IMX-104 Characterization for DoD Qualification

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IMX-104 CHARACTERIZATION FOR DoD QUALIFICATION

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OUTLINE

- Acknowledgement
- Background
- IMX-104 Qualification
- Summary

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  - PM Combat Ammunition Systems (PM-CAS)
  - PEO Ammunition
  - Office of the Secretary of Defense (OSD)
  - Joint Insensitive Munitions Technology Program (JIMTP)

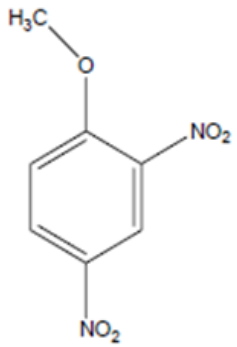
BACKGROUND

- **PM CAS initiated Common Low-cost Insensitive Munitions Explosive Program**
  - **Affordable TNT and Comp B Replacement for near term insertion**
    - Goal 1 - Select one common candidate to replace both
    - Goal 2 - Select one candidate for TNT and one for Comp B energy levels
  - **Results**
    - IMX-101 qualified as TNT replacement
    - IMX-104 selected as Comp B replacement

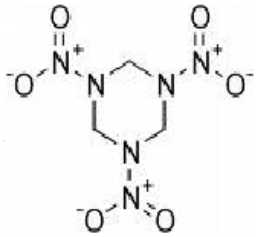
- **Overall Program Objectives**
  - **Provide an insensitive replacement for Comp B with equivalent performance**
  - **Provide characterization data to support the qualification of IMX-104 for full use in Army and USMC ammunition**
  - **Accelerate Implementation of IM Solution in 81mm & 60mm Mortars**

IMX-104

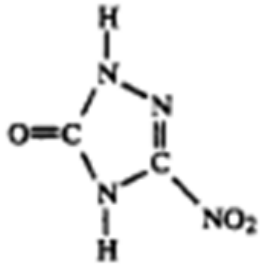
- **IMX-104 Formulation**
  - **2,4-Dinitroanisole (DNAN)**
  - **3-Nitro-1,2,4-triazol-5-one (NTO)**
  - **RDX**



DNAN



RDX



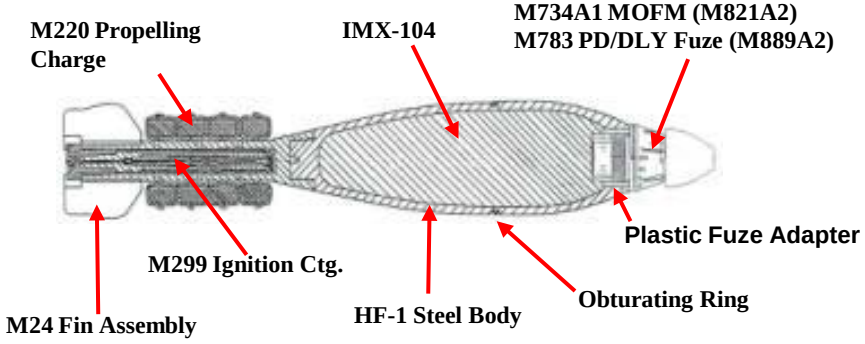
NTO

- **Formulated from available ingredients**
- **Detonation energy equivalent to Comp B**
- **Low hazard sensitivity**
- **Melt Pour processing similar to Comp B**
  - **95,600 lbs produced at Holston AAP**
  - **Batch size = 545 kg (1200 lb)**

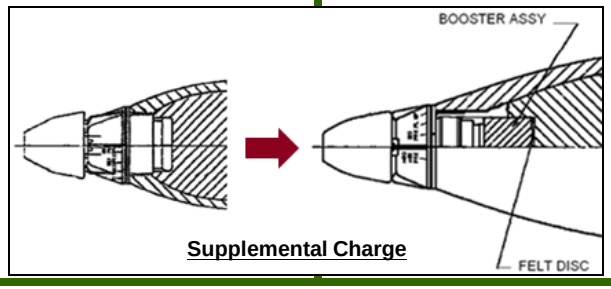
81mm IM MORTAR

Item Nomenclature

Cartridge, 81mm: HE, M889A2/M821A2 (IM Enhanced)

