Large Scale Manufacturing of Insensitive Explosive IMX-104 at Holston Army Ammunition Plant

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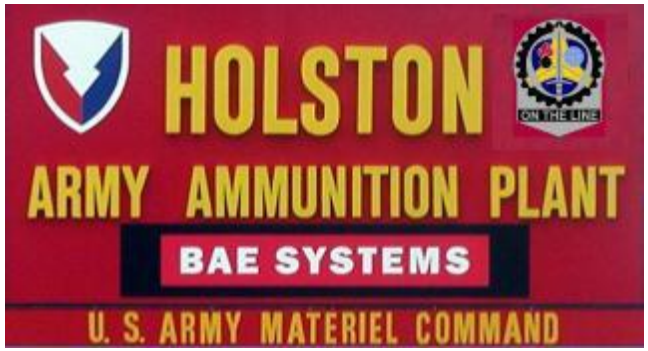
Briefing Outline

- IMX-104 Explosive Overview
- Recent Manufacturing Achievement
- IMX-104 Manufacturing Technology (MANTECH) Program Overview
- Modernized Melt-Cast Explosive Manufacturing Facility at HSAAP
- Concluding Remarks
- Acknowledgements



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IMX-104 Explosive Overview

- An insensitive melt-pour explosive to replace Composition B for Mortar Applications
- IMX-104 and all starting ingredients manufactured at Holston Army Ammunition Plant
- Exhibited superior IM properties and comparable performance over Composition B in 81mm Mortar HE
- IMX-104 qualified as an main fill explosive in June, 2011
- Type qualification on-going for 81mm Mortar HE (60mm and 120mm to follow)

IM Test:	Fast Heating	Slow Heating	Bullet Impact	Fragment Impact	Sympathetic Reaction	Shaped Charge Jet Impact
81mm M889A1 (Comp-B)	(II)	(II)	(II)	(II)	(FAIL)	(FAIL)
81mm M889A1 (IMX-104)*	V	V	V	V	(PASS)**	(FAIL)

Assessed score in parentheses ( )

* Logistical configuration with full packaging

** Result obtained from M889A2

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IMX-104 – Superior IM Performance

Bullet Impact (TYPE V)

Fragment Impact (TYPE V)

Fast Heating (TYPE V)

Sympathetic Detonation (PASS – no mass detonation)

Slow Heating (TYPE V)

Photos courtesy of PM-CAS

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A Family of Insensitive Melt Cast Explosive Formulations

Insensitive Melt Cast Explosives manufactured at Holston Army Ammunition Plant

Formulation	Key Ingredients	Purpose	Qualification Status
IMX-101	DNAN + NTO + NQ	TNT replacement (for Artillery and other large caliber munitions)	Material qualified; Type qualified for 155mm M795, on-going for 155mm M1122 and 105mm projectiles
IMX-104	DNAN + NTO + RDX	Comp B replacement (for mortar applications)	Material qualified; Type qualification on-going for 81mm mortar, 60mm & 120mm to follow
PAX-48	DNAN + NTO + HMX	Comp B replacement (for mortar & tank ammunition)	Material qualified; Type qualification achieved for 120mm IM HE-T tracer round (NAMMO)
OSX-12	DNAN + NTO + RDX + Al	PAX-28 replacement (high blast applications)	Material under evaluation
PAX-21	DNAN + RDX + AP + MNA	Main fill for the 60mm M768 Mortar Rounds	Currently in-use in theater
PAX-41	DNAN + RDX + MNA	Main fill for the Spider Grenade	Currently in-use in theater

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Recent Manufacturing Achievements

- Current batch size over 1300 lb. (1500 lb. possible)
- Over 90,000 lb. manufactured at HSAAP to date
- IMX-104 supplied to support US ARMY Mortar Loading Trial and Qualification
- Utilize existing equipment in the melt-pour explosive facility
- Robust and repeatable processes established for IMX-104, and the raw ingredients (DNAN, NTO, RDX FEM)
- Optimization opportunities identified to reduce process cycle time & to improve process efficiency

IMX-104 MANTECH Program Overview

- Objective: To maximize the manufacturing process efficiency of IMX-104 in order to lower unit cost while maintaining the desirable properties
- Funded by US ARMY Research, Development and Engineering Command (RDECOM)
- Program Management and Producibility Support from RDECOM-ARDEC Munitions Engineering & Technology Center (METC)
- Program executed by the Research & Development and Operations Department at BAE Systems Holston Army Ammunition Plant

