

**GENERAL DYNAMICS**  
Ordnance and Tactical Systems—Canada



**BAE SYSTEMS**



# STUDIES OF HBU88B MANUFACTURED WITH CONUS RDX



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# Presentation Outline



- Background
- Studied formulation and variations
- Processing studies
- NOL LSGT tests
- Summary and Future work



# Background



- **IM enhanced 120mm mortar cartridge**
  - Development program of an IM enhanced 120mm mortar ammunition by a team led by GD-OTS Canada started in 2001.
  - Main charge explosive: HBU88B cast-cure formulation based on I-RDX<sup>®</sup>
  - Type IV reaction for all IM tests (fuze and adapter more than 15 meters)
  - Cartridge qualification under M932A2 in 2006
- **Recrystallized I-RDX<sup>®</sup> from Bachman RDX showed to loose its properties over time (Spyckerelle et al. studies)**
- **Goal: Study of the link between NOL LSGT test and IM tests**
- **Phase 1: formulation processing work and LSGT tests of HBU88B produced with two versions of premixes of RDX produced by BAE OSI HSAAP.**



## ➤ HBU88B formulation

- Formulation originally developed by Eurenco France
- 88% I-RDX<sup>®</sup>
- 12% binder based on Hydroxyl Terminated Polybutadiene (HTPB) prepolymer cured with Isophorone di-isocyanate (IPDI) containing Di-Octyl Adipate (DOA) plasticizer.

## ➤ Modified formulations studied: Replacement of I-RDX<sup>®</sup>

- BAE OSI HSAAP proprietary mix of RDX (OSXP-1)
- Mix of standard materials premixes (CXM-7/CXM-AF-1)
  - CXM-7: Premix of RDX in DOA used for PBXN-109 (Coarse particles)
  - CXM-AF-1: Premix containing fine FEM RDX in DOA used by USAF (Fine particles)

## ➤ Processing method

- Bi-component method developed by Eurenco France



# Processing studies



## ➤ Viscosities and curing properties

- Same optimal ratios of coarse (CXM-7) to fine particles (CXM-AF-1) as for the I-RDX®

Properties	I-RDX®	OSXP-1	CXM-7 / CXM-AF-1
EOM viscosity (component A) (kP)	5.0 – 10.0	9.1	11.0
EOM viscosity (HB U88B) (kP)	3.0 - 7.0	2.0	5.2
Pot life (min)	25	35	25
Curing time (hr)	24	24	24

## ➤ Material properties

Properties	Specification	I-RDX® (qualification)	OSXP-1	CXM-7 / CXM-AF-1
% RDX*	$87.0 \leq \leq 89.0$	$88.1 \pm 0.5$	$88.9 \pm 0.1$	$88.1 \pm 0.7$
Hardness (shore A)	$60 \leq \leq 95$	$66 \pm 3$	$72 \pm 0.2$	$74 \pm 2$
Density (g/cc)	$1.60 \leq \leq 1.65$	$1.62 \pm 0.005$	$1.61 \pm 0.001$	$1.61 \pm 0.001$
S <sub>m</sub> (MPa)	$\geq 0.6$	$0.87 \pm 0.05$	$0.70 \pm 0.02$	$0.96 \pm 0.03$
e <sub>m</sub> (%)	$\geq 4$	$8 \pm 3$	$10 \pm 0.1$	$18 \pm 3$
VST (cc/g)	$\leq 0.5$	$0.11 \pm 0.04$	$0.03 \pm 0.01$	$0.04 \pm 0.01$

\* This includes both the RDX and HMX for the BAE OSI HSAAP material.



