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Gun and Missile Systems Symposium
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DIEHL
BGT Defence

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

Don Gloude, 20mm Design Engineer
ATK Medium Caliber Systems

Mark Weron, 20mm Program Engineer
Hill AFB

Bradley with M242, 25mm



LW25mm Bushmaster



Medium Caliber Ammunition



M230 Chain Gun



- **Cartridge Concept Overview**
- **OT&E Ground-to Ground Test Plan**
- **Test Performance**
- **Conclusion**
- **Acknowledgements/Contacts**
- **Questions & Answers**

- 1997 – 1999** **Feasibility Studies and Proof of Principle of PELE[®] Technology**
- 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**

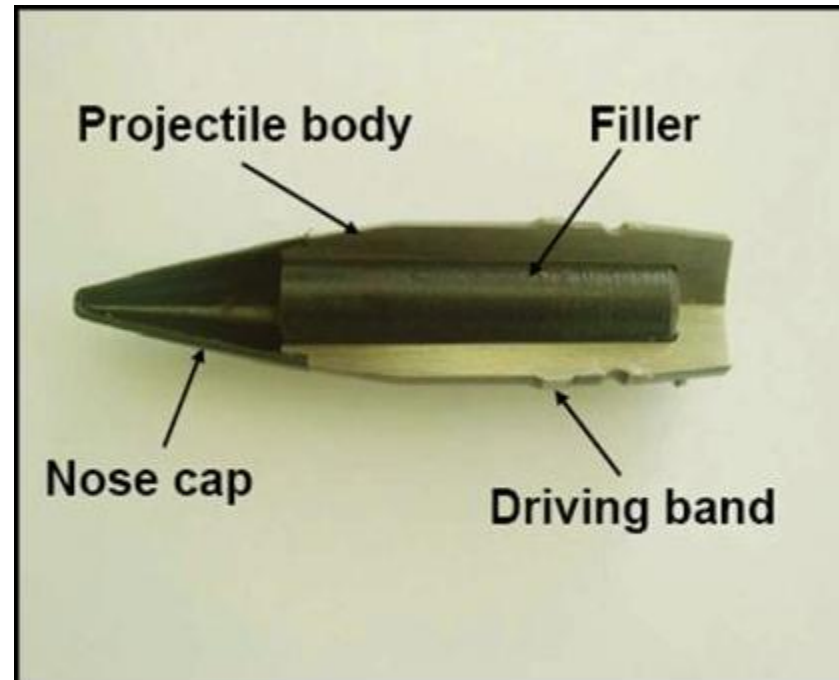
Ammunition 20 mm x 102 mm PELE[®]



PELE



PGU-28



20 mm PELE[®] Design Characteristics



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Length (max):	168 mm
Weight:	264 g
Projectile Mass:	100 g
Muzzle Velocity:	3410 f/s
Accuracy:	Average Mean Radius = 15 in. at 500 yds
Penetration:	Ballistic limit < 2750 f/s against 0.375 in. (9.5mm) armor at 0°
Ballistics:	Comparable to PGU 28A/B or PGU 27A/B
Design:	Low drag version

Key Features of PELE[®] Cartridge



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- **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



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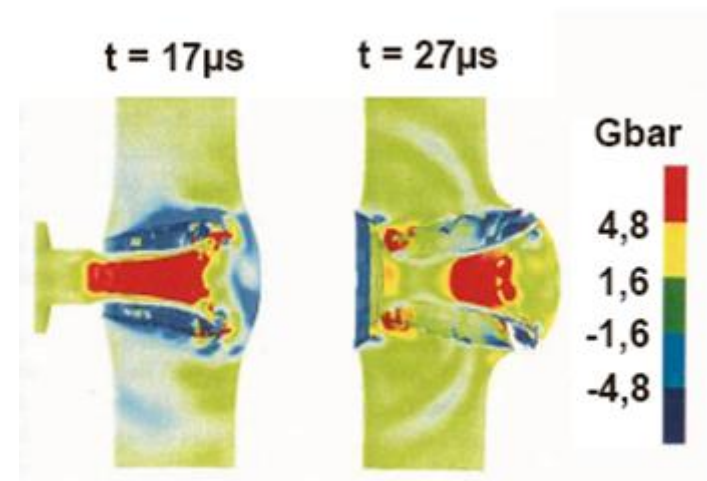


Projectile Body: High density material (steel or tungsten)

Inner Core: Low density material (plastic or aluminum)

