

# GENERAL DYNAMICS

Ordnance and Tactical Systems

## 120 mm High Explosive - Tracer (HE-T) IM Development and Design



# 120 MM HE-T Background

The 120 mm HE-T is a direct fire round developed by NAMMO and is in service with the Leopard equipped Swedish Defense Forces. GD-OTS has improved the round to meet the accuracy and survivability requirements typical of USG fielded tank ammo.

The 120 mm HE-T is a “Full Bore” High Explosive round with capabilities against **multiple** threat targets.

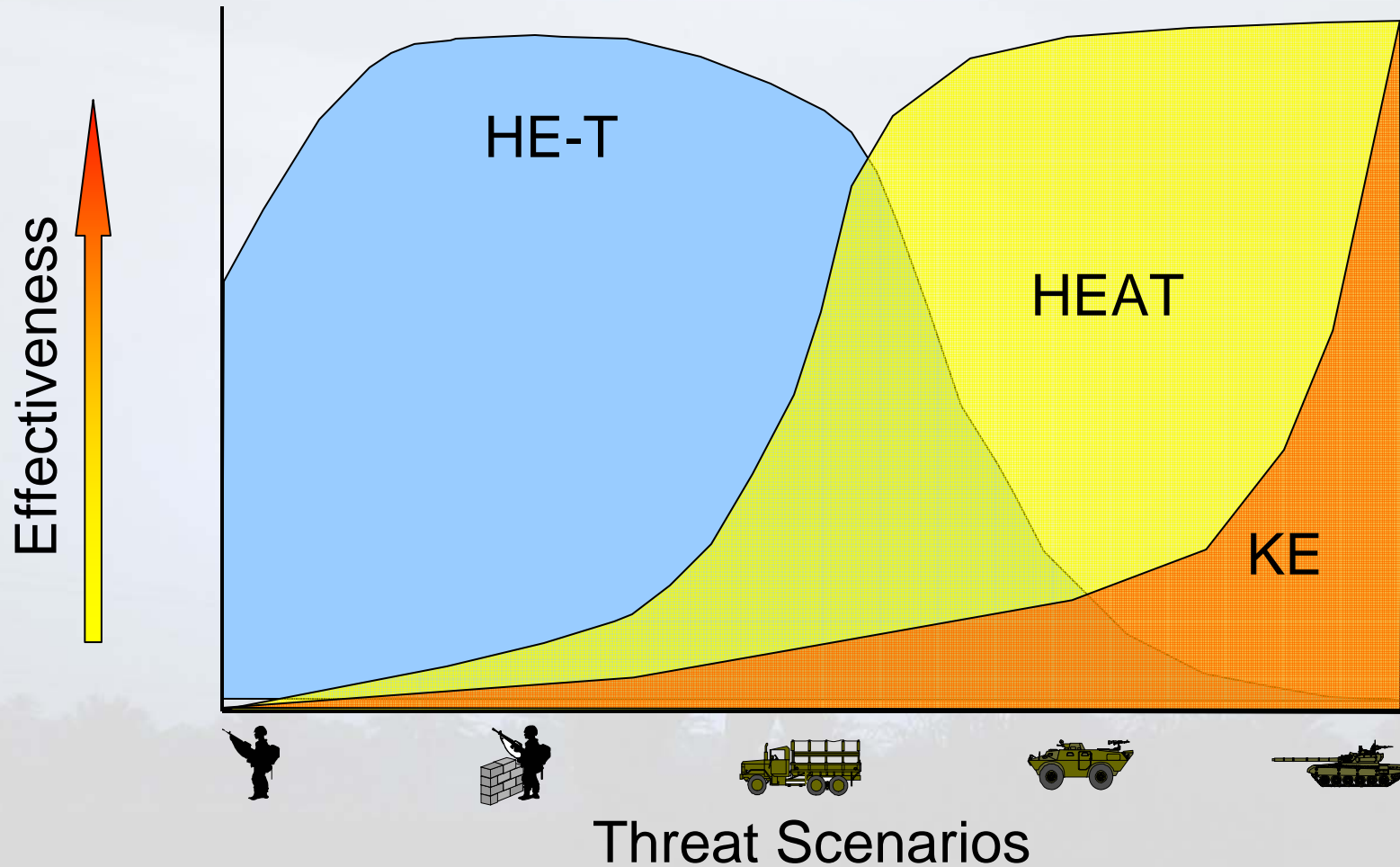


# 120 mm HE-T

- Americanized by GD-OTS for Abrams Tank
  - St. Marks Hybrid propellant, 6 lbs of PAX-34 Explosive, Propellant bag, Cool primer, Combustible cartridge case and Case base
- Technical Requirements:
  - Direct fire against multiple targets
  - Dual safe fuze with SQ & delay (complaint to MIL-STD-1316)
  - US Army accuracy requirement
  - Direct fire capabilities
  - Indirect fire capabilities



# 120 mm HE-T Effectiveness



# HE-T Against a Mini-Bus



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# Accuracy (TID) Test

- GD-OTS and Nammo have improved the accuracy of the HE-T by redesigning the projectile fin blades. The fin blades are larger and more rigid.
- Testing at NTS was completed Dec. 12-16, 2005.
  - Target Distance: 2000 meters
  - Conditioning Temp: +21°C
  - Accuracy was significantly improved