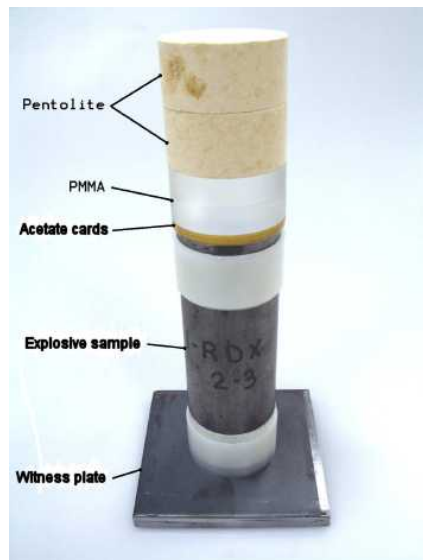


# NOL LSGT TESTS



## ➤ Set-up

- Similar to NOL Large Scale Gap TEST
  - RP-502 detonator
  - Views of the set-up and DRDC Valcartier detonation bay



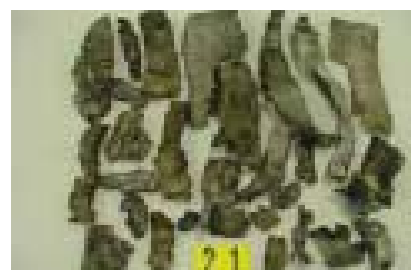
# NOL LSGT TESTS



## ➤ Data for comparison – 50% detonation point

### – Composition B

- Measured value: 216 cards
- Literature value: 209 cards



215 cards - GO

217 cards – NO GO



# NOL LSGT TESTS



## ➤ Data for comparison – 50% detonation point

### – PBXN-109

- Measured value: 142 cards
- Literature value: 134 - 200 cards ( Beyard, M., *Variations of PBXN-109 sensitivity*, NIMIC/AC-326 RS-RDX technical meeting 2003 – MSIAC Gap tests database)



142 cards - GO

142 cards – NO GO





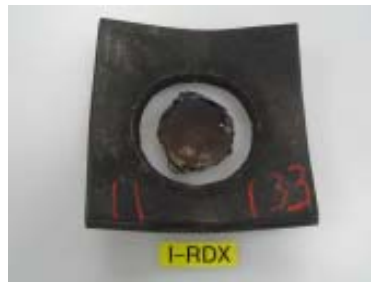
# NOL LSGT TESTS



## ➤ Data for comparison – 50% detonation point

### – HBU88B (I-RDX)

- Measured value: 133.5 cards
- ARDEC values: 141.5 – 143 cards



133 cards - GO



134 cards – NO GO



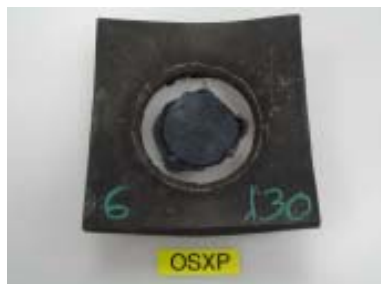
# NOL LSGT TESTS



## ➤ Data – 50% detonation point

### – HBU88B (OSXP-1)

- Measured value: 131 cards



130 cards - GO

131 cards – NO GO (?)

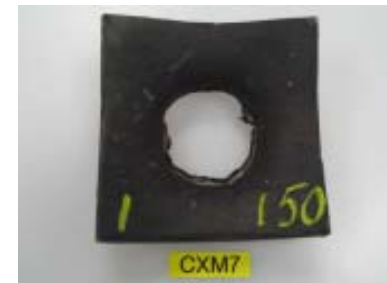
132 cards – NO GO



# NOL LSGT TESTS



- Data – 50% detonation point
  - HBU88B (CXM-7/CXM-AF-1)
    - Measured value: 149.5 cards



149 cards - GO



150 cards – NO GO



# Summary and future work



- **Processing of two HBU88B formulations with CONUS RDX**
  - Properties in the same range as HBU88B with I-RDX<sup>®</sup> except for lower end-of-mix viscosity for OSP-1 formulation and higher mechanical properties for CXM mixes.
  
- **Validation DRDC-V LSGT equipment: results in the same range as those obtained in the literature for standard explosives (Composition B and PBXN-109).**
  
- **HBU88B produced with CONUS RDX gives NOL LSGT results in the same range as HBU88B made with Eurenco I-RDX:**
  - I-RDX: 133.5 cards (ARDEC: 142 cards – same range)
  - OSXP-1: 131 cards
  - CXM-7/CXM-AF-1: 149.5 cards (More sensitive)
  
- **Phase 2: IM test results to be presented by PM CAS organization (CLIMEx program)**

