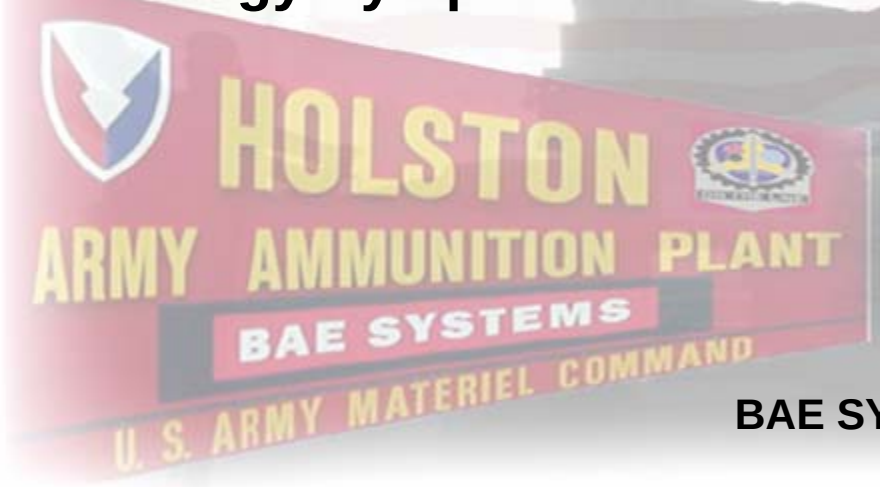
GENERAL DYNAMICS
Ordnance and Tactical Systems

BAE SYSTEMS

# DEVELOPMENT AND FILLING OF NEW INSENSITIVE MELT POUR EXPLOSIVES FOR 120MM DIRECT FIRE AMMUNITION

## NDIA Insensitive Munitions & Energetic Materials Technology Symposium 2007

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# Briefing Objectives

- Background
- Program Goals
- Formulation Methodology
- Candidates
- Testing / Results
- Conclusions

# Acknowledgement


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  - Mr. Andrew Wilson
  - Mr. Curtis Teague
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- General Dynamics-OTS
  - Mr. Jason Gaines
  - Mr. Tom McGovern

# Formulation Background / Goals

- Melt-Pour Formulations
  - Extensively Used by NATO Countries
  - Existing Industrial Base Capability
  - Historically Used “TNT” as HE Melt-phase
    - e.g. Composition B – RDX/TNT (60/40)
  - TNT Suffers from Poor IM Performance
    - International Initiatives to Replace “Composition B” in Essentially all Ammunition Products
- Formulation Goals
  - Match Composition B or TNT Performance
  - Pass IM Tests in System Tests
  - Address Stakeholder Cost Issues
    - Use of Existing Infrastructure; Demil; Material Costs etc.

Holston Army Ammunition Plant

# Formulation Methodology

- Development Strategy
  - Use of CONUS Materials
    - DNAN
    - RDX
    - HMX
    - Nitrotriazalone (NTO)
      - Similar Performance to RDX
      - Much Improved IM Response
    - TATB
      - Outstanding IM Performance
      - Good Detonation Performance


2,000 Gallon Glass-lined Reactor

- All Materials are Standard Production Items at Holston AAP

# Formulation Methodology

- Melt-Cast HE
  - Allow for Optimization for varying Applications / Customer Req.
- Good Intrinsic IM Properties
- Energetic Performance
  - Similar or Exceeds Current Systems
- Potential for *COST SAVINGS* in Ammunition
  - Ability to Use “Lower Grade” Steel
  - Recycle / Demil (Not Economical for Cast-Cured Energetics)
  - Easier to Process than Composition B
    - Reduced Shrinkage; Rapid Cooling; No Post-Cycle Heating

# OSI Formulation Development

- Energetic Formulations Focus
  - Two Formulations Selected for Development and Scale-up
  - Both Show Low Shock Sensitivity
  - Stable Thermal Properties
- Selected Formulations
  - PAX-34 – Developed Initially
  - OSX-8 – Follow-on Development After PAX-34

