

Common Low-cost IM Explosive Program



Joint U S Army & U S Marine Corps

NDIA-2008

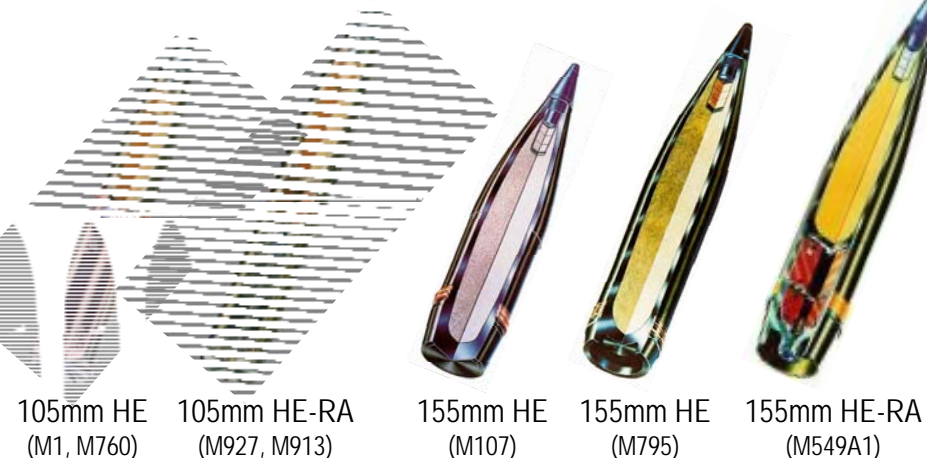
Department of the Army
Army Research Development and Engineering Center
Attn: Mr. Anthony Di Stasio
Tel 973-724-4547 Fax 973-724-4308
anthony.r.distasio@us.army.mil
Picatinny Arsenal, New Jersey 07806-5000



Common Low-cost IM Explosives



Artillery HE Projectiles



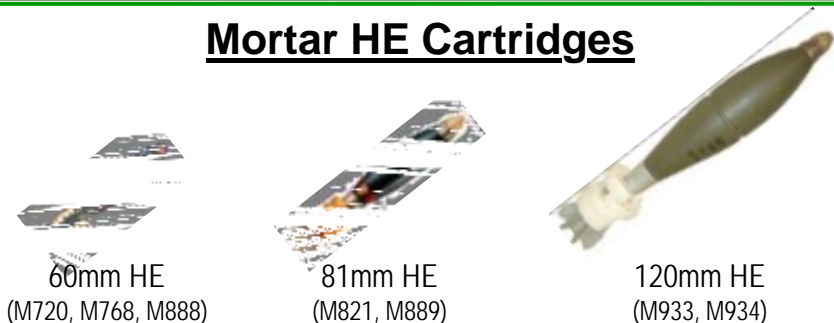
Baseline Explosive = TNT

TNT filled Projectiles FAIL all IM Tests

➤ ISSUE:

- ✓ TNT & Comp-B explosives have poor IM results
- ✓ 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

Mortar HE Cartridges



Baseline Explosive = Comp-B

Comp-B filled Cartridges FAIL IM Tests

➤ CORRECTIVE ACTION:

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



Background

✓ Objective: Common Low-cost IM Explosive Program

- ✓ New IM Explosive for Artillery and Mortar applications that are:
 - 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
 - Producibile within the National Technology and Industrial Base (NTIB)
 - Infrastructure
 - Raw Ingredients
 - Explosive formulation
 - Projectile Load, Assemble & Pack (LAP)
 - Other Considerations
 - Intellectual Property Rights
 - Demilitarization
 - Environmental

Primary Objective is to provide a Common IM Fill

-- *OR* --

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



Background: IM Test Results 155mm Artillery Baseline



Reactions:

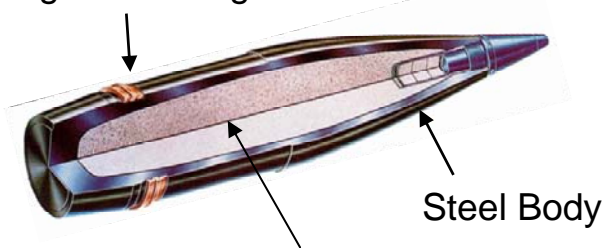
VI No Sustained Reaction	V Burn	IV Deflagration	III Explosion	II Partial Detonation	I Detonation
-----------------------------	-----------	--------------------	------------------	--------------------------	-----------------