Original Fin Blade Design



Improved Fin Blade Design

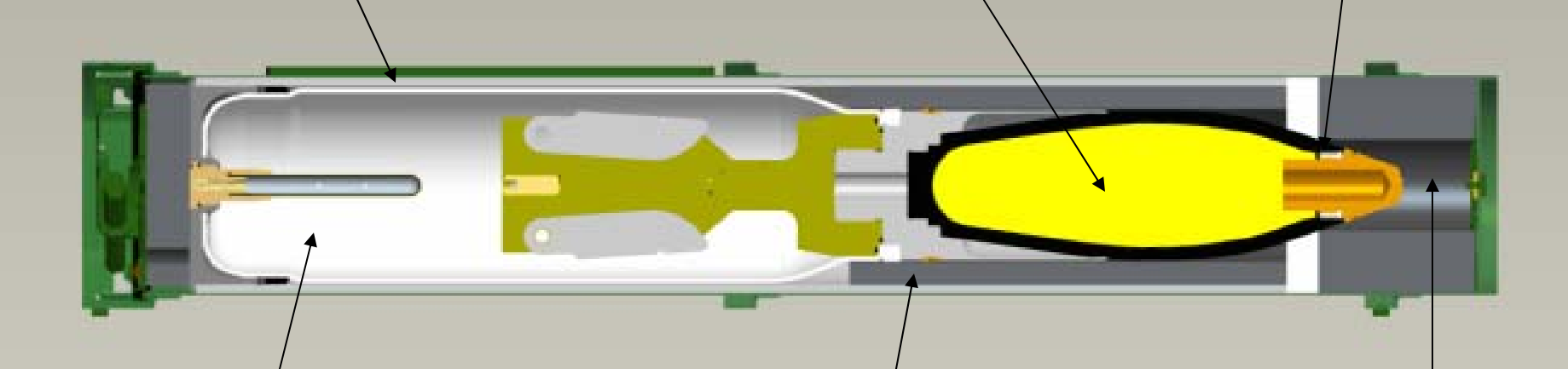


# HE-T IM Characteristics

PA 171 Vented Ammo Can

PAX-34 Explosive Fill

Fuze Venting Sleeve



St. Mark's Powder HYBRID Propellant

Closed Cell Foam Packaging

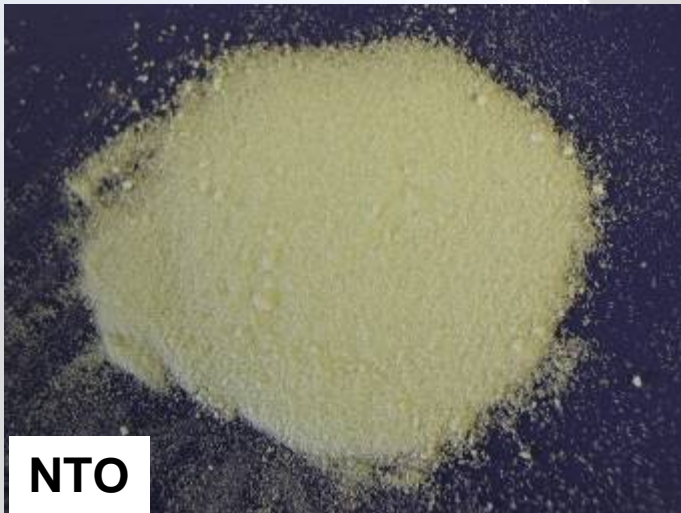
Fuze Relief Area

## PAX 34 Background Information

- Traditional Melt-Cast Explosive Fills
  - Good explosive performance
  - Poor IM performance
