

CARBON COMPOSITE ROCKET MOTOR SYSTEMS

PAC-3 Missile

THAAD Missile

The performance advantages of carbon composite rocket motor cases have been recognized since the 1960's. Composite cases are strong, yet light weight. They have large fractures and vent areas when they fail, which reduces internal pressure. Direct exposure to fire weakens the cases.

Composite rocket motor cases represent a “low hanging fruit” where safety and performance can both be improved together. This technology has been demonstrated in the THAAD and PAC-3 large missile systems

PACKAGE VENTING

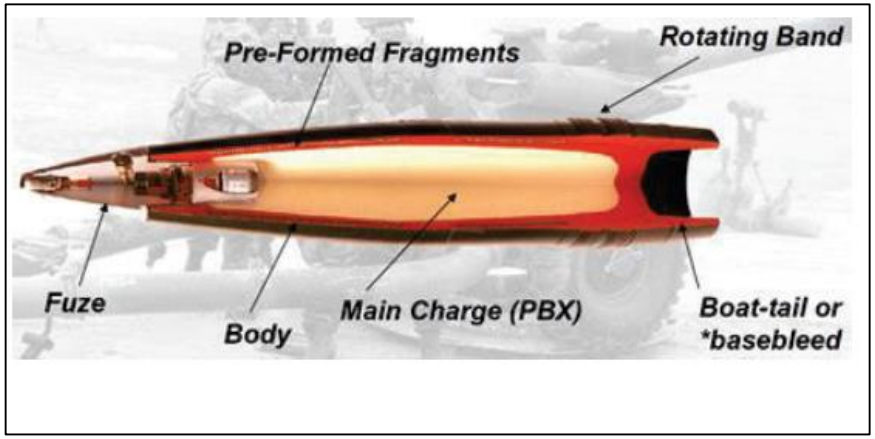
The packaging of munitions has evolved far beyond putting an item in a box.

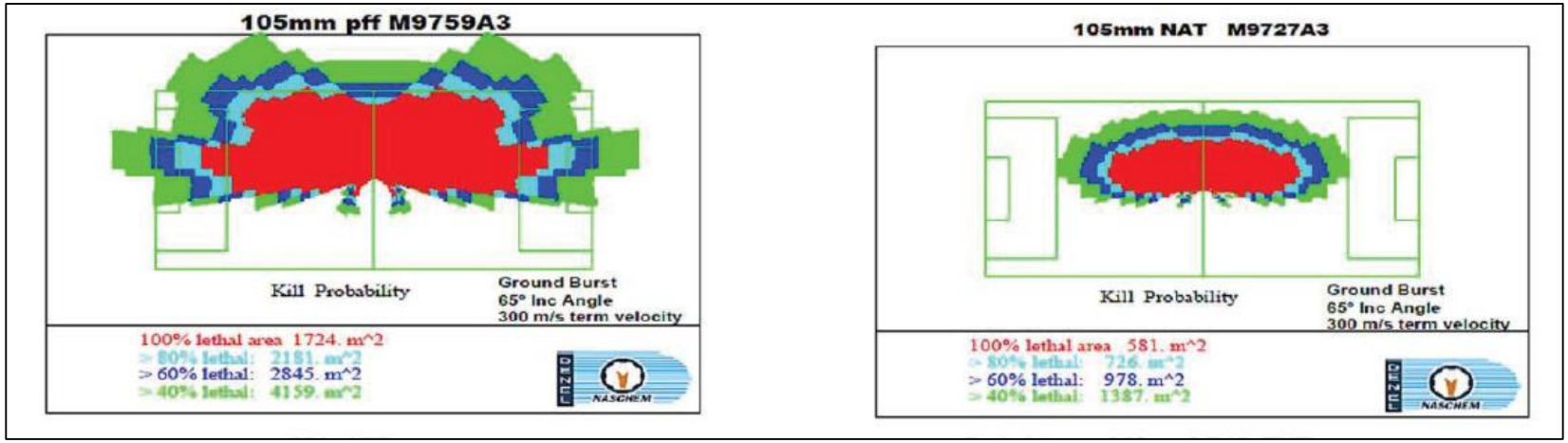
Munitions packaging design must address: difficult handling, drop testing, electro-static protection, long shelf life etc. Simple changes to the protective packaging used for munitions have been shown to have profound effects on munition responses.

Panels and packages that melt-away in the event of a fire have proven to be effective.
This technology has been applied to the Modular Artillery Charge System (MACS). During a fire at the manufacturing plant there was significant fire damage, but no blast or fragmentation damage due to the improved IM packaging design.

IMPROVED FRAGMENTATION

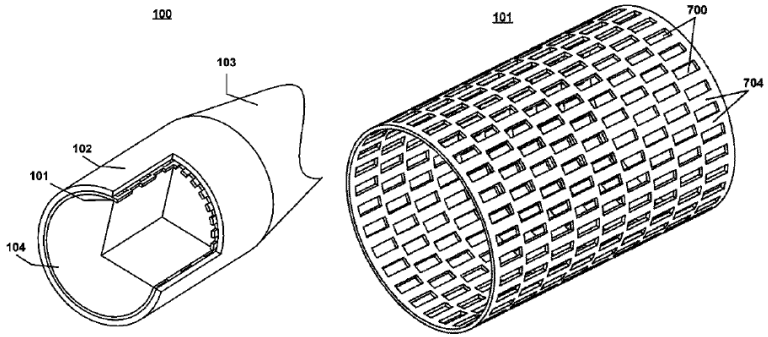
- Designed fragmentation eliminates the chaotic nature of natural fragmentation.
- This improves both the lethality and fragment distribution from a warhead.
- This has been demonstrated on the HE-PFF (High Explosive - Preformed Fragmentation) 105 mm M1130 artillery projectile.