IMX-104 MANTECH Program Technical Approach

- Test Plan Development
  - Design of Experiments (DOE) technique utilized
- Laboratory Scale Evaluation
  - Effect of ingredient variation on processability
- Laboratory Analytical Method Development
  - Alternate analytical method to evaluate processability
- Production Scale Evaluation
  - Alternate vessel to pre-melt DNAN
  - Steam supply modification at discharge valve
- Manufacture of Design of Experiment (DOE) batches
- Manufacture of Confirmation Batches
- Validation of IMX-104 via
  - First Article Testing
  - Loading Study

Lab-scale Melt Kettle

DNAN Pre-Melter

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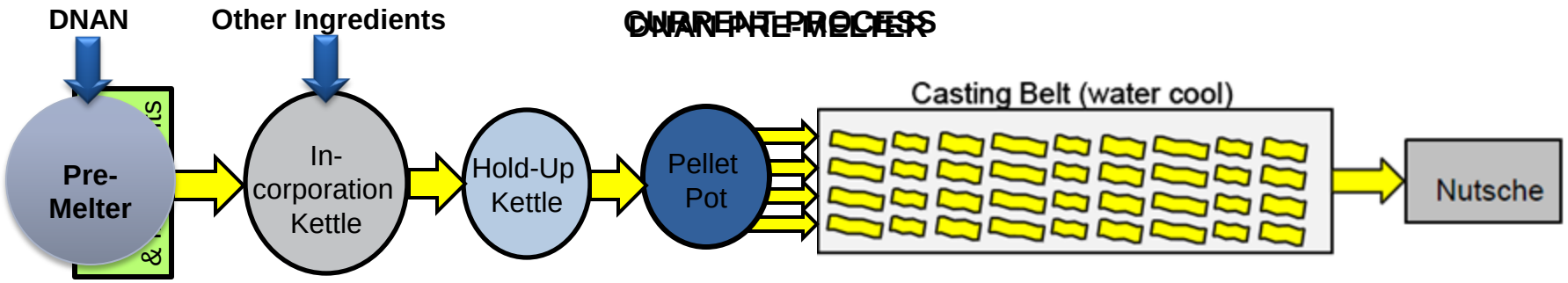
IMX-104 MANTECH Design of Experiments

Variables	Conditions
Baseline	1,325 lb batch Ingredient addition temp @ 105°C Final mixing time & temp 90 minutes @ 100°C
DNAN Pre-Melter	Various loading methods of DNAN Various steam supply levels
Process Temperature	Elevated ingredient addition and processing temperature
Ingredients Addition Rate	Fastest possible addition rate without compromise on product temp in kettle
Final Mixing Time & Temperature	Reduced mixing time combined with higher mixing temperature
Batch Size	High and low (1,500 lb / 700 lb)



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IMX-104 MANTECH Program Status and Schedule

- Lab Scale Ingredient Evaluation Completed
- DNAN Pre-melter received, awaiting installation
- DNAN Pre-melter proof out scheduled for June 2012
- IMX-104 DOE and confirmation batches scheduled for Q3/4 2012
- First Article Testing and Loading Trial scheduled for Q1 2013

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Modernized Melt-Cast Explosive Manufacturing Facility

- Current Melt-Cast Facility (Bldg. L-4) at HSAAP will not meet future requirements of IM explosives
  - IMX-101, IMX-104, PAX-48, PAX-21, PAX-41
- MANTECH Programs will improve currently process efficiency at L-4
- Modernization of the Melt-Cast Facility will satisfy future production requirements
  - New design & technologies featured to further improve process efficiency
- Funded by the US Army Project Director for Joint Services (PD-JS)
- Construction started: May 2011
- Scheduled completion date: Oct 2012

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Modernized Melt-Cast Explosive Manufacturing Facility

Benefits / Improvements

- Annual production capacity increase > 250% (3.9M lb.)
  - DNAN Pre-melter concept to streamline process
  - Growth opportunity with other IM products
- Replacing aging equipment with state-of-the-art systems
  - New flaker belt design eliminates water exposure
  - New discharge valve with better flow control
  - New loss-in-weight feeder (accurate discharge rate)
- Better control of temperature profile in melt kettle
  - Improve process and product consistency
- Accurate material balance resulting in consistent product composition
  - Load cell in kettle to ensure accurate ingredient increment