  - Low cost, high volume manufacture
  - Multiple LAP options
- IM Improved Melt-cast Explosive Fills
  - Good explosive performance
  - Good to excellent IM performance
  - Combination new/traditional explosive ingredients
  - Low cost, high volume manufacture
  - Multiple LAP options



# IM Explosive Ingredients



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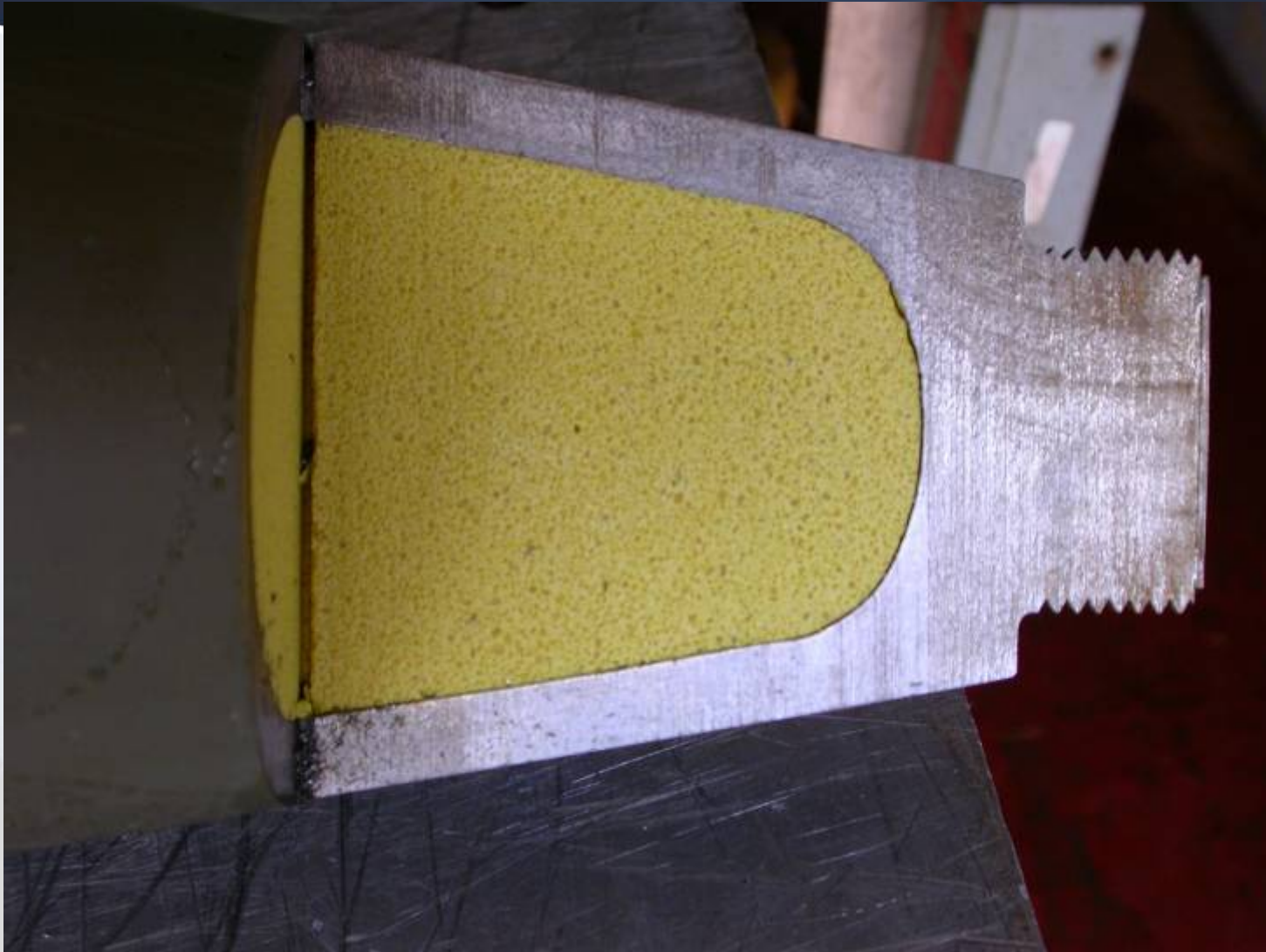
## Sectioned 120mm PAX-34 Filled Mortar



