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Capabilities of Penetrator with Enhanced Lateral Efficiency (PELE®)
Medium Caliber Cartridge vs. KE or HE Ammunition

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Hill AFB
• Cartridge Concept Overview
• OT&E Ground-to Ground Test Plan
• Test Performance
• Conclusion
• Acknowledgements/Contacts
• Questions & Answers
PELE® Development History


2000 – 2001  Technology Transfer to 20 mm x 102 mm PELE® and Target Effect Evaluation specified by MoD

2002  German MoD decision for 27 mm x 145 mm PELE® FSD

2003  In-House Technical Evaluation of 20 mm x 102 mm PELE® by Diehl

2004  In-House Technical Evaluation of 27 mm x 145 mm PELE® by Diehl

2005  USAF Decision to select 20 mm x 102 mm PELE® for OT&E (Operational Test and Evaluation) as potential replacement for PGU-28/B

2006  OT&E testing began at Eglin AFB
Ammunition
20 mm x 102 mm
PELE®
### 20 mm PELE® Design Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (max)</td>
<td>168 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>264 g</td>
</tr>
<tr>
<td>Projectile Mass</td>
<td>100 g</td>
</tr>
<tr>
<td>Muzzle Velocity</td>
<td>3410 f/s</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Average Mean Radius = 15 in. at 500 yds</td>
</tr>
<tr>
<td>Penetration</td>
<td>Ballistic limit &lt; 2750 f/s against 0.375 in. (9.5mm) armor at 0°</td>
</tr>
<tr>
<td>Ballistics</td>
<td>Comparable to PGU 28A/B or PGU 27A/B</td>
</tr>
<tr>
<td>Design</td>
<td>Low drag version</td>
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</table>
Key Features of PELE® Cartridge

- Compatible with all 20mm M39A2, M61, M197, M621 and ATK Viper chain gun systems
- Inert Projectile has no Explosives or Fuze
- Multi-role Ammunition
  - Air-to-Air
  - Air-to-Ground
  - Ground-to-Ground
  - Ground-to-Air
- Enhanced Performance
  - Fragmentation (w/o HE)
  - Penetration (like SAPHEI)
  - Can be tailored to customer objectives
- Dual Purpose for Combat and Training
- Reduced Cost and Logistics
- High Reliability
Principles of PELE® Function

Projectile Body: High density material (steel or tungsten)

Inner Core: Low density material (plastic or aluminum)

Steel or tungsten penetrates the target

Plastic or aluminum does not penetrate the target

Simple Design ...
Principles of PELE® Function

- Density differences between inner core and projectile body
- Upon target impact, projectile body penetrates target; interior core does not penetrate
- Impact generates an extremely high pressure in the inner core causing the projectile body to fragment as it exits the target

... Yet Effective.
Fragmentation of PELE® Projectile

Target: 2 mm Al / 0° NATO
Impact Velocity: 750 m/s

Target: 2 mm Al / 80° NATO
Impact Velocity: 750 m/s

X-ray images of function
FIXED WING EQUIVALENT TARGET S1

2mm Al

1  2  3  4  5  6  7  8  9  10

20°

300  300  300  300  300  300  300  300  300  300

> 3000

- Function point - Projectile fragments
- Maximum fragmentation effect
- Nearly no fragments leave the target - all energy stays in the target
PELE® Performance vs Other Combat Ammo

PELE® Delivers More Energy in the Target Compared to Other Tactical Ammunition
**PELE® Performance on Multi-Plate Array**

<table>
<thead>
<tr>
<th>plate 1</th>
<th>plate 2</th>
<th>plate 3</th>
<th>plate 4</th>
<th>plate 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Plate 1" /></td>
<td><img src="image2.png" alt="Plate 2" /></td>
<td><img src="image3.png" alt="Plate 3" /></td>
<td><img src="image4.png" alt="Plate 4" /></td>
<td><img src="image5.png" alt="Plate 5" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>plate 6</th>
<th>plate 7</th>
<th>plate 8</th>
<th>plate 9</th>
<th>plate 10</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image6.png" alt="Plate 6" /></td>
<td><img src="image7.png" alt="Plate 7" /></td>
<td><img src="image8.png" alt="Plate 8" /></td>
<td><img src="image9.png" alt="Plate 9" /></td>
<td><img src="image10.png" alt="Plate 10" /></td>
</tr>
</tbody>
</table>

**Fixed Wing Equivalent Target S1 – 2mm Al Spaced at 300mm**

*Few fragments leave the target – all the energy stays in the target.*
PELE® able to penetrate 10 mm Rolled Homogeneous Armor (RHA)
Less than 0.5 mil difference out to 4000m range.
TARGETS

- Cessna Cardinal (light aircraft)
- F-16/C-130 Wing Sections
- F-16 Tail Section
- M577 Armored Personnel Carrier (APC)
- M577 APC Rear Hatch
- Light Utility Trucks

(each test set-up included dummies)

