Common Low-cost IM Explosive Program

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Insensitive Munitions (IM) Roadmap

Transition towards Fully Compliant

Legacy Ammo

17 Major Munitions-related Incidents since 1926
(600+ Casualties / 1,600+ Injuries / $4B+ Losses)

Camp Doha (1991)

USS Forrestal (1967)

Port Chicago (1944)

Lake Denmark (1926)

Afghanistan (Sep 2009)
MRAP carrying 60mm Mortar hit by I.E.D.
60mm Mortar – Burned only
Minor Injuries

I.M. Improvements

60mm M720A1/M768 Mortar (PAX-21 Explosive)
155mm MACS Propelling Charge
PM-CAS Common IM Explosive (CLIMEx)

Camden, AR (Nov 2007)
MACS LAP-facility Fire
3.3 tons of Energetics – Burned only
No Injuries, Building remained

Fully-I.M. Fielded

105mm M1A1 & M913A1 (IMX-101 Explosive)
155mm M795 & M1122 (IMX-101 Explosive)
60/81/120mm Mortar (IMX-104 Explosive)

Common Low-cost IM Explosives

Joint program with Army (PM-CAS) & USMC (PM-AMMO)

Artillery HE Projectiles

105mm HE (M1, M760) | 105mm HE-RA (M927, M913) | 155mm HE (M107) | 155mm HE (M795) | 155mm HE-RA (M549A1)

Baseline Explosive = TNT

TNT filled Projectiles FAIL all IM Tests

Mortar HE Cartridges

60mm HE (M720, M768, M888) | 81mm HE (M821, M889) | 120mm HE (M933, M934)

Baseline Explosive = Comp-B

Comp-B filled Cartridges FAIL all IM Tests

(except 60mm passes 1 of 6, BI)

➢ISSUE:

- ✓ TNT & Comp-B explosives have poor IM results
- ✓ Mortar and Artillery HE items require IM Waiver
- ✓ IM explosives identified under prior efforts
  - – Specific to individual program requirements
  - – Lacked commonality
  - – Some IM improvements – still need waiver
  - – NTIB Cost Impacts

➢CORRECTIVE ACTION:

- ✓ Investigate new IM Explosives with intention to insert into production in near-term

Primary Objective is to provide a Common IM Fill

-- or --

one common TNT replacement (Artillery)...

...and one common Comp-B replacement (Mortars)