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## Sectioned 120mm PAX-34 Filled Mortar



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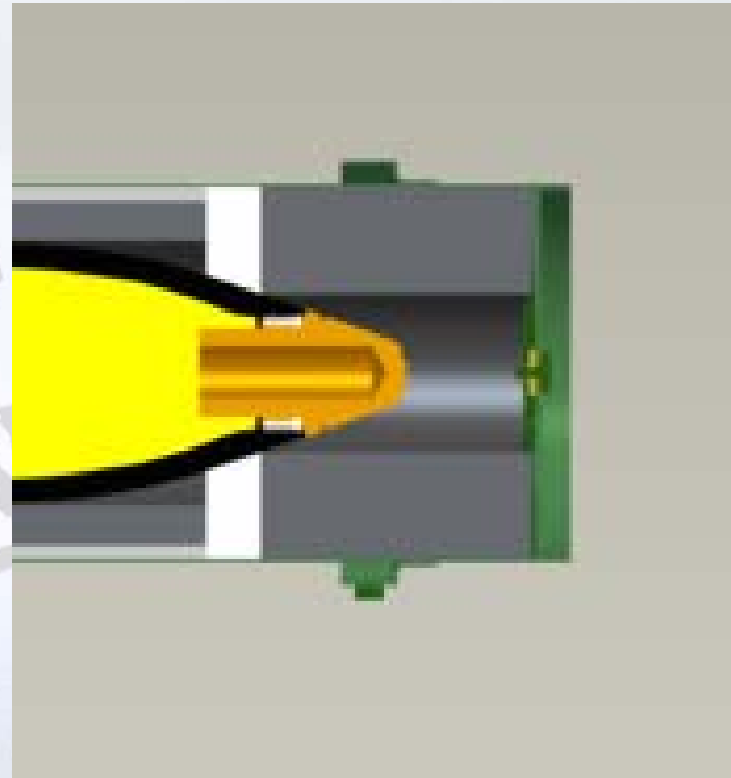
# St. Marks HYBRID Propellant

- Initial testing indicates GD-OTS's HYBRID propellant is an insensitive energetic comparable to JA2
- HYBRID propellant grains are more plasticized than M14 and will not break or crack as easily.
- Nitrocellulose is completely dissolved prior to extrusion.



# Fuze Venting Sleeve

- Fuze venting sleeve melts prior to reaction temperature of PAX-34, allowing the pressure of the explosive to vent out of the fuze cavity.
- Material is extruded Polycarbonate, very hard plastic able to maintain its structural integrity during ballistic firing.
- Enough area forward of fuze to allow proper venting.



# PA171 Ammo Can and Closed Cell Foam Packaging

- Venting windows effectively vent high pressure built up inside of the ammo can during Slow and Fast Cook Off environments.
- Closed cell foam produced at Foam Design once heated to its melting point returns to a resin type state rather than sealing the round causing an additional pressure seal.