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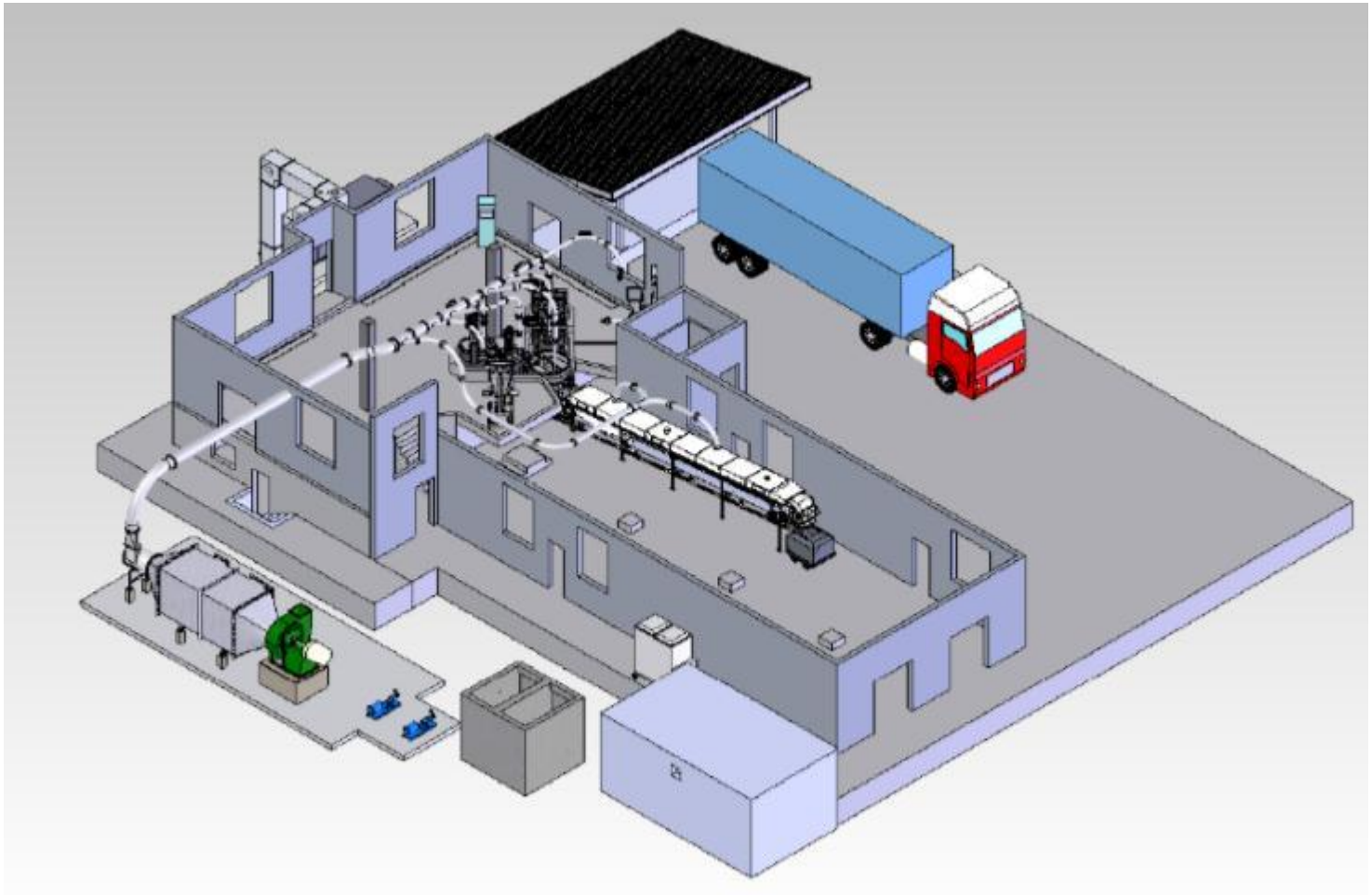
Modernized Melt-Cast Explosive Manufacturing Facility