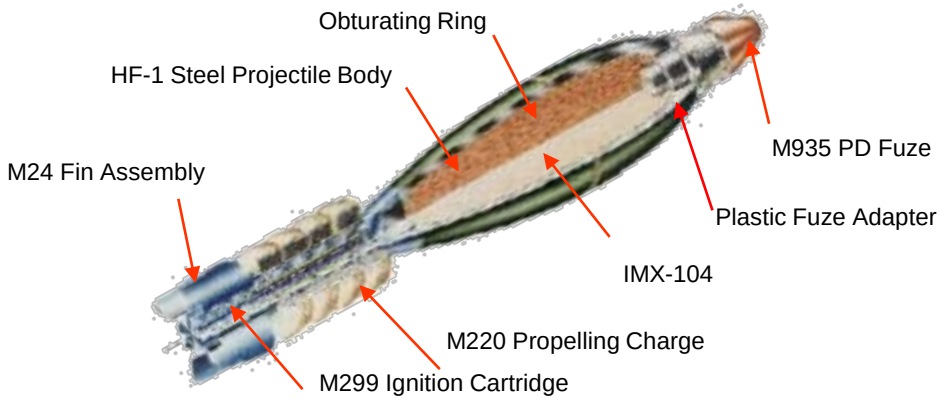


Component	Current Material
Fuze Lead	PBXN-5
Fuze Booster	PBXN-5



Item Nomenclature

Cartridge, 81mm: HE, M889A1 (IM Enhanced)



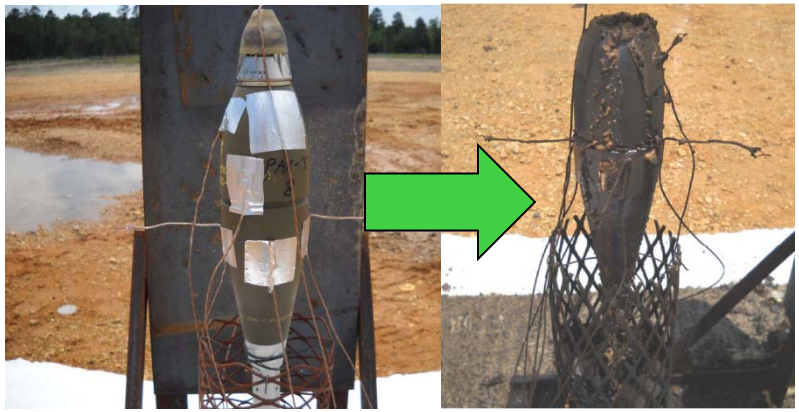
Component	Current Material	IM Enhanced Material
Fuze Lead	RDX	PBXN-5
Fuze Booster	Comp A-5	PBXW-14

- Changes to be implemented on all 81mm HE cartridges
  - Main fill replacement
  - Fuze venting technology – plastic fuze adapter
  - Supplemental charge to reliably initiate the more insensitive main fill.
- Additional changes to the M889A1 incorporate IM-compliant fuze energetics.