# Summary of 120 mm HE-T IM Testing

## Vulnerability Testing

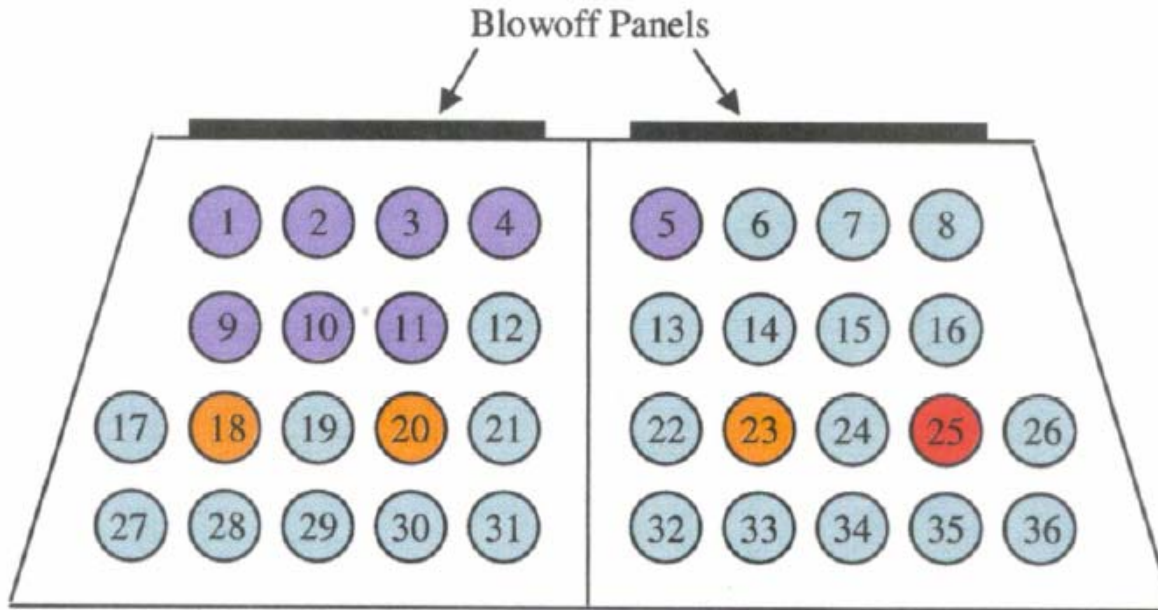
- M1A1 Bustle Test
- Sympathetic Detonation Test 1
- Sympathetic Detonation Test 2
- Sympathetic Detonation Test 3

## Slow Cook Off Test

- Three (3) warhead configurations

# M1A1 Bustle Testing

## Stowage Configuration in Bustle for HE-T Test



Commander's/Semi-Ready Side  
Compartment

Loader's/Ready-Side  
Compartment



120-mm HE-T donor cartridge



120-mm HE-T acceptor cartridges



120-mm KEW-A2 slug cartridges



120-mm KEW-A2 inert cartridges



# Bustle Test Results

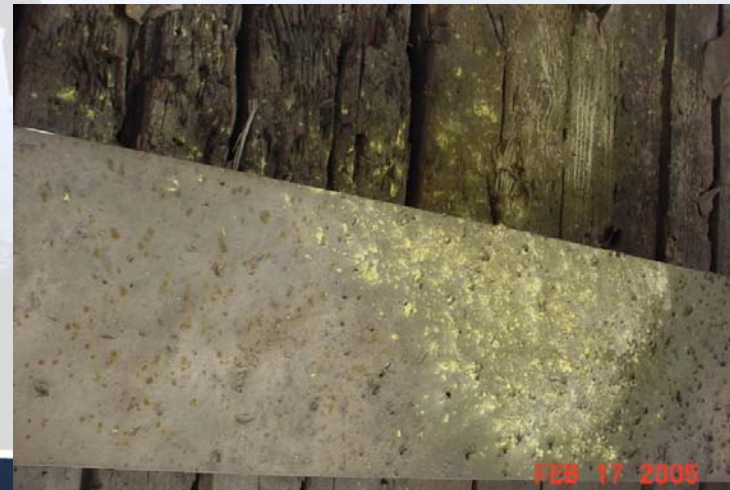
- No sympathetic detonation of acceptor cartridges
- The various features built into the Abrams turret effectively vented the pressure generated during the explosive event.
- Majority of propellant was consumed during the explosive event
- Peak pressure measured within the ammunition compartments was within threshold criteria.
- Results considered successful.
  - It is possible to store HE-T rounds in the Abrams turret ammunition compartment without violating crew survivability criteria.