- Building Layout



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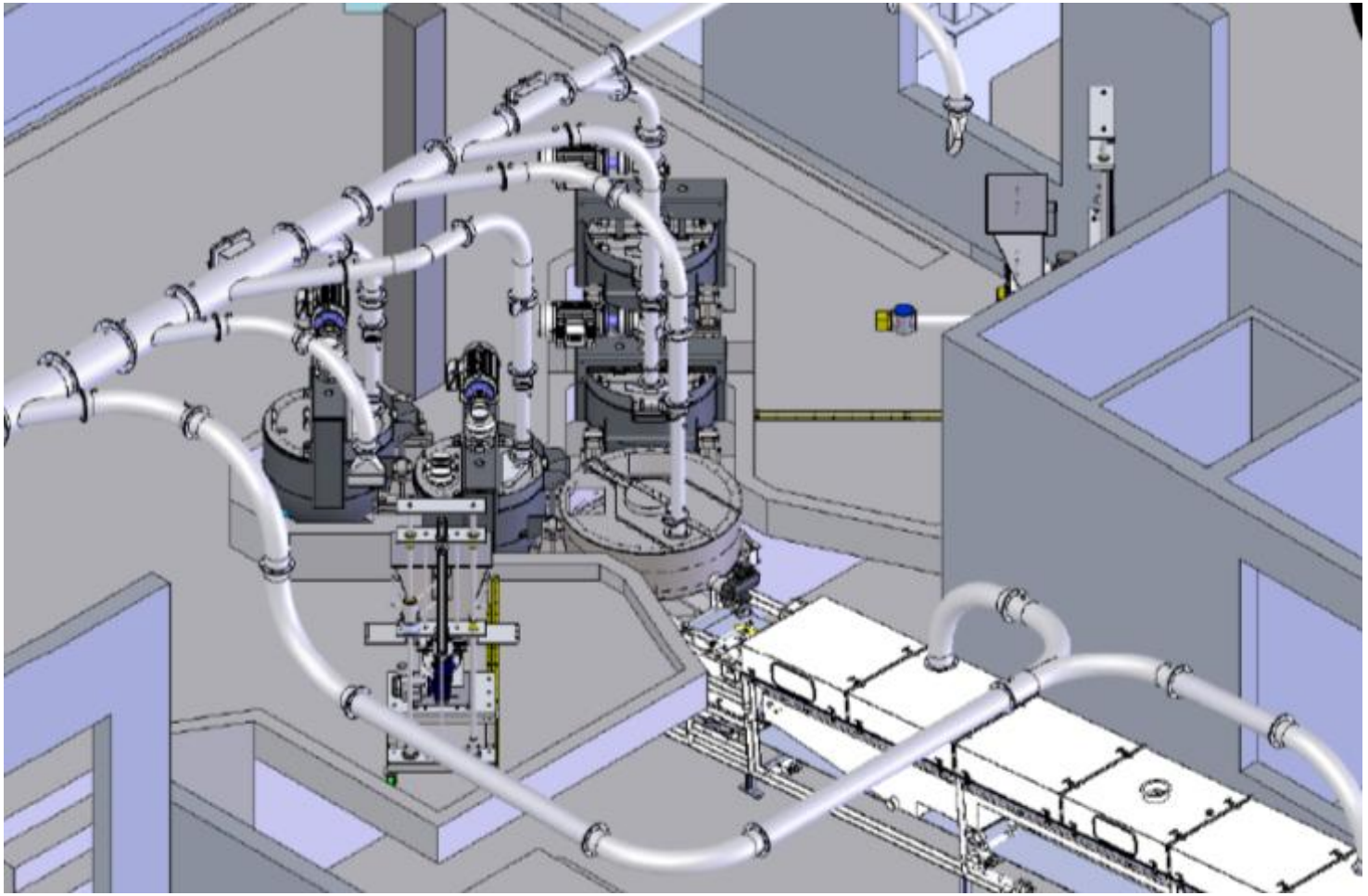
Modernized Melt-Cast Explosive Manufacturing Facility