IM Test:	FCO	SCO	BI	FI	SD	SCJI
Passing Criteria	V	V	V	V	III	III
155mm M107 (TNT)	III	III	III	III	(I)*	(I)*
155mm M107 (Comp-B)	III	III	III	I	(I)*	(I)*
155mm M795 (TNT)	III	III	IV	IV	(I)*	(I)*

* Assessment (not tested)

M107

Swaged Rotating Band

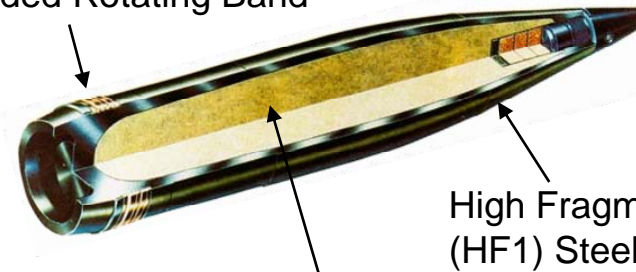


Steel Body

15.4 lb Explosive Fill [Comp-B]

M795

Welded Rotating Band



High Fragmenting (HF1) Steel Body

23.8 lb Explosive Fill [TNT]



Background Test Configuration



- ✓ **Established IM Test Configuration for TNT-Replacement**
 - ✓ **155mm established as test vehicle**
 - M795 Projectile with HF1 Steel
 - Vented Nose Plug
 - Supplementary Charge of Pressed-TNT (or other standard explosive)
 - ✓ **Palletization**
 - 8 Projectiles per Pallet, Wood (2 x 4)
 - No S.D. Barriers



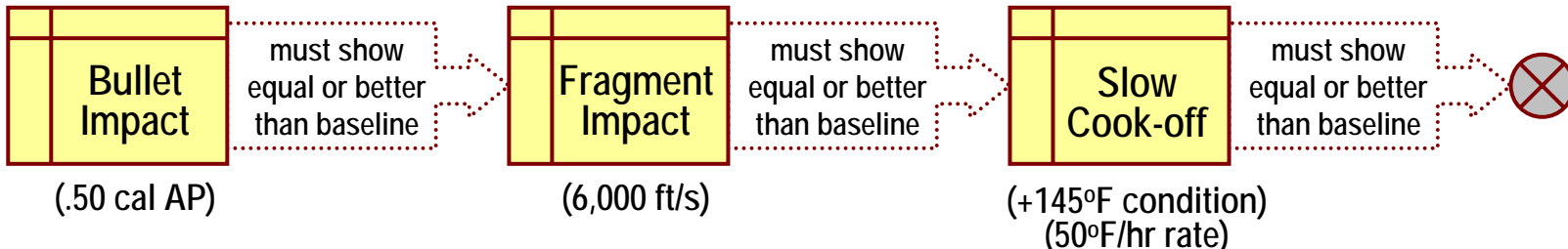


Background Test Protocol



✓ Established IM Test Protocol for Artillery (155mm M795)

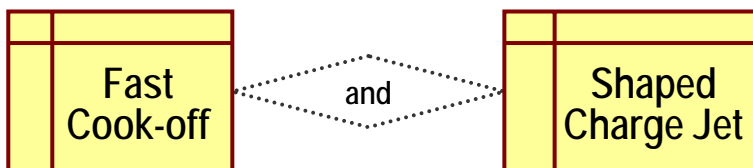
✓ Tier 1 Tests



✓ Tier 2 Tests -- must show improvement in at least 1 of Tier 1 Tests



✓ Tier 3 Tests – Candidates based on Tier 1 & 2 Test Results



- Protocol Considerations:
- Cost of Test
 - Ease of Setup
 - Threats for Comparison to Baseline
 - Reaction Level for proceeding



Tier 1 & 2 Summary



✓ Performed IM Tests

- 23 Explosive candidates considered
- 9 candidates tested (melt-pour, cast-cure, pressed)
- Top 3 Candidates
 - **All three are Melt-pour and each passed SD test without Barriers**
 - » Insufficient difference to select the go forward candidate
 - **Perform Tier 3 prior to entering Qualification Testing and address**
 - 1) Producibility
 - 2) High Risk Areas
 - 3) Lethality Assessment



