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U. S. ARMY COMMON LOW-COST INSENSITIVE MUNITION PROGRAM IMX-101 REPLACEMENT FOR TNT EXPLOSIVE

155mm M795 IM Projectile

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U. S. Army CLIMEx Program Strategy and Goals

Common Low-cost Insensitive Munitions Explosive (CLIMEx)

Program Strategy

To accelerate candidate explosive fill formulations and compositions that satisfy the selection criteria into test material using representative manufacturing facilities.



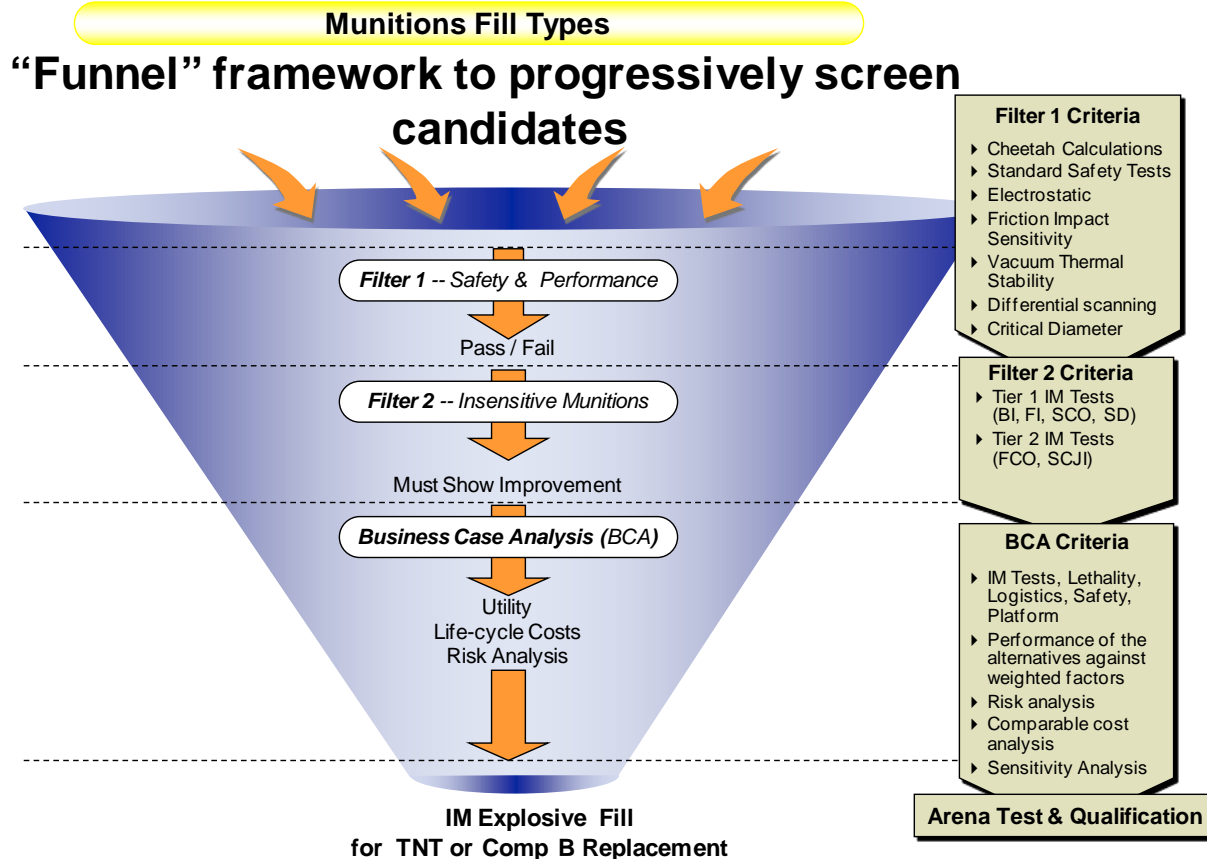
Program Goals

- 1. Selection of one single common explosive fill for all artillery and mortar products.**
- 2. Selection of two explosive fills, one that is common for replacement of TNT and another that is common for the replacement of Composition B.**



CLIMEx Program – Selection of IM Explosive

Execution of the CLIMEx Program by PM CAS involved the evaluation of multiple explosive technologies (melt-cast, cast-cure, and cast-cure injection) and numerous IM candidate explosives from the Industrial Base and foreign sources.





CLIMEx Program – Selection of IM Explosive

- M795 155mm Artillery Mmunition selected as the initial test vehicle for identifying a common IM replacement for TNT in artillery systems.