# Sympathetic Detonation Test 1

## Setup

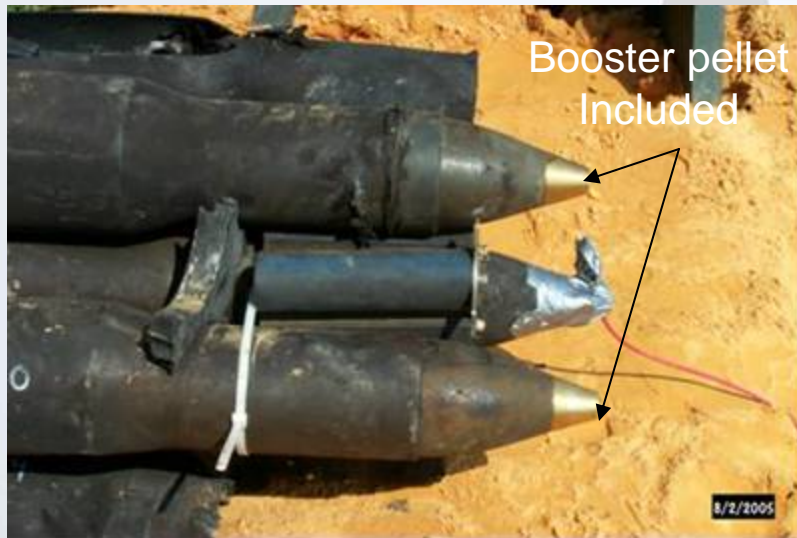


## Results



# Sympathetic Detonation Test 2

## Set-up



The test setup included three HE-T warheads, each loaded with 6 lbs of PAX-34 explosive and a PBXN-5 booster pellet. The center warhead was detonated to verify no sympathetic detonation occurs.

# HE-T Sympathetic Detonation Test

## HE-T SD Test

Aug. 5, 2005

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# HE-T SD Results

No detonation or deflagration to acceptor warheads



# Slow Cook-Off (SCO) Test Setup

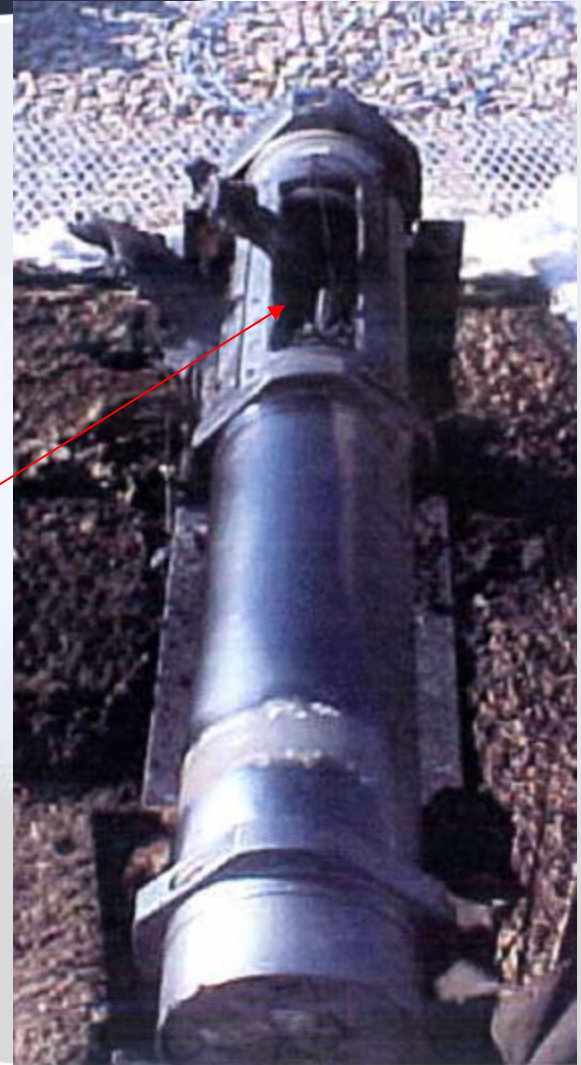
- Three warhead designs were tested.
  - Design 1: Venting sleeve between F985 fuze and warhead. Venting sleeve made of Polycarbonate.
  - Design 2: Eight (8) 3/8" venting holes surrounding warhead body filled with High Density Polyethylene (HDPE) Plugs.
  - Design 3: Current Nammo warhead design
- All test rounds were full-up cartridges with live F985 Fuze, filled with GD-OTS' Hybrid Propellant, packaged inside vented PA171 ammo cans.