Steel or tungsten penetrates the target

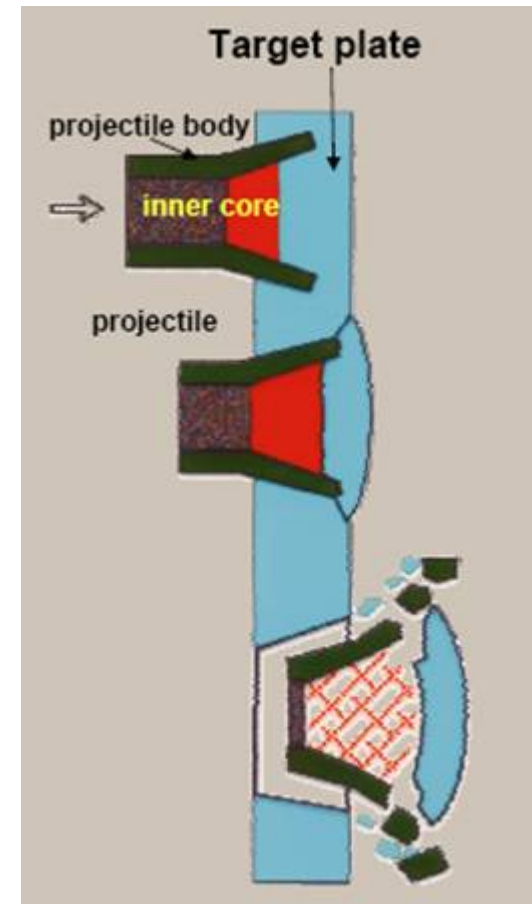
Plastic or aluminum does not penetrate the target



Pressure distribution on penetrator

Simple Design ...

- **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**

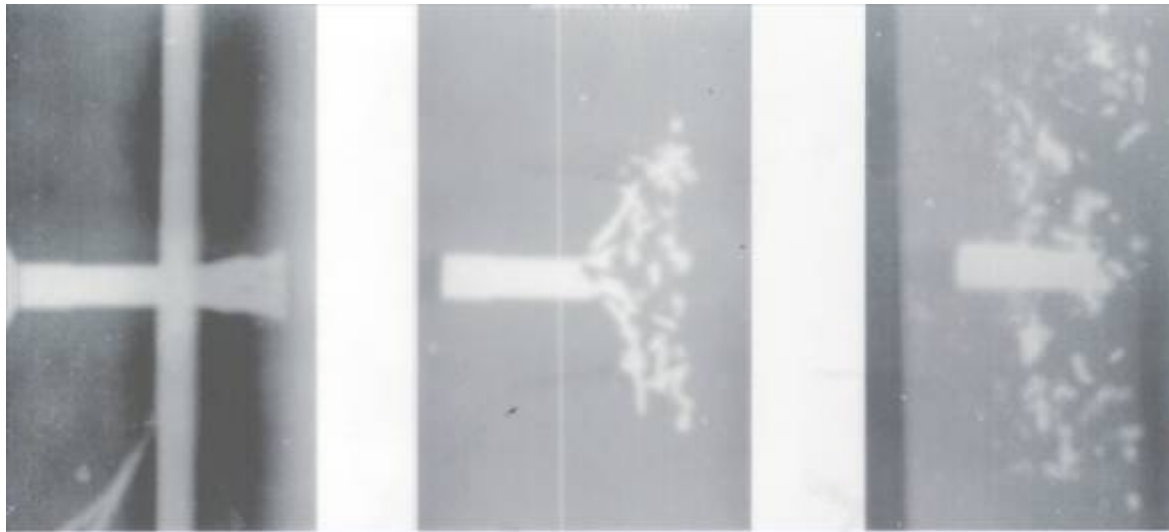


... Yet Effective.