- CLIMEx Criteria for candidate IM explosive fills:
 - ❖ Must be significantly less sensitive than TNT explosive , if not fully IM compliant.
 - ❖ Must maintain lethality, as compared to the TNT baseline, with minimal or no degradation.
 - ❖ Overall IM solution needs be affordable.
 - ❖ Must be producible within the National Technology & Industrial Base to include ingredients, formulation, and LAP. *Ideally a “drop-in” replacement for TNT in LAP activities.*



CLIMEx Program – Selection of IMX-101 Explosive

IMX-101 Explosive

- Selected as IM replacement to TNT in U. S. Artillery systems
- Developed and produced by BAE Systems at Holston AAP
- Utilizes standard LAP infrastructure for melt-cast explosives
- LAP of M795 Rounds performed at Picatinny Arsenal & Iowa Army Ammunition Plant
- Subjected to comprehensive IM and performance test criteria to include BI, FI, SCO, FCO, SD, SCJI (50mm & 81mm), etc

**Energetics Material Qualification
Completed for IMX-101**



Molten IMX-101

Flaked Final Product

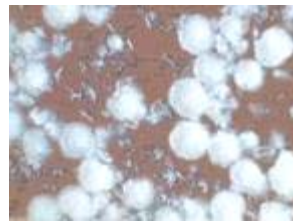




Making the IM Mission Possible

- ❖ Achieving the IM Mission Required New Technologies
- ❖ Energetic and Critical Materials for IM / EM Applications

- DNAN
- NTO
- TATB
- High Bulk Density NQ
- FEM RDX and HMX
- DMDNB
- “Special Grade” RDX
- R8002 Energetic Plasticizer



NTO Crystals



Nutsches of TATB



**Incorporation of DNAN
in IMX-101**



**2,000 gallon
Glass-lined Reactor**

- ❖ All Materials Produced on a True Production Scale at HSAAP



IM Melt Cast Explosives from Holston AAP

IMX-101	DNAN & NTO based formulation. Selected by the Army as the common TNT replacement. Applications include 105mm, 120mm, & 155 mm munitions.
IMX-104 (aka OSX-7)	Contains DNAN, NTO, and RDX in various grades. Selected by the Army as the common Comp B replacement in IM Mortar systems (60mm, 81mm, & 120mm) and various submunitions.
OSX-8	Contains DNAN, NTO, and HMX in various grades and provides excellent IM and energetic performance properties. Being evaluated in 60mm Mortar (Europe) and 120mm HET Tank Ammo (FMS).
OSX-12	An aluminized version of IMX-104 which offers excellent IM properties combined with high blast energetic output.
PAX-21	DNAN based melt-cast explosive which is currently qualified and fielded in the U. S. Army 60mm Mortar system.
PAX-41	DNAN based melt-cast explosive which is currently qualified and fielded in the U. S. Army Spider Munitions system.



M795: System Enhancements for IM

Venting Technology for Cook-off Environments

- ❖ IM explosive alone cannot meet cook-off criteria in 155mm Artillery
- ❖ Total system analysis and design will provide complete **IM Solutions**

Evaluated and Incorporated Venting Solutions



Standard
Lifting Plug
Will Not Pass (Type III)



Partial Venting (Type
IV)



Meltable Fuze Plug (Type V)



IM Test Results: Fast Cook-Off (FCO)

Test Conditions: Mil-Std-2105C, Liquid Fuel Fire, Witness Plate & Pressure Gauge



**IMX-101 Passed with
Type V Response**





IM Test Results: Slow Cook-Off (SCO)

Test Conditions: Mil-Std-2105C, Precondition Temp at 145F, Heating Rate of 50F / Hr, Witness Plate & Pressure Gage



SCO Test Set-up



**IMX-101 Passed with
Type V Response**





IM Test Results: Fragment Impact (FI)

Test Conditions: Mil-Std-2105C, Impact Velocity of 6,000 ft/sec, Army Fragment, Witness Plate & Pressure Gage



FI Test Set-up



**IMX-101 Passed with
Type V Response**





IM Test Results: Bullet Impact (BI)

Test Conditions: Mil-Std-2105C, .50 Caliber AP Bullet, Witness Plate & Pressure Gage