BAE SYSTEMS

Booz | Allen | Hamilton



Bullet Impact

MIL-STD-2105C / .50 Caliber AP Bullet / Witness Plate & Pressure Gage



IMX -101

Pass

IMX -102

Pass

IMX -103

Fail - Equivalent to TNT (Type IV)



Fragment Impact

MIL-STD-2105C / 6000 fps Army Fragment / Witness Plate & Pressure Gage



IMX -101

IMX -102

IMX -103

} **Pass**



Sympathetic Detonation

Sympathetic Detonation never passed before without Barriers



MIL-STD-2105C, Diagonal Configuration, Witness Plate & Pressure Gages



SD Test Setup



Donor Side Witness Plate



Acceptor Bottom Witness Plate

IMX -101 } **Pass**
IMX -102 }
IMX -103 }



Donor Bottom Witness Plate - Dented



Common Low-cost IM Explosives TNT Replacement Program 50mm Shaped Charge Jet Impact (SCJI)



May 4th, 2007
(Picatinny Arsenal)



Test Set-up with 50mm SCJ



IMX-101



3 "Large" Pieces
NO Detonation

PASS

IV



IMX-102



4 "Large" Pieces
NO Detonation

PASS

IV



Common Low-cost IM Explosives TNT Replacement Program 81mm Shaped Charge Jet Impact (SCJI)



May 17th, 2007
(Picatinny Arsenal)



Test Set-up with 81mm SCJ



IMX-101



IMX-102



NO Detonation
PASS

III



NO Detonation
PASS

III



Common Low-cost IM Explosives TNT Replacement Program FCO Results



Without adequate venting



Pass



With adequate venting



Common Low-cost IM Explosives TNT Replacement Program IMX-101 Slow Cook-Off



Type IV – Fail

Without adequate venting



Pass



Common Low-cost IM Explosives TNT Replacement Program Lethality Assessment



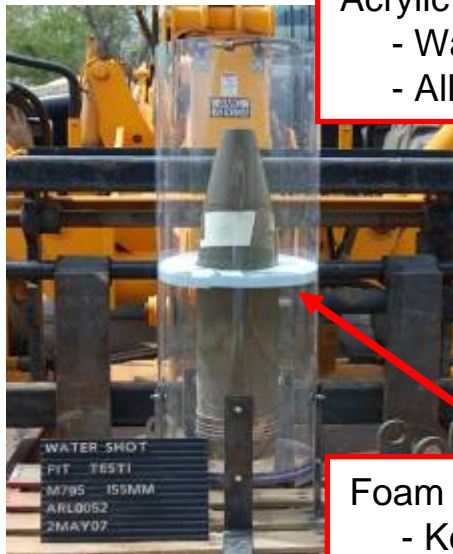
✓ Comparison to TNT

✓ Water Pit Tests

- M795 projectiles loaded with IM formulations

✓ Cylinder Expansion Tests

- 4" copper cylinders due to large critical diameters



Acrylic Tube

- Watertight seals
- Allows expansion to 2x CD

Foam Spacer

- Keeps projectile upright
- Centering device

All 3 formulations
have
fragmentation
and Gurney Energy
equivalent or better
than TNT



Summary

- ✓ Phase 1 identified 3 formulations that exceeded expectations
 - ✓ Passed SD in standard pallet
- ✓ Phase 2 attained what many considered unattainable
 - ✓ Demonstrated IM Compliance
 - ✓ Lethality comparable to TNT

IMX-101 & IMX-102 Formulations made on Production equipment with Production ingredients

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	
						50mm	81mm
IMX - 101	PASS	PASS	PASS	PASS	PASS	PASS	PASS
IMX - 102	PASS	PASS	PASS	PASS	PASS	PASS	PASS
IMX - 103	PASS	PASS	FAIL	PASS	PASS	PASS	FAIL



Qualification Program Schedule for TNT-Replacement



- ✓ Phase 1 – Screening / Downselect
- ✓ Phase 2 – Selection / Qualification
- ✓ Phase 3 – Transition / Qualification
 - ✓ EMQB Certification and Gun Qualification of top candidate

Phase 3 STATUS:

- Several production batches of IMX-101 have been produced
- LAP of projectiles has commenced
- Energetic qualification testing of IMX-101 has begun

TNT-Replacement (IMX-101)

Phase 1 “Screening”

- Identify & Test Candidates
- Downselection

Qualification Phase 2

- Selection (IMX-101)

Qualification Phase 3

- ECP into TDP