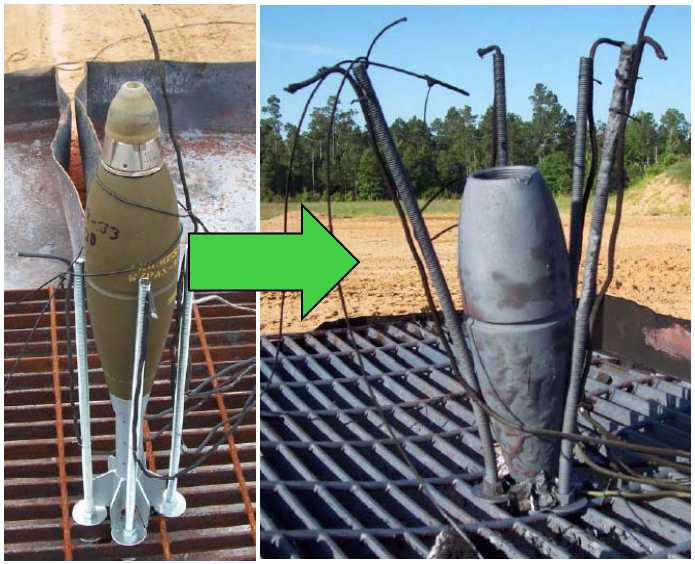
ENGINEERING IM TEST RESULTS

Bullet Impact

Slow Cook Off



Fast Cook Off



IM TEST:	FCO	SCO	BI		FI		SD	SCJI
Passing Criteria	V	V	V		V		III	III
81mm (Comp-B)	(II)*	(II)*	(III)*		(III)*		(I)*	(I)*
81mm (IMX-104)	V	V	IV	V	III	IV	III	I
		6° F / hr	0.50 cal	7.62 mm	8300 ft/s	6000 ft/s		

( ) Assessment - not tested*

IMX-104 QUALIFICATION

➢ DoD Energetic Materials Qualification Process

Test Protocol:

(1) Allied Ordnance Publication Seven (AOP-7) (Edition 2 Rev. 3), “Manual of Data Requirements and Tests for the Qualification of Explosive Materials for Military Use”, December 2007.

(2) Standardization Agreement (STANAG) 4170 (Edition 3), “Principles and Methodology for the Qualification of Explosive Materials for Military Use”, 2007.

(3) DoD Energetics Qualification Program Matrix for Main Charge Explosives

- ➢ Comprehensive assessment of the Energetic Material
  - Safe and Suitable for the intended use
  - Test Protocols Coordinated with NOSSA
- ➢ Assessment Includes
  - Small Scale Impact, Friction, ESD
  - Cap Sensitivity
  - Vacuum Thermal Stability (VTS)
  - Differential Scanning Calorimetry (DSC)
  - Small Scale Burn Test
  - Variable Confinement Cook-off Test
  - One Liter Cook-Off Test

SMALL SCALE HAZARD SENSITIVITY

	ERL / Bruceton Impact	BOE Impact	BAM Friction	ABL Friction	Small Scale ESD	Cap Sensitivity Test
Test Data	50% Impact Height (cm)	10 trials at 4 in. drop height	10 TIL (N)	20 TIL (N)	0.25 Joules	#8 Blasting Cap
IMX-104	114.4	No Go	160	4450	No Go	No Go
Comp B	33.9	Go	168	8000	No Go	Go
RDX	18	Go	168	1870	No Go	Go