Goals of the Common Low-cost Insensitive Munitions Explosive Program

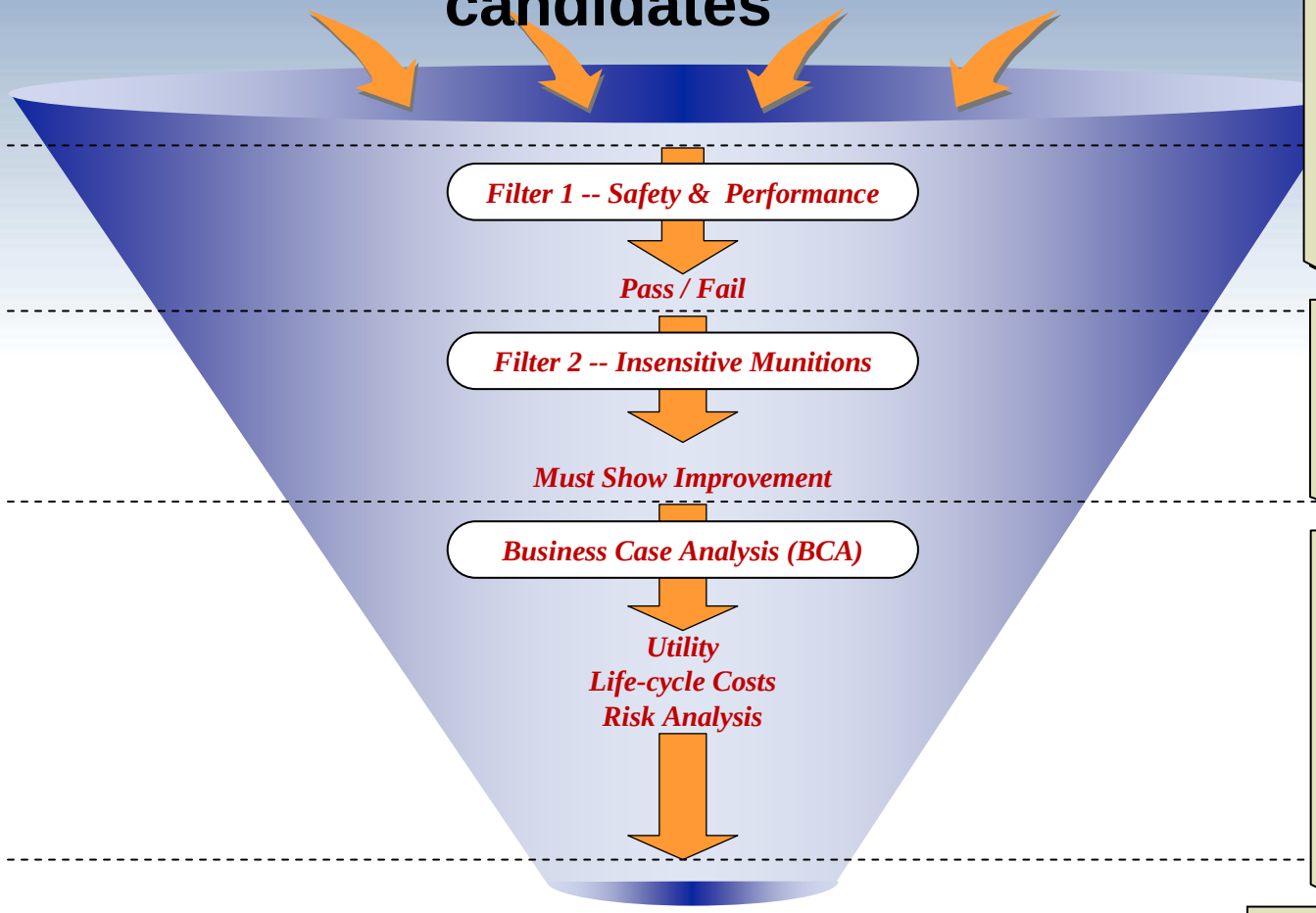
- **Effective**
  - ✓ Maintain Lethality with minimal or no degradation
- **Less Sensitive**
  - ✓ If not fully compliant, must show improvement over Baseline explosive
- **Affordable**
  - ✓ Artillery Cost Drivers = Steel Body Material & Explosive Fill
  - ✓ Mortar Cost Drivers = Steel Body Material, Fuze & Propelling Charges
- **Producible within the National Technology and Industrial Base**
  - ✓ Infrastructure
  - ✓ Raw Ingredients
  - ✓ Explosive formulation
  - ✓ Projectile Load, Assemble & Pack (LAP)
- **Other Considerations**
  - ✓ Demilitarization
  - ✓ Environmental
  - ✓ Intellectual Property Rights

Common Low-cost IM Explosive Program

- **Value to the Warfighter**
  - ✓ **Drastically increase Safety from unplanned stimuli**
    - ✓ **Increases Soldier Survivability**
    - ✓ **Increases Equipment Survivability**
- ✓ **Maintains Lethality**
  - ✓ **Significantly improve their ability to store and move ammunition**
  - ✓ **Safer transport on combat loaded vehicles, air cargo and Navy ammo ships**

Common Low-cost IM Explosive Program

"Funnel" framework to progressively screen candidates



IM Explosive Fill for TNT & Comp B Replacement

Filter 1 Criteria

- Cheetah Calculations
- Standard Safety Tests
- Electrostatic
- Friction Impact Sensitivity
- Vacuum Thermal Stability
- Differential scanning
- Critical Diameter