BI Test Set-up



**IMX-101 Passed with
Type V Response**



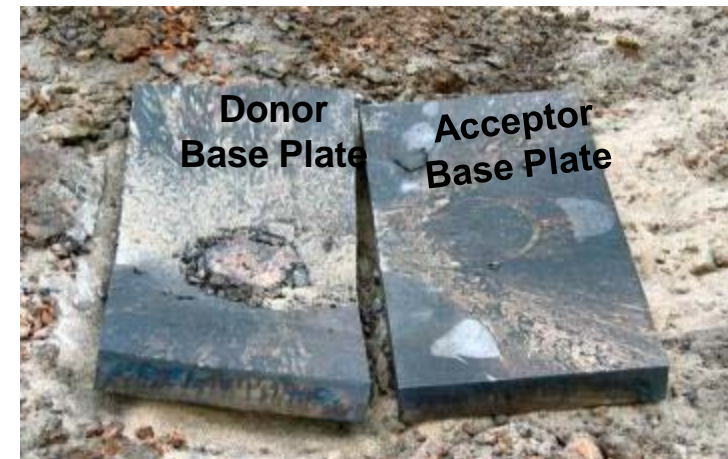


IM Test Results: Sympathetic Detonation (SD)

Mil-Std-2105C, Diagonal Configuration, Witness Plate & Pressure Gages



IMX-101
Passed with
Type III Response





IM Test Results: Shaped Charge Jet Impact (81mm)

Mil-Std-2105C, Unconditioned Jet, Witness Plate & Pressure Gages



Test Set-up with 81mm SCJ



Example



NO Detonation **III**



High-order Detonation **I**

IMX-101 Passed III



Summary of IM Test Results

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

**Passed SD
Passed SCJI**

VI No Sustained Reaction	V Burn	IV Deflagration	III Explosion	II Partial Detonation	I Detonation
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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
IMX-101	PASS	PASS	PASS	PASS	PASS	PASS



Maturity of M795 IM Design

• Safety Confirmation from Development Test Command



- Produced 132K lbs of IMX-101
- Loaded over 1,000 M795 projectiles
- Transition to production for FY10 Army procurement

Test	Qty
Initial firing tests	√
12m Drop	√
Initial Safety Test	√
Sequential Environmental Safety & Performance	√
Shock Attenuating Lifting Plug	√
Worn Tube	√
Explosive Ordnance Disposal (EOD)	√
High Humidity & Temperature (16) / Fungus (8)	√
Solar Radiation	√
Long Term Storage - Uncontrolled	√
Final Reduced Qty Firing Table Confirmation	√
Arena Testing (Fragmentation)	√
Initiation Reliability	√
IM Testing (BI/FI/SCO/FCO/SD/SCJI)	√



Conclusions

- **U. S. Army CLIMEx program was successful in identifying IMX-101 Explosive as a common insensitive replacement for TNT.**
 - **IMX-101 qualified by US Army as main charge explosive**
- **IM M795 155mm Munitions demonstrated far superior IM properties in all test categories with no barriers (BI, FI, SCO, FCO, SD, SCJI).**
 - **Formal IM tests completed – scores expect to be presented at IM&EM in October 2010**
- **Initial explosiveness & fragmentation performance of the IM M795 with IMX-101 indicates equivalency to the legacy TNT filled M795.**
 - **Arena tests completed – Analysis in process**
- **LAP of M795 Rounds using standard processing equipment was successfully developed and demonstrated with excellent cast quality.**
- **Safety Confirmation for projectile from DTC**