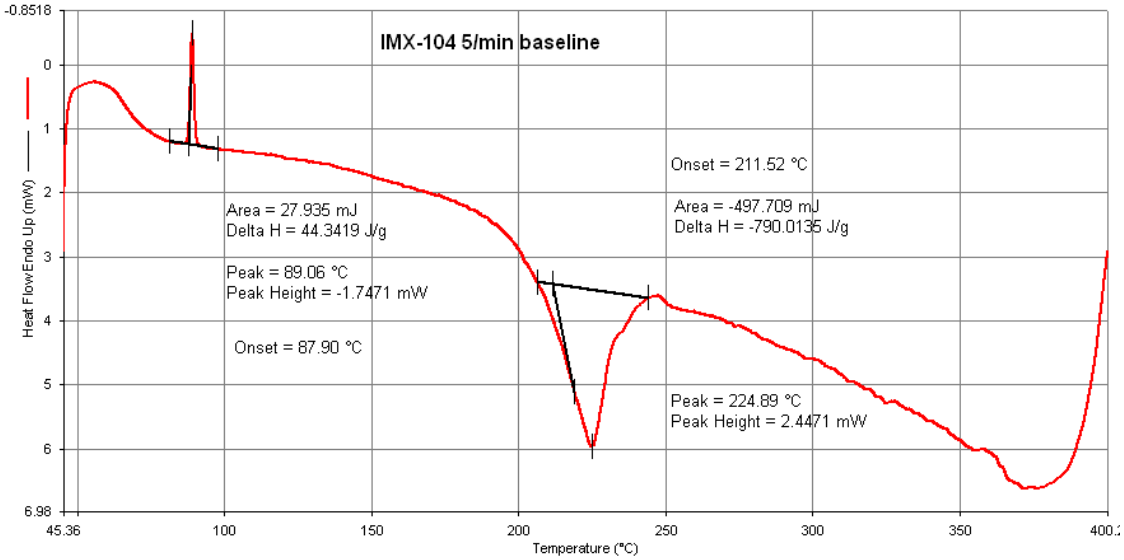
- **Hazard Sensitivity Tests**
  - Limit: Not More Sensitive than Comp B
  - IMX-104 shows less sensitivity to Impact, Friction, ESD, and Shock

THERMAL STABILITY

	Vacuum Thermal Stability (VTS)
Test Data	**ml/g of gas evolved at 100°C**
IMX-104	0.571
RDX	0.12
Comp B	0.602

	Differential Scanning Calorimetry (DSC)		
Test Data	**Endotherm**	**Exotherm Onset**	**Exotherm Peak**
IMX-104	89°C	212°C	224.89°C
RDX	205°C	210°C	241°C
Comp B	75°C	202.14°C	228.66°C

- VTS
  - Limit: ≤ 2 ml/g of gas evolved
  - IMX-104 well under this limit



EXPLOSIVE RESPONSE WHEN IGNITED

- **Small Scale Burn Test**
  - 2 10g trials
  - 2 100g trials
- All tests result in NO GO

Variable Confinement Cook-off Test (VCCT) Slow Cook-off Results

	Steel Confinement (in)	Reaction
IMX-104	**0.075**	**Deflagration**
IMX-104	**0.090**	**Deflagration**
IMX-104	**0.105**	**Deflagration**
IMX-104	**0.120**	**Pressure Rupture**
Comp B	*0.015*	*Explosion*
Comp B	*0.030*	*Explosion*
Comp B	*0.090*	*Explosion*
Comp B	*0.120*	*Detonation*
Comp A5 (98.5% RDX)	*0.015*	*Partial Detonation*

Variable Confinement Cook-off Test (VCCT) Fast Cook-off Results

	Steel Confinement (in)	Reaction
IMX-104	**0.075**	**Pressure Rupture**
IMX-104	**0.090**	**Pressure Rupture**
IMX-104	**0.105**	**Deflagration**
IMX-104	**0.120**	**Pressure Rupture**
Comp A5 (98.5% RDX)	*0.015*	*Detonation*

- **VCCT**
  - FCO = ~10°C / sec
  - SCO = 3.3°C / hr
- Pass = Burn to deflagration transition
- All VCCTs result in passing reaction

CRITICAL TEMPERATURE

- **One Liter Cook-off Test**
  - Non-catastrophic self heating
    - 142°C - 144°C
  - Catastrophic self heating or Critical Temperature
    - Tc = 161°C - 163°C
  - Acceptable processing Safety margin

SUMMARY

- **IMX-104 Characterization shows promising results**
  - Hazard sensitivity test results demonstrate IMX-104 is less sensitive than Comp B
  - Thermal testing shows improved response to cook-off compared to Comp B
  - Critical temperature assessment indicates that IMX-104 is safe to process under typical melt pour operations
- Aging study results to be finalized this coming fall
- Formal IM testing scheduled for January 2011