Filter 2 Criteria

- Tier 1 IM Tests (BI, FI, SCO, SD)
- Tier 2 IM Tests (FCO, SCJI)

BCA Criteria

- IM Tests, Lethality, Logistics, Safety, Platform
- Performance of the alternatives against weighted factors
- Risk analysis
- Comparable cost analysis
- Sensitivity Analysis

Arena Test & Qualification

Common Low-cost IM Explosive Program

Prioritization Matrix (Mission Tasks & Measures)

Rank	*Mission Tasks*	
2	Survivability	19.6%

FCO	.11
SCO	.05
BI	.07
FI	.08
SD	.49
SCJI	.21

Representation

USMC
Army
Energetics Technician
Producibility Technician
End Item Technician
Logistics Technician
Research Laboratory
Project Management

Replacement Candidates

- **23 IM explosive candidates**
  - 12 for TNT replacement, 11 for Comp B replacement

- **Melt-pour**
  - ✓ Traditional Ingredients
    - RDX
    - HMX
  - ✓ Less Sensitive Explosive Filler
    - NTO
    - NQ
  - ✓ Less Sensitive Energetic binder
    - DNAN
    - Nitrate Salts
  - ✓ Reduced Nitramines (Aluminized)

- **Cast-cure**
  - ✓ Inert binder
    - RDX
    - IRDX
    - Rounded RDX

- **Press-fill**
  - ✓ Inert binder with RDX
    - (Redesign of metal parts – Not Evaluated)

- **155mm HE selected for screening TNT replacement candidates**
  - 9 candidates tested => IMX-101
- **120mm HE selected for screening Comp B replacement candidates**
  - 9 candidates tested => IMX-104

Implementation Approach

I. **Explosive Producibility - Assure explosive can be produced in production scale and ingredient supplies are available**

II. **Load Assemble & Pack - Assure projectile can be loaded without defects. Explosive growth in aging desirable to maintain good wall adhesion.**

IMX-101 HE Loading of 155mm Projectiles – Anthony Di Stasio

III. **Venting - IM venting technology integrated into item design to pass thermal tests**

IV. **Energetic Material Qualification – Assure explosives are safe to handle, store and transport**

The Insensitive TNT Replacement Explosive IMX-101 – Wendy Balas Hummer

V. **Initiation Reliability - Reconfigure initiation system to initiate IM explosive.**

Initiation Trials of the IMX-101 Explosive in the M795 Projectile – Anthony Di Stasio

VI. **Qualification of M795 IM Projectile – Perform all safety, performance and reliability testing**

155mm HE Projectile Qualification Program – Charlie Patel

Sample IMX-101 Results

Pallet Fast Cook-off

Shaped Charge Jet Impact

Slow Cook-off

Summary of IMX-101 Test Results

M795 Filled with IMX-101 Demonstrated Full IM Compliance!!

(Based on IM Protocol at Initiation of Program)

