Common Low-cost IM Explosive Program to Replace TNT

Joint U S Army & U S Marine Corps

Explosive Ingredients and Compositions for the IM M795 Artillery Ammunition

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Briefing Outline

- Background and Introduction to IMX-101, -102 and -103
- Manufacturing Overview
  - ✓ Non-traditional Ingredients
    - Large Scale Manufacture
      - DNAN, NTO
    - Lab Scale Manufacture
      - Nitrate Salt Eutectic
  - ✓ Compositions
    - Large Scale Manufacture - IMX-101, IMX-102
    - Lab Scale – IMX-103
- Strategic Supply Capability
  - ✓ Current Capacity
  - ✓ Pricing and Availability

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Background and Introduction

- PM-CAS Common Low-cost IM Explosives Program
- Seeking IM Explosives that are:
  - ✓ Effective
  - ✓ Less sensitive
  - ✓ Affordable
  - ✓ Producible
  - ✓ Life-cycle compliant
- Phased Evaluation Program
- Led to 3 Primary Candidates
  - ✓ IMX-101, -102 and -103
- Undergoing Qualification Testing (Phase 3)
- Formulations & Ingredients:

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Formulations

- Largely composed of "non-traditional" ingredients:

Formulation	AKA	Non-traditional Ingredient(s)	
IMX-101	OSX-CAN	DNAN, NTO	
IMX-102	MCX-8	NTO	
IMX-103	DEMN-III J	Nitrate Salt Eutectic	

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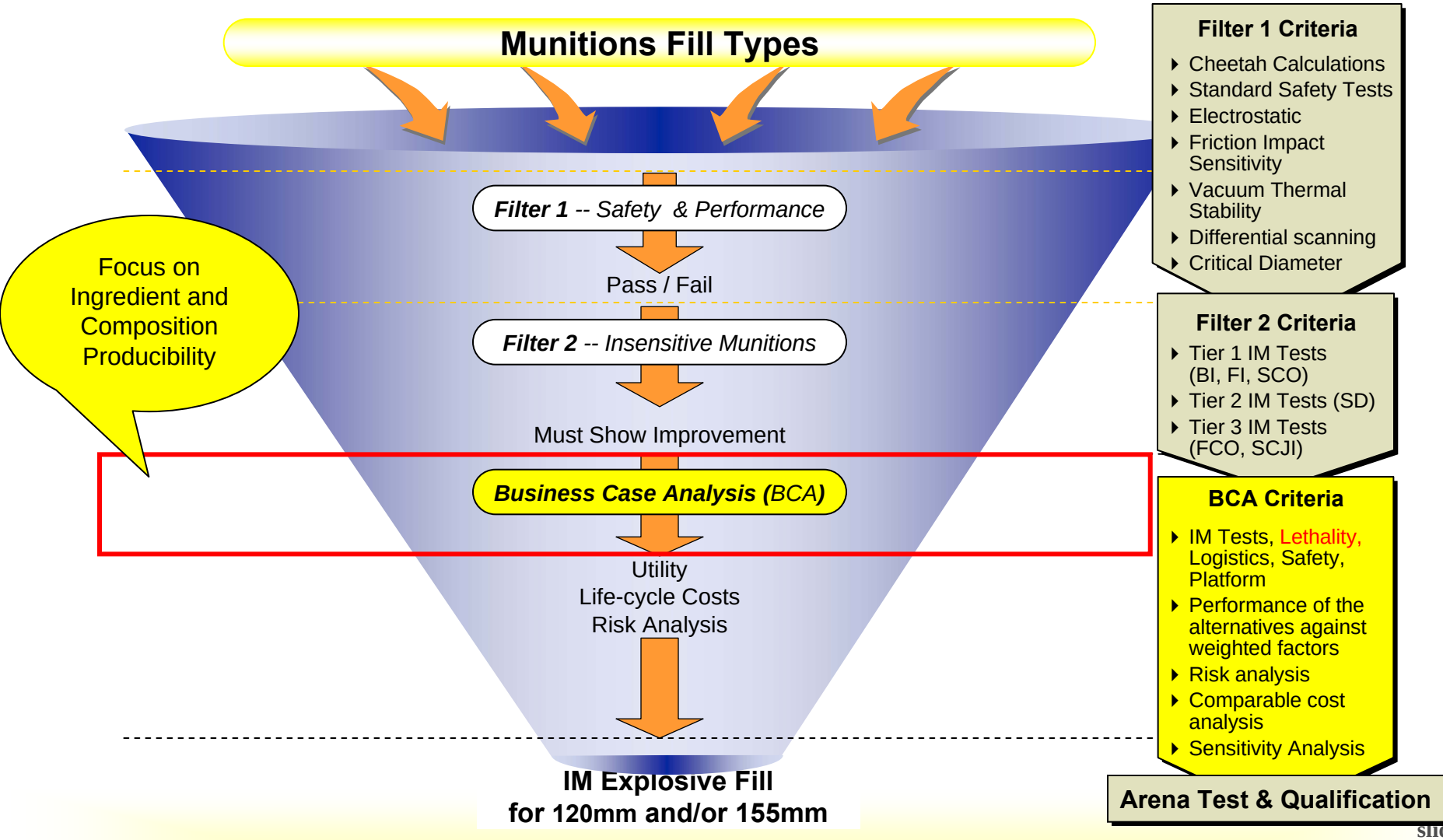
Review of Business Case of Down-selected Candidates