# PAX-34

- DNAN Based Explosive
  - Incorporates HMX, NTO, TATB
  - Greater than TNT Performance
  - Low Shock Sensitivity
  - Outstanding IM Properties
- Manufactured Using Existing HSAAP Casting Equipment / Facilities
  - Nominal 1200 lb Batch Size
- No modifications to LAP Infrastructure
- Used to Establish Baseline Performance and IM Data 2005/06

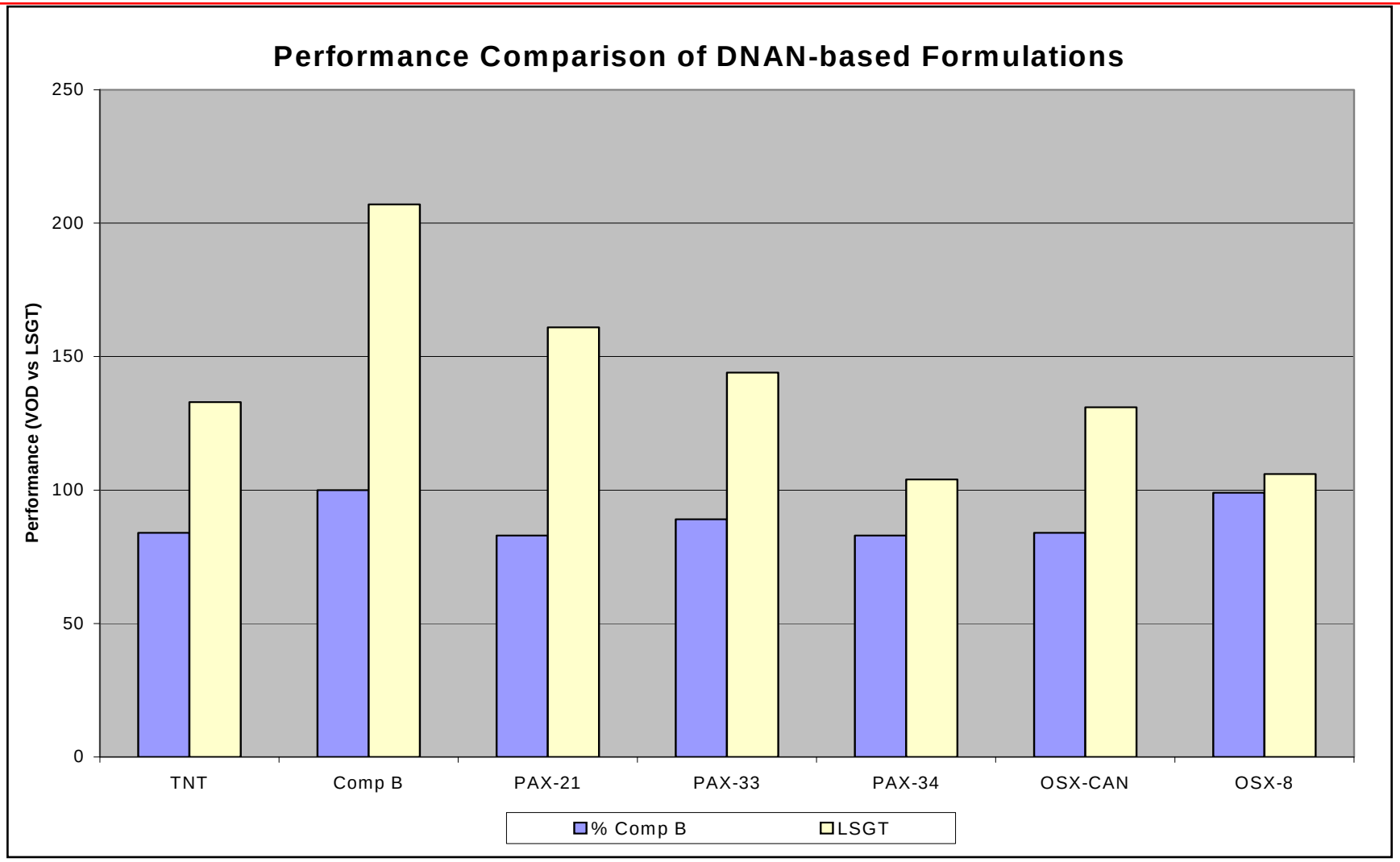
# OSX-8

- Lower Cost Alternative to PAX-34
- DNAN Based Explosive
  - Incorporates HMX and NTO
  - Similar Energetic Performance to Comp. B
  - Low Shock Sensitivity
  - Excellent IM Properties
- Manufactured Using Existing HSAAP Casting Equipment / Facilities
  - Nominal 1200 lb Batch Size
- No modifications to LAP infrastructure

# Formulation Performance Results

| Material | TMD (g/cc) | VOD (% Comp B) | VOD (% TNT) | LSGT (Cards) | Reference | DSC MP/ Exotherm Onset (°C) | Efflux Viscosity @ 96°C (sec.) |
|---|---|---|---|---|---|---|---|
| TNT | 1.654 | 84 | 100 | 133 | MSIAC | 80/280 | n/a |
| Comp B | 1.763 | 100 | 120 | 207 | LLNL | 80/125 | n/a |
| PAX-21 | 1.728 | 83 | 99 | 161 | ARDEC | 89/193 | 4.8-8.6 |
| PAX-33 | 1.736 | 89 | 106 | 144 | ARDEC | 88/207 | 8.7 |
| *PAX-34* | *1.761* | *83* | *99* | *104* | *ARDEC* | *87/245* | *8.5* |
| OSX-CAN | 1.594 | 84 | 100 | 131 | OSI | 93/225 | 5.9 |
| *OSX-8* | *1.763* | *99* | *118* | *106* | *OSI* | *93/205* | *6.7* |