Fragmentation of PELE[®] Projectile

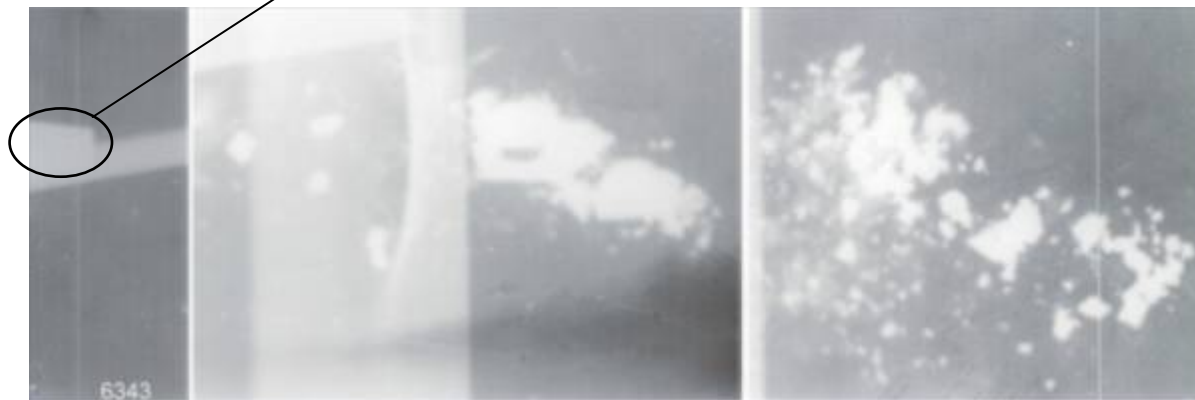


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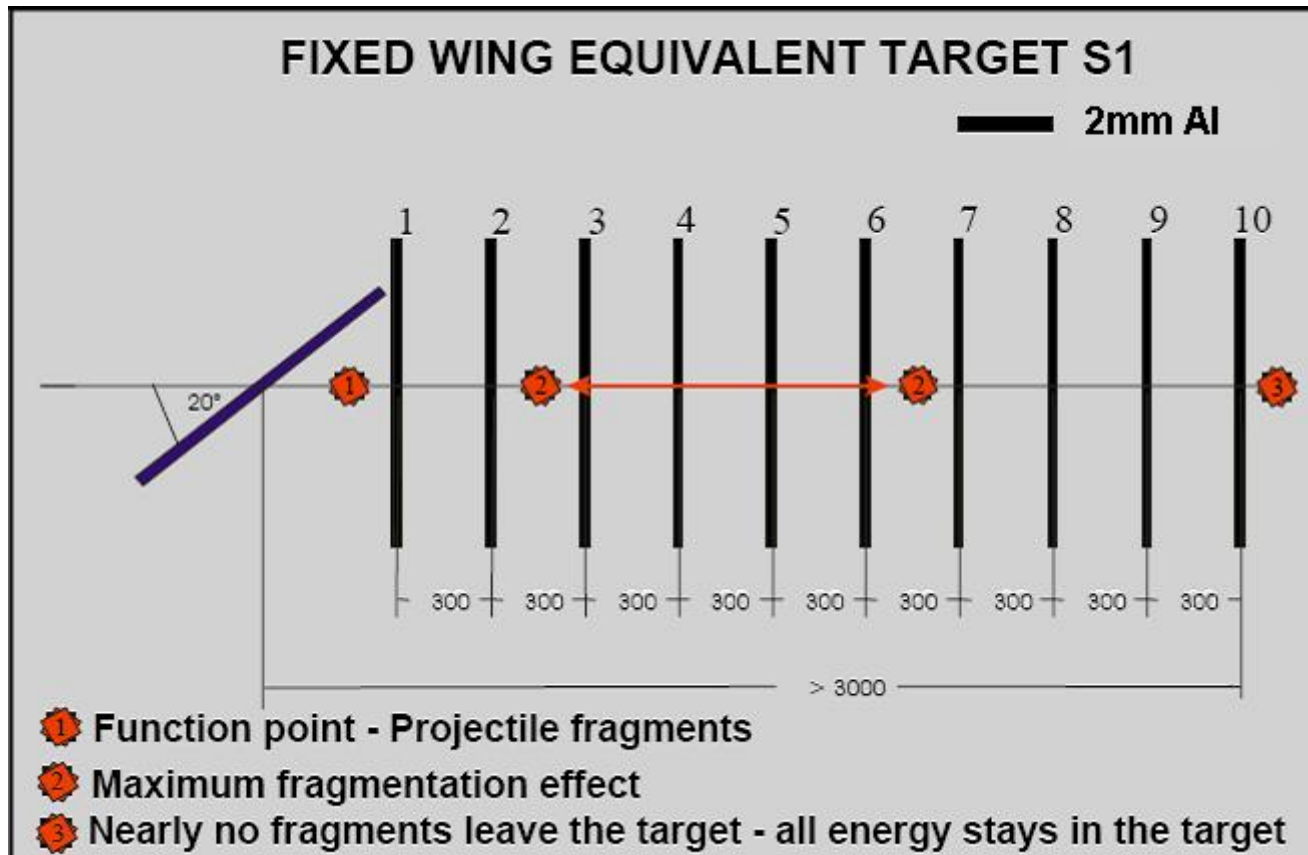
Target: 2 mm Al / 0° NATO
Impact Velocity: 750 m/s