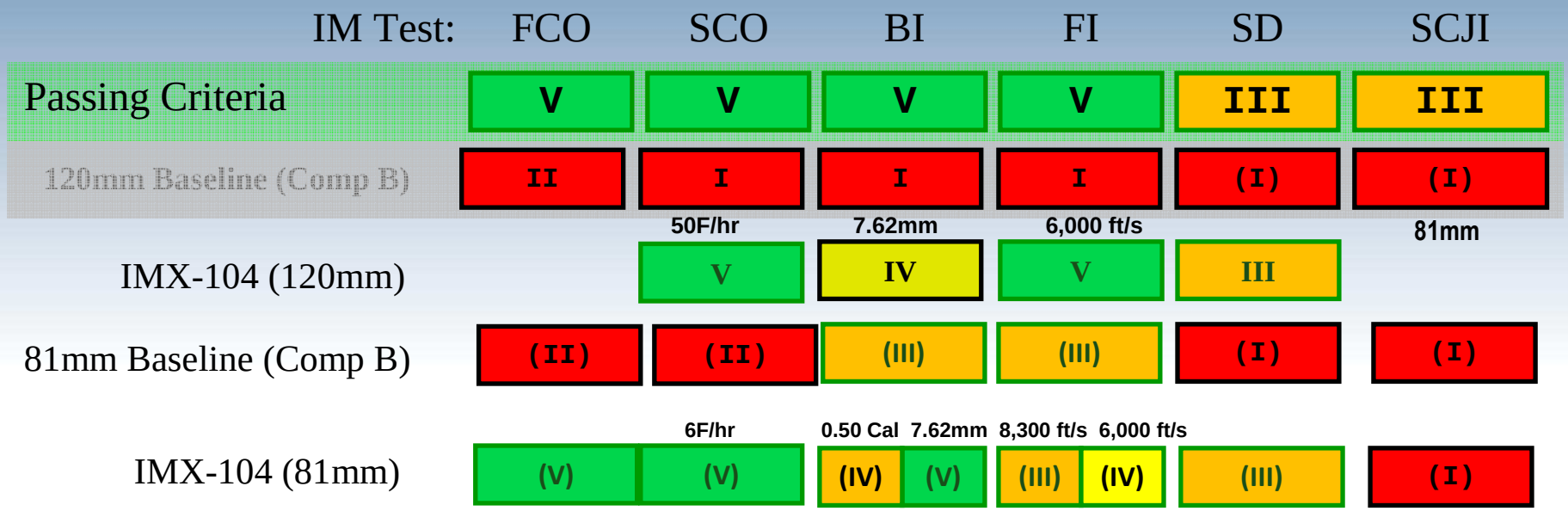
First Time an Artillery Projectile Passed SD without barriers
First Time an Artillery Projectile Passed an RPG SCJI

IM Test:	FCO	SCO	BI	FI	SD	SCJI
Passing Criteria	V	V	V	V	III	III
M795 Baseline (TNT)	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
						81mm
IMX-101	PASS	PASS	PASS	PASS	PASS	PASS

Sample IMX-104 Results
Fast Cook-off

MIL-STD-2105C / Jet Fuel Fire / Witness Plate & Pressure Gage

IMX-104 Test Results



Engineering IM Tests in the M934A1 120mm Mortar and M821A2 81mm Mortar with IMX-104 show vast improvement over baseline Comp B

CLIMEx Insertion

PM-CAS and PM-AMMO are committed to IM

END ITEM	IM FILL	SCHEDULE
155mm M795 HE Artillery Projectile	IMX-101	2010
105mm M1A1 Artillery Cartridge	IMX-101	2011
155mm M1122 Training Projectile	IMX-101	2010
120mm M933A1 Mortar Cartridge	IMX-104	2012
120mm M934A1 Mortar Cartridge	IMX-104	2012
81mm M821A1 Mortar Cartridge	IMX-104	2011
81mm M821A2 Mortar Cartridge	IMX-104	2011
81mm M889A2 Mortar Cartridge	IMX-104	2011
60mm M720A2 Mortar Cartridge	IMX-104	2011
60mm M768 Mortar Cartridge	IMX-104	2011
60mm M888 Mortar Cartridge	IMX-104	2011

Conclusions

- CLIMEx program was successful in identifying and qualifying IMX-101 Explosive as a common insensitive replacement for TNT.
- CLIMEx program was successful in identifying IMX-104 Explosive as a common insensitive replacement for Comp B.
- IM Explosives have demonstrated far superior IM properties.

Quote from US Army Public Health Command (formerly USACHPPM) presented at the Force Health Protection Conference

The decreased toxicity, coupled with the reduced sensitivity to environmental stimuli and equal performance during testing, make the formulations tested desirable replacements for currently fielded munitions

Questions