# Formulation Performance Results



# GD-OTS IM Testing with PAX 34 and OSX 8

## PAX 34

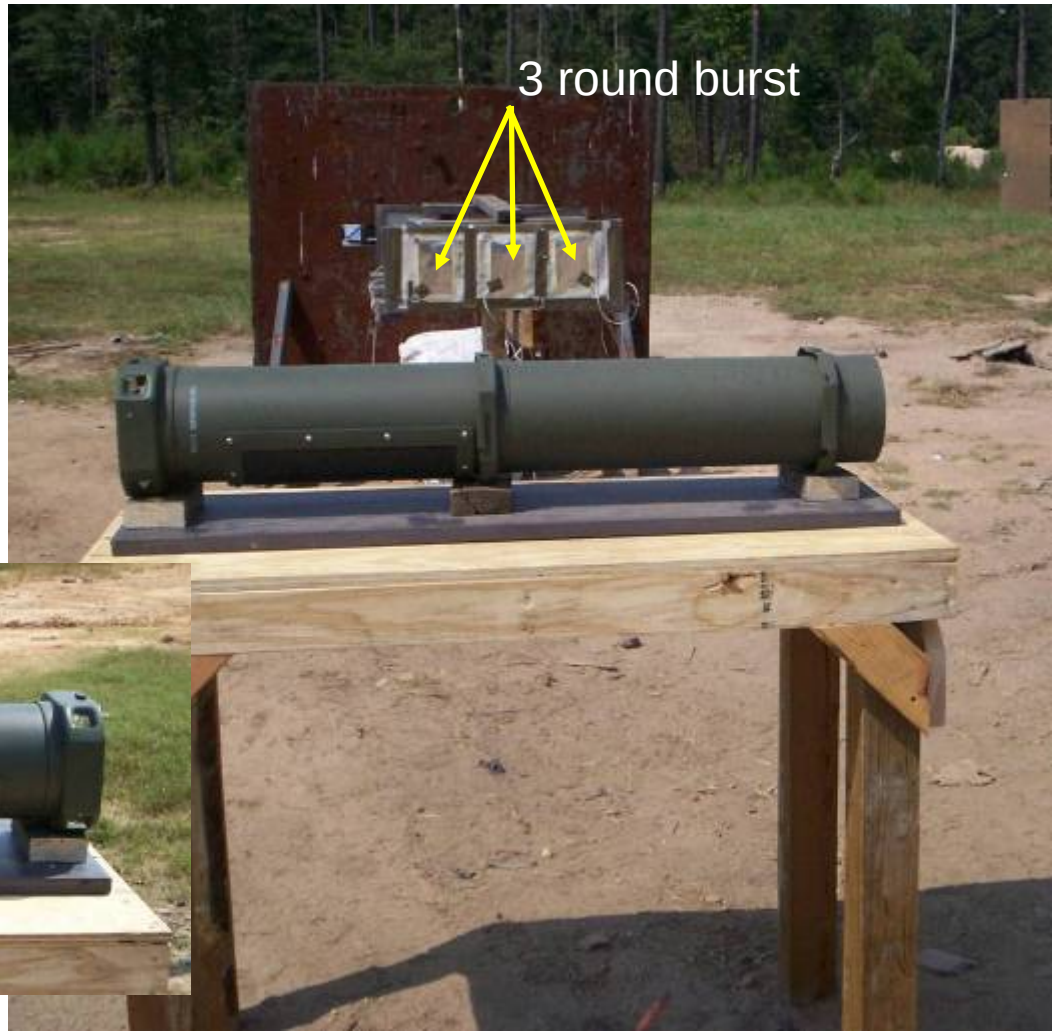
- Test Article: Steel warhead with 6 lbs of PAX 34
- Test Date: 2005
- IM Test Completed
  - Slow Cook Off
  - Sympathetic Detonation
  - Bustle Test
- *Results presented at 2006 IM conference*

## OSX 8

- Test Article: Steel warhead with 7 lbs of OSX 8
- Test Date: 2007
  - Bullet Impact
  - Sympathetic Detonation
  - Shaped Charge Jet
  - Slow Cook Off
  - Fast Cook Off
  - Environmental Sequence
    - 28 Day T&H
    - Transportation/Vibration
    - 4 Day T&H
    - 40 ft. drop

# GD-OTS OSX-8 IM Tests – Bullet Impact Setup

- IAW MIL STD 2105C and STANAG 4241
- 3 round burst, cal .50 AP
- Munition in full packaging configuration