Projectile



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

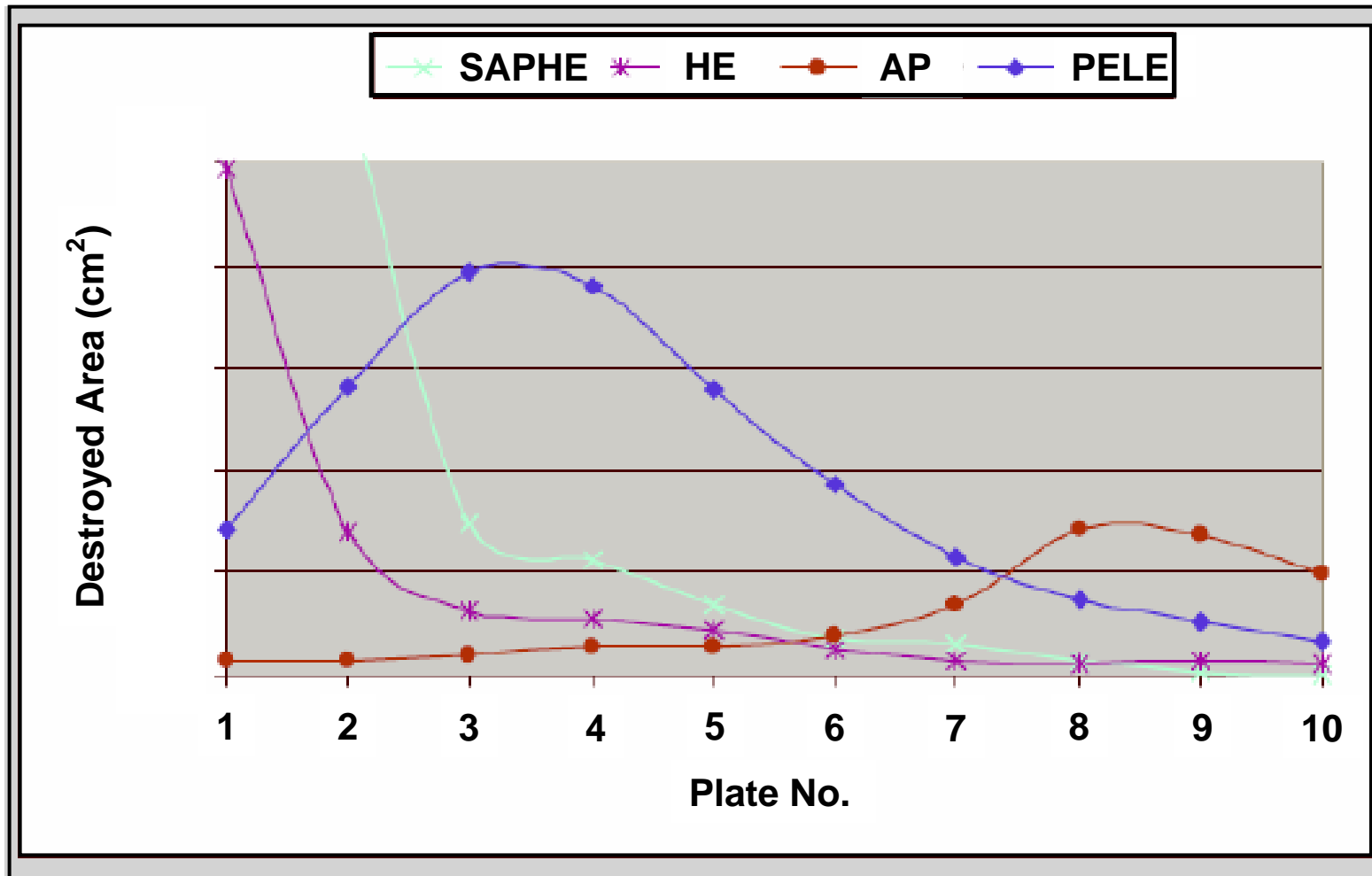
X-ray images of function



PELE[®] Performance vs Other Combat Ammo



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