- Equipment Layout



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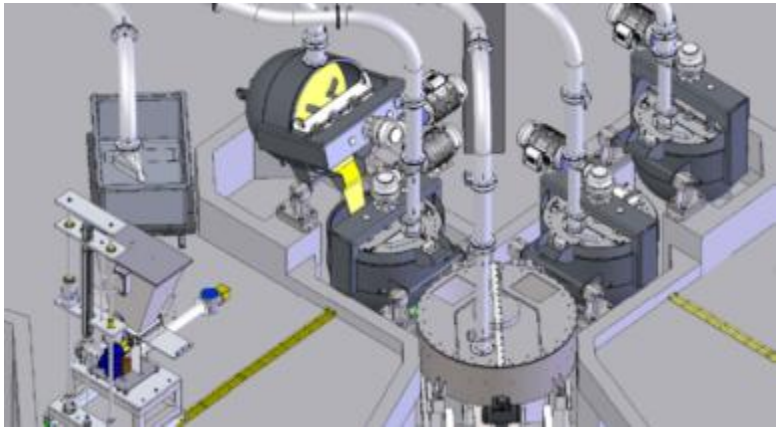
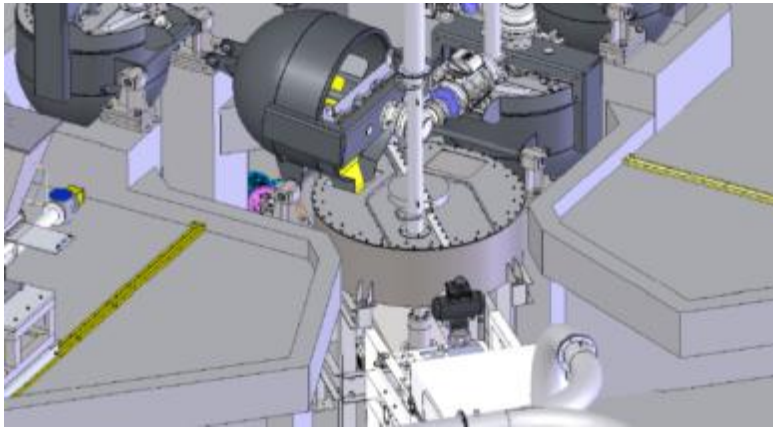
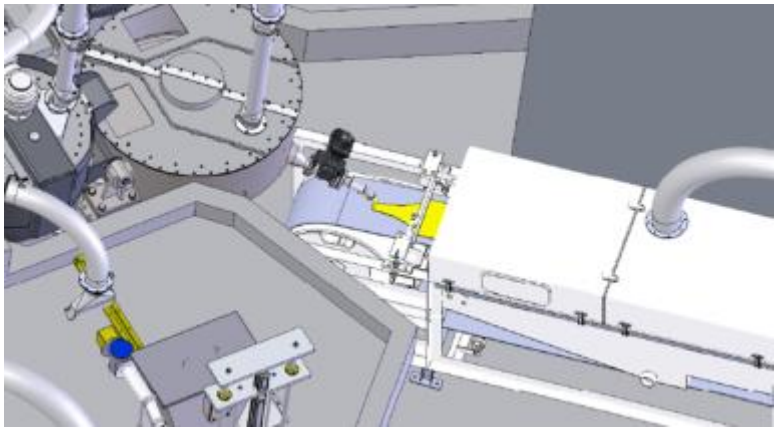
Modernized Melt-Cast Explosive Manufacturing Facility

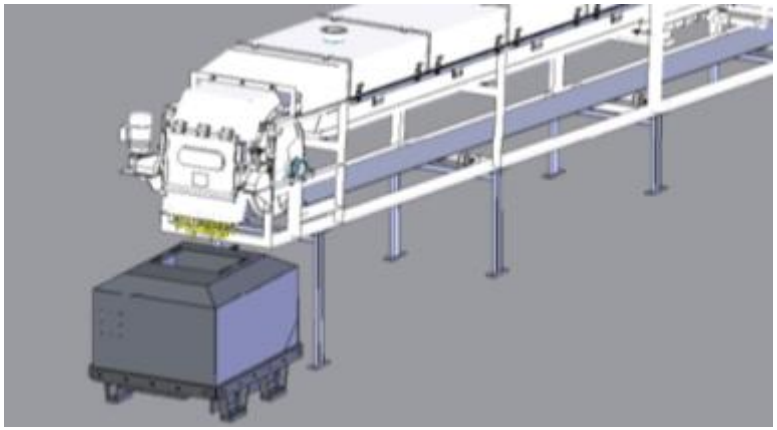
- Ingredient Incorporation





- Product Casting





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Concluding Remarks

- A NEW FAMILY of IM melt-pour explosives now available at HSAAP
  - IMX-104 demonstrated excellent IM properties over Composition B
- IMX-104 material qualified by U.S. Army – qualification for 60 and 81mm Mortar HE in progress, and 120mm planned
- Robust large scale manufacturing process for IMX-104
- Process efficiency shall further improve after MANTECH program
- Modernized Melt-Cast Explosive Manufacturing Facility shall further enhance HSAAP capability and capacity as the center of excellence in IM explosive manufacturing
  - Improved product quality
  - Improved process efficiency

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