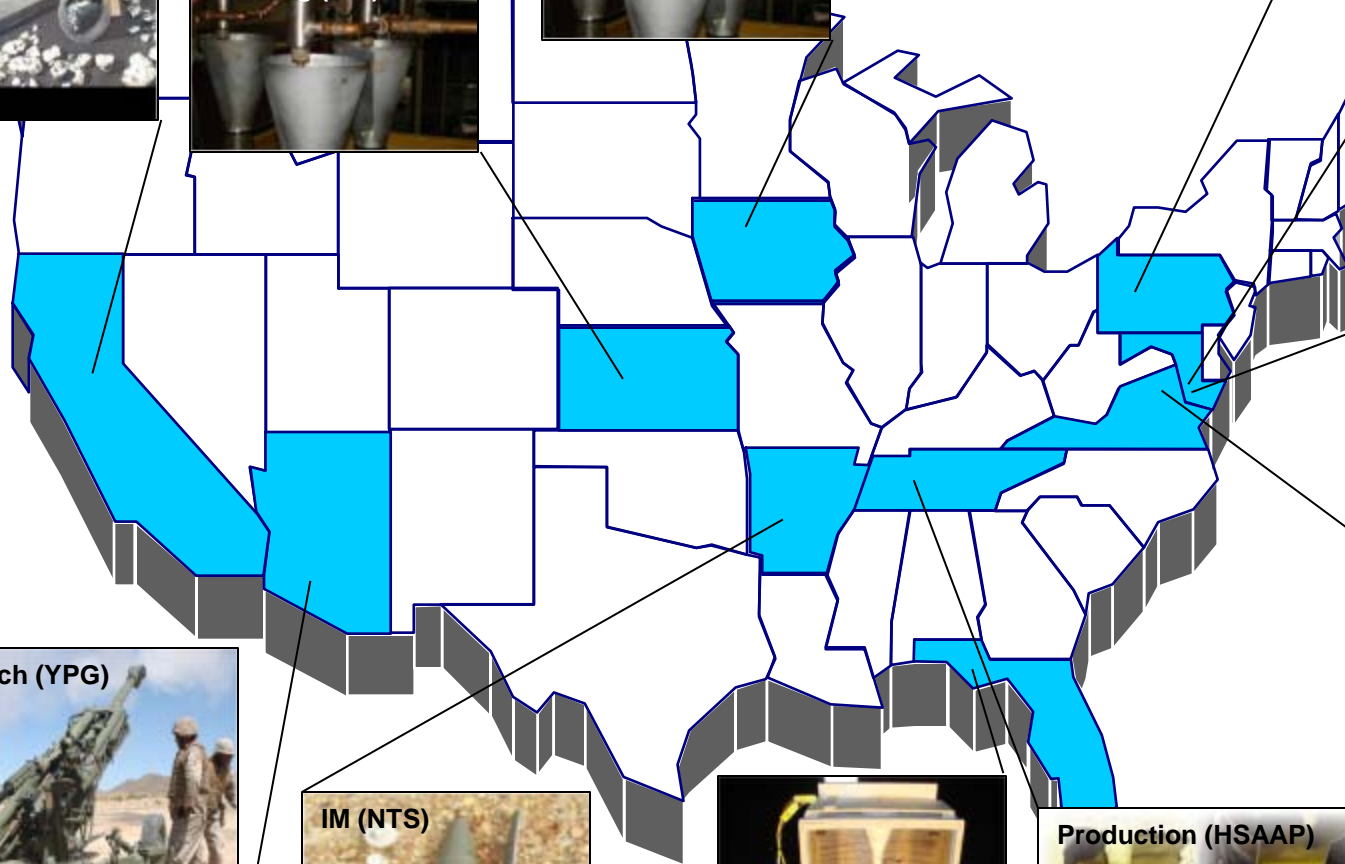
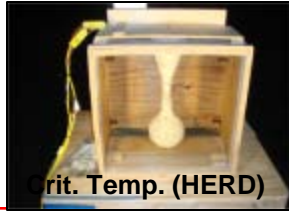
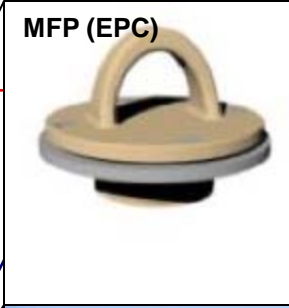
Conclusions (cont.)

- **IMX-101 explosive is effectively a “drop-in” replacement for TNT in melt-cast LAP operations.**
- **BAE Systems at Holston AAP has robust manufacturing processes and essentially unlimited capacity for both the IM ingredients (i.e. DNAN, NTO, etc) and melt-cast formulations.**
- **The marvelous achievement of the CLIMEx program is a strong testimony of the dedication and teamwork of PM-CAS and its industry partners.**





M795 Joint Program





On-going Activities

- **Finalizing Technical Data Package for the IM M795 Munitions (FY-2010)**
- **Production and fielding of the IM M795 Munitions (FY-2011)**
- **Evaluation of IMX-101 Explosive in 105mm HE Ammunition**
- **Qualification of IMX-104 Explosives as a common replacement for Comp B in various mortar and artillery systems.**





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Questions



Highlights of Other Testing - IM M795 Munitions

- **Successful loading trials at Picatinny Arsenal (>150 projectile in recent LAP with “Zero” defects in cast quality).**
- **Completed firing trials at top service charge under extreme service conditions.**
- **Firing Table confirmation tests completed which validated a ballistic match to the legacy, TNT filled M795 Munitions.**
- **Completed Safety Test Series [ITOP 4-2-504(1)] to include drop tests in various orientations, tactical vibration sequence, and temperature extremes followed by confirmation of cast quality.**
- **Firing of the “abused” M795 Munitions evaluated in the Safety Test series under extreme service conditions.**