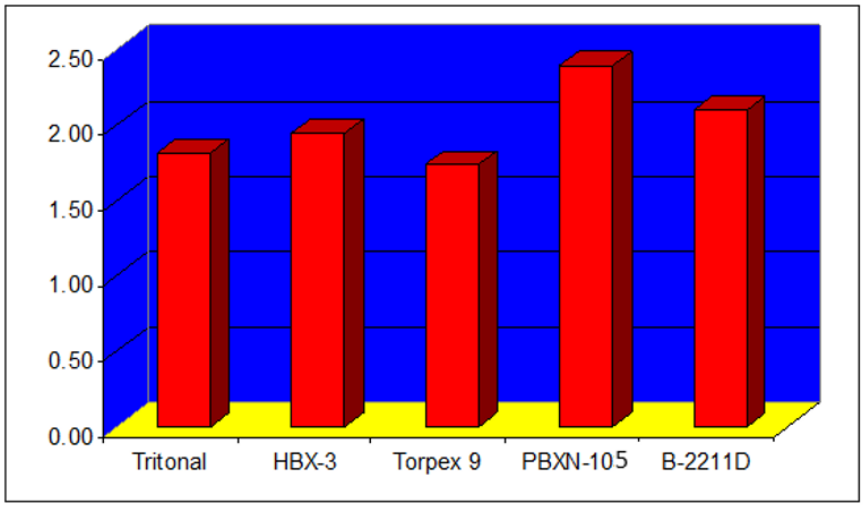
IMPROVED FRAGMENTATION IM IMPROVEMENTS

Dense fragments embedded in a polymer matrix. The melting of the matrix provides venting.



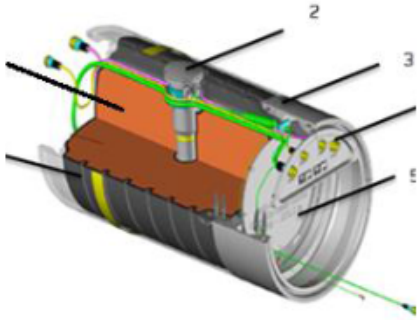
Melting plastic liners provide both venting area and designed fragmentation.

TORPEDO EXPLOSIVES



Relative Bubble Energies for Different Explosives

Newer explosive formulations (PBXN-105, B-2211D and PBXN-111 (same formulation as B-2211D)) provide increased bubble energies over traditional torpedo explosives (Tritonal, HBX-3 and Torpex 9). F21 torpedo incorporates IM design features including thermal protection and controlled ignition for cook-off mitigation, providing an improved IM signature.

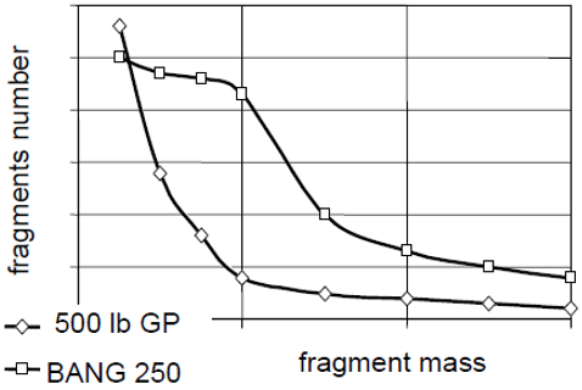


	FCO	SCO	BI	FI	SR	SCJ
HBX/Torpex					>III	
F21	V	IV	V	V	III	IV

F21 torpedo Improved IM signature

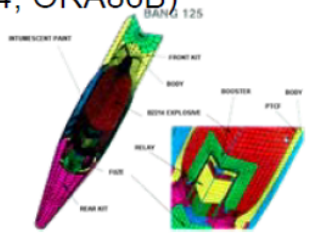
INTEGRATED TECHNOLOGIES

Performance Comparisons



IM Technology

- IM High explosives (B2214, ORA86B)
- Discharge of combustion gas by the liner towards the end
- Intumescent paint
- Logistic pallet geometry
- Venting devices in rear frame



IM Signature

	FCO	SCO	BI	FI	SR
Mk82 mod 2 TP	I	I	I	I	I
CBEMS/BANG	V	V	V	V	III

4 palletized bombs without the fuze MURAT **

Integrating Technologies is required to obtain the best reductions in violence. The French CBEMS 500 lb bomb utilizes a new energetic with improved venting and logistics. The munition passes 5 of the six standard IM tests. For improved safety, Intumescent paint was applied to increase the time to reaction in fires.

CONCLUSION

- With a new emphasis on performance, it is anticipated that innovative and updated systems will be fielded.
- This is an opportunity to implement the IM technologies.
- Improved performance and reduced sensitivity are not necessarily conflicting.
- An integrated approach to performance and safety are required for future weapon systems.