# Slow Cook-Off Test Results Design 1

Design 1: (Fuze Venting Sleeve):

- **Type V Reaction**, burning only
  - HYBRID Propellant burned
  - PAX-34 burned

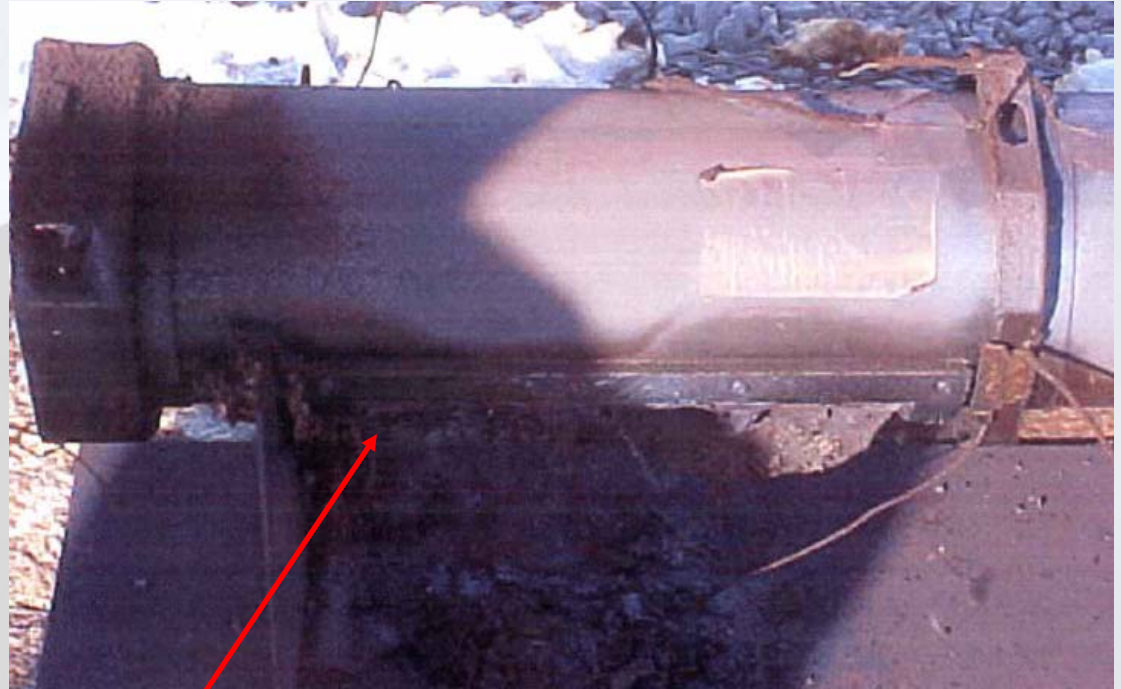
PA 171 effectively vented the pressure and no explosive event occurred



# Slow Cook-Off Test Results Design 2

Design 2 (Venting Plugs):

- **Type V Reaction**, burning only
  - HYBRID Propellant burned
  - PAX-34 burned



PA 171 effectively vented the pressure and no explosive event occurred



# Slow Cook-Off Test Results Design 3

Design 3 (Original Design):

- **Type III Reaction**, explosion
  - HYBRID Propellant burned
  - PAX-34 exploded



Fragments after detonation

# Conclusions

- The 120 mm HE-T is an effective Multi-purpose High Explosive round, capable of destroying many of the threats in today's operating environment.
- The aerodynamic design reduces the drag of the HE-T providing the war-fighter with highly effective indirect fire capabilities.
- The improved fin blades the HE-T makes the round exceptionally accurate
- As a goal, the HE-T will be considered an IM compliant HE tank round.