- "Funnel" framework to progressively screen candidates



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Manufacturing Producibility Non-Traditional Ingredients

- **Cost of ingredients:**
  - DNAN
  - NTO
  - Nitrate salts
- **Strategic Synthesis Capability**
  - Current, active manufacturing capacity at HSAAP (as of 2007)
  - Ingredients synthesized in the HSAAP Agile Plant
    - Combined DNAN/NTO capacity is ≈2-3m LB / year
      - » Using existing facilities and infrastructure

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Agile Plant Manufacture Overview

- Reported at Prior IM EM Conferences
- Established in CY2001
  - ✓ 2,000 Gallon Reactor at Heart of Facility
  - ✓ Installed in a facility designed to be flexible in operation
    - Rapidly reconfigurable
    - Multi-purpose chemistry capability
    - Extensive infrastructure support
    - Expandable
- Presently used for the LARGE SCALE manufacture of:
  - ✓ DNAN
  - ✓ NTO
  - ✓ DMDNB
  - ✓ Special grades of PETN, RDX
  - ✓ TATB
  - ✓ R8002 (short-term future production)

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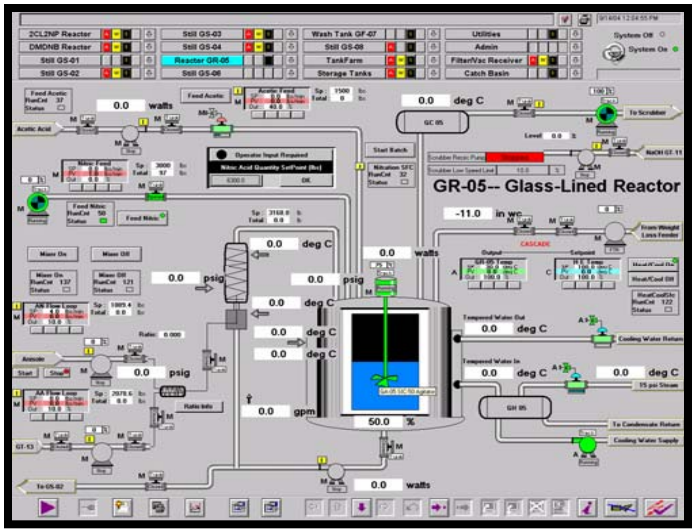
Product Collection: Nutsche De-watering



Process Control – SIEMENS PCS-7

Pfaudler 2,000 Gallon Reactor

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2,4-Dinitro anisole (DNAN)

- Batch-Manufacture
- A Good Melt-phase Insensitive Substitute for TNT
  - ✓ A critical component of IMX-101
- Two Synthetic Routes Demonstrated on Production Scale
- Multiple raw-material sources (U.S., international)
- Qualified in U.S. Weapon Systems
  - ✓ PAX-21 (60mm Mortar)
  - ✓ PAX-41 (SPIDER)

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HSAAP DNAN – INDICATIVE PRICING

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Note: Prices subject to formal RFQ review.

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Nitrotriazolone (NTO)

- **Batch Manufacture**
  - ✓ Synthesis based upon published route
  - ✓ Modified to improve safety and productivity
  - ✓ Multiple raw-ingredient sources
- **Used as an insensitive RDX Replacement**
  - ✓ Critical for achievement of adequate product functioning
    - Performance and sensitivity
  - ✓ Available in various particle sizes
    - Key to achieving desired processability