TEST SET-UP

- Air/ground (A/G) engagements converted to ground-to-ground (G/G) using PRODAS® software
- Ballistic trajectories simulated for both A/G and G/G engagements
- Impact velocities matched to position targets
## Cessna Cardinal Test Set-up

| Target Set | 1 Cessna Cardinal  
|            | 1 Pilot / 1 Co-pilot  
|            | 2 Passengers         |
| PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s) | 3444.9 / 3169.23 |
| PRODAS Ground-Ground Target Location (ft) | 535 |
Cessna Cardinal Test Damage

09/28/2006

Entrance Hole

REAR

REAR
Cessna Cardinal Test Damage

ENGINE DAMAGE 09/28/2006

ENGINE DAMAGE 09/28/2006
### F-16/C-130 Wing Section Test Set-up

| Target Set                  | 1 F-16 Wing w/ 1 dummy  
|                            | 1 C-130 Wing w/ 2 dummies |
| PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s) | 3444.9 / 3130.77 |
| PRODAS Ground-Ground Target Location (ft) | 610 |
F-16 Wing / ‘Troop’ Damage
C-130 Wing / ‘Troop’ Damage

Residual Fuel in Wing Foam Burning
## F-16 Tail Section Test

<table>
<thead>
<tr>
<th>Target Set</th>
<th>1 F-16 Tail w/ 3 dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s)</td>
<td>3444.9 / 2978.13</td>
</tr>
<tr>
<td>PRODAS Ground-Ground Target Location (ft)</td>
<td>915</td>
</tr>
</tbody>
</table>

Significant damage to exit surface with composite skins.
F-16 Tail Section Test

Test Set-up

‘Troop’ Damage
### M577 APC Test Set-ups

<table>
<thead>
<tr>
<th>Target Set</th>
<th>1 M577 APC w/ 5 passengers 6 dummies in hasty cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODAS Muzzle / Impact Velocity (ft/s)</td>
<td>3444.9 / 2808.94 2460.36</td>
</tr>
<tr>
<td>PRODAS Ground-Ground Target Location (ft)</td>
<td>1210 2000</td>
</tr>
</tbody>
</table>
20mm PELE® is effective against light armor.
M577 APC Test Damage

'Troop' damage inside APC

Penetrated 8” Reinforced CMU Wall

Did not penetrate APC at extended range (5000 ft) in all shots
### M577 APC Rear Hatch Test

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<table>
<thead>
<tr>
<th>Projectile Type</th>
<th>Muzzle Velocity (ft/s)</th>
<th>Impact Velocity (ft/s)</th>
<th>Impact Range (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PELE®</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3388.406</td>
<td>2472.430</td>
<td>1966.881</td>
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<tr>
<td>3429.776</td>
<td>2505.556</td>
<td>1968.057</td>
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<tr>
<td><strong>PGU-27A/B</strong></td>
<td></td>
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<tr>
<td>3405.015</td>
<td>2432.786</td>
<td>1968.880</td>
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<tr>
<td>3402.988</td>
<td>2405.282</td>
<td>2021.135</td>
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<tr>
<td>3424.768</td>
<td>2347.559</td>
<td>2212.883</td>
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<tr>
<td>3412.408</td>
<td>2253.949</td>
<td>2359.837</td>
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<tr>
<td>3418.592</td>
<td>2435.984</td>
<td>1965.469</td>
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<tr>
<td>3415.898</td>
<td>2426.698</td>
<td>1972.231</td>
<td></td>
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</tbody>
</table>

PELE® penetrates vs PGU-27
## Light Truck Test Set-ups

<table>
<thead>
<tr>
<th>Target Set</th>
<th>2 Light Utility trucks w/ passengers 6 dummies in hasty cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s)</td>
<td>3444.9 / 2460.36 1262.07</td>
</tr>
<tr>
<td>PRODAS Ground- Ground Target Location (ft)</td>
<td>2000 5000</td>
</tr>
</tbody>
</table>
Light Truck Test ‘Troop’ Damage

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Light Truck Test Damage

Fire in 5 gal. Diesel Fuel Can Hit by PELE®

Engine Damage
Test Summary

• All targets were incapacitated except the APC at 5000 ft ground-to-ground.

• PELE® ignited residual fuel in AC-130 wing foam and diesel fuel in 5-gallon fuel can.

• ‘The round met or exceeded performance projections.’ – Air Force assessor.

• Air Force down-selected to the PELE® round because Qualification Testing showed it to be as good or better than the PGU-28/B, especially if you factor in the life cycle cost savings.
20 mm x 102 mm PELE® cartridge offers:

- Combined HE and KE performance characteristics
- 100% safe – No reactive materials and no fuze
- High reliability and long shelf life
- Low cost – standard materials, simple manufacturing, short lead times
- “One round for all” – combat and training round (reduced logistic burden)
- Can be optimized for individual customer’s requirements
- Ready for service – ballistic match to PGU-27 and PGU-28/B, existing ignition system and no impact to aircraft operating systems (e.g. software) or handling equipment

PELE® is an ideal form-fit-function tactical solution.
Acknowledgements

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• Mr. Dan Delaney, ATK Medium Caliber Systems
• Mr. Duane Bjorlin, ATK Medium Caliber Systems
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