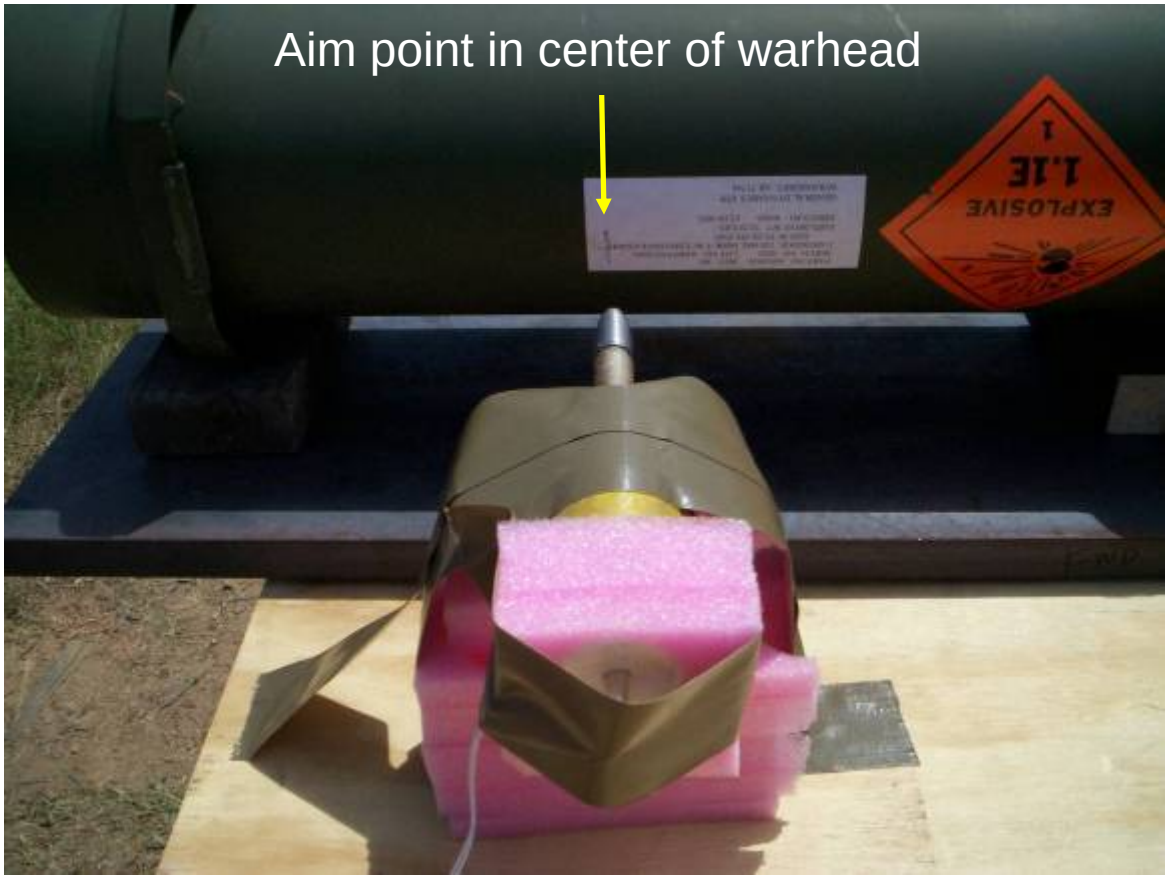



# GD-OTS OSX-8 IM Tests – Bullet Impact Results

Result Type V – Burning only, no detonation, no deflagration

# GD-OTS OSX-8 IM Tests– Shaped Charge Jet Setup

- IAW MIL STD 2105C & STANAG 4526, Procedure 1
- 50mm Rockeye SCJ
- Munition in full packaging configuration