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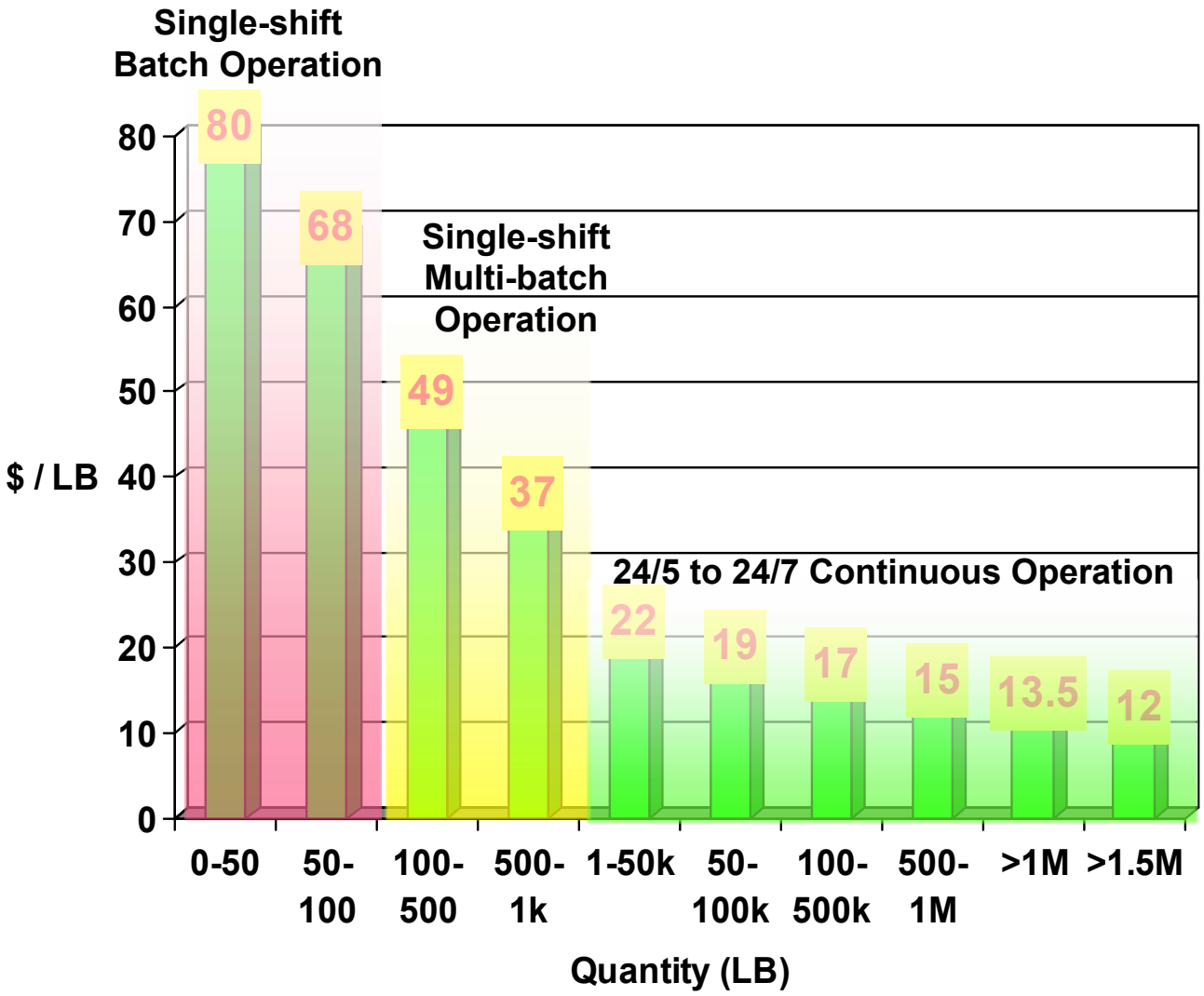
HSAAP NTO – INDICATIVE PRICING



Note: NTO pricing is influenced by a key raw-ingredient index, linked to oil prices. Prices subject to formal RFQ review.

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Nitrate Salt Eutectic

- Manufactured on Lab-Scale only to Date
- Elegant Salt Manufacturing Method
  - ✓ Water-based synthesis
  - ✓ Acid-base neutralization
- Robust Salt Eutectic
  - ✓ Insensitive to composition variation (+/-2% tested)

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Melt-Pour Explosive Manufacture

- **Traditional Melt-Pour Technology**
  - ✓ Melt-phase ingredient (TNT, DNAN, Wax etc.)
  - ✓ Fillers (RDX, NTO, etc.)
  - ✓ Low-shear incorporation
  - ✓ Flaking
  - ✓ Quality control / assurance, final packaging
- **Industrial Capacity**
  - ✓ Current active capacity: 6m LB / year
    - Surge capacity >25m LB / year
- **Life-cycle Management**
  - ✓ IMX-101, -102 and -103 are melt-pour explosives
  - ✓ Existing Demil technology base applies to IMX products

Test Quantities of IMX-101 and IMX-102 Manufactured on FULL PRODUCTION SCALE at HSAAP in support of PM-CAS Common Explosive Program (1,500 LB nominal batch size)

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Concluding Remarks

- **IMX-101, -102 and -103 Candidates for 155mm Artillery Projectile**
  - ✓ **Contain "non-traditional" ingredients**
    - **NTO, and/or DNAN, or nitrate-salt eutectic**
  - ✓ **NTO and DNAN produced on full production scale**
  - ✓ **Nitrate-salt eutectic producible on same scale (not yet demonstrated)**
  - ✓ **Raw ingredients available CONUS and OCONUS**
  - ✓ **IMX-101 and -102 Manufactured on full production scale**

Demonstrated IM Compliance
Results far exceeded expectations
Safe, Suitable & Sustainable

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Acknowledgements

- ARL
- ARDEC
- BAE Systems
- PM-CAS
- DZI (Kansas)
- NTS

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Briefing Session Summary

- Common Low-cost IM Explosive Program – Jim Rutkowski, PM CAS
- The Characterization of IM Explosive Candidates for TNT Replacement
- Manufacture of Explosive Ingredients and Compositions for the IM M795 Artillery Ammunition – Andrew Wilson, BAE Holston OSI
- The Application of New IM Explosive Candidates in the M795 Projectile – Sanjeev Singh, US Army ARDEC
- IM HE Loading of 155 mm Projectiles – Erik Boykin, US Army ARDEC

Less Sensitive and Meets Performance Requirements