# GD-OTS OSX-8 IM Tests – Shaped Charge Jet Results

- Type IV Reaction
- No detonation or explosion
- Deflagration only


# GD-OTS OSX-8 IM Tests – Fast Cook Off Setup

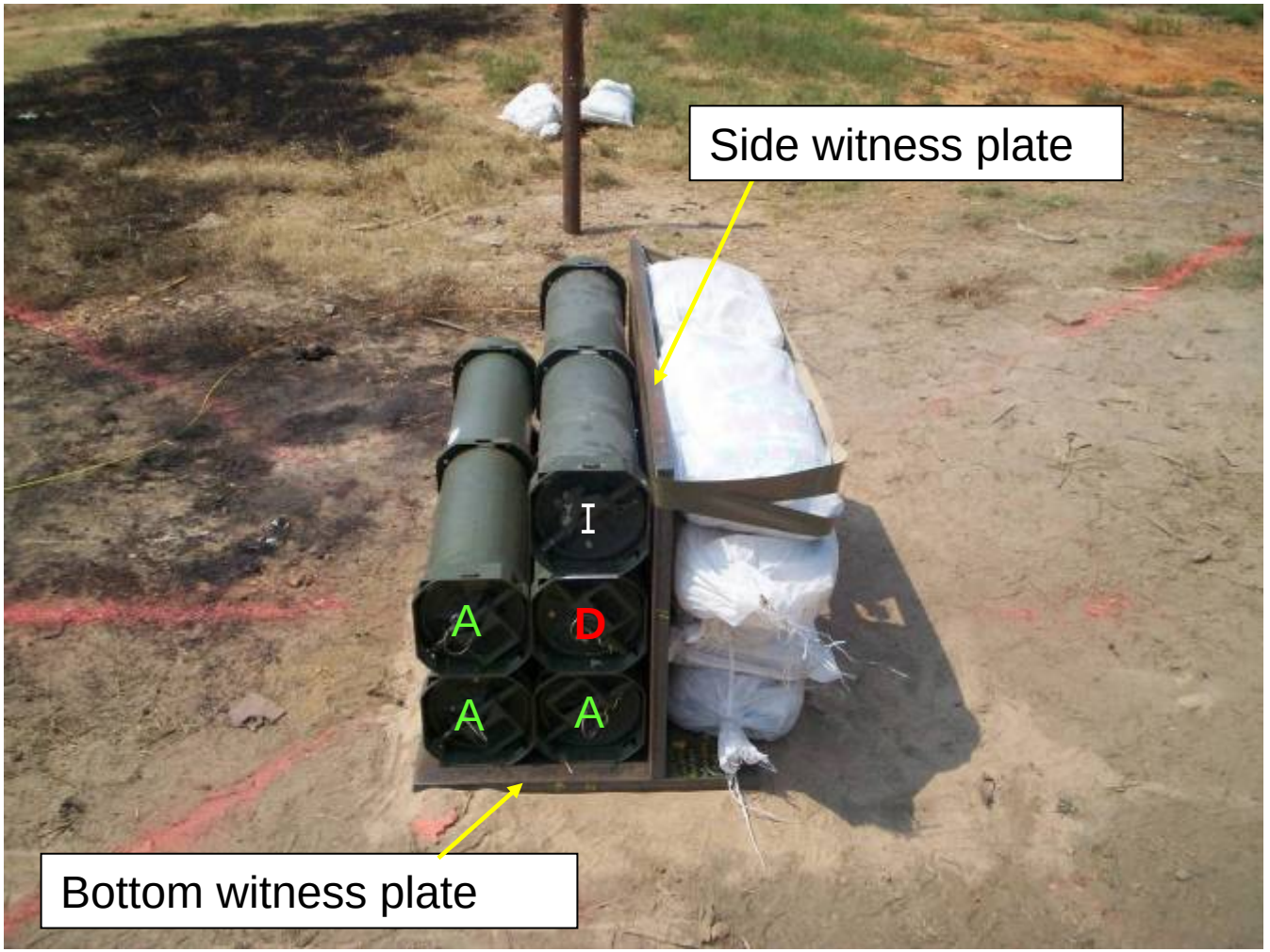
- IAW MIL-STD-2105C & STANAG 4240
- Munition in full packaging configuration

# GD-OTS OSX-8 IM Tests – Fast Cook Off Results

- Type IV Reaction
- No detonation or explosion
- Propulsive reaction

# GD-OTS OSX-8 IM Tests – Sympathetic Detonation Setup

- IAW MIL STD 2105C & STANAG 4396.
- 1 donor round, 3 acceptor rounds.
- Inert can filled with sand.



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# GD-OTS OSX-8 IM Tests – Sympathetic Detonation Results

No reaction from acceptor warheads

Witness plate shows evidence of fragmentation marks from donor warhead

Side witness plate

Bottom witness plate

Bottom witness plate shows no evidence of fragmentation marks.

Forward piece of warhead

# Conclusions

- OSX-8 and PAX-34 both provide significant IM improvement over TNT and Comp B
- OSX-8 and PAX-34 can both be manufactured at Holston AAP
- Formulations can be loaded at existing facilities across the Industrial Base
- OSX-8 has energy equivalent to Comp B
- OSX-8 is a lower cost explosive formulation than PAX-34
- OSX-8 and PAX-34 can both be demilled easily and economically
- Both formulations are made using high volume, low-cost, less sensitive ingredients, such as DNAN, NTO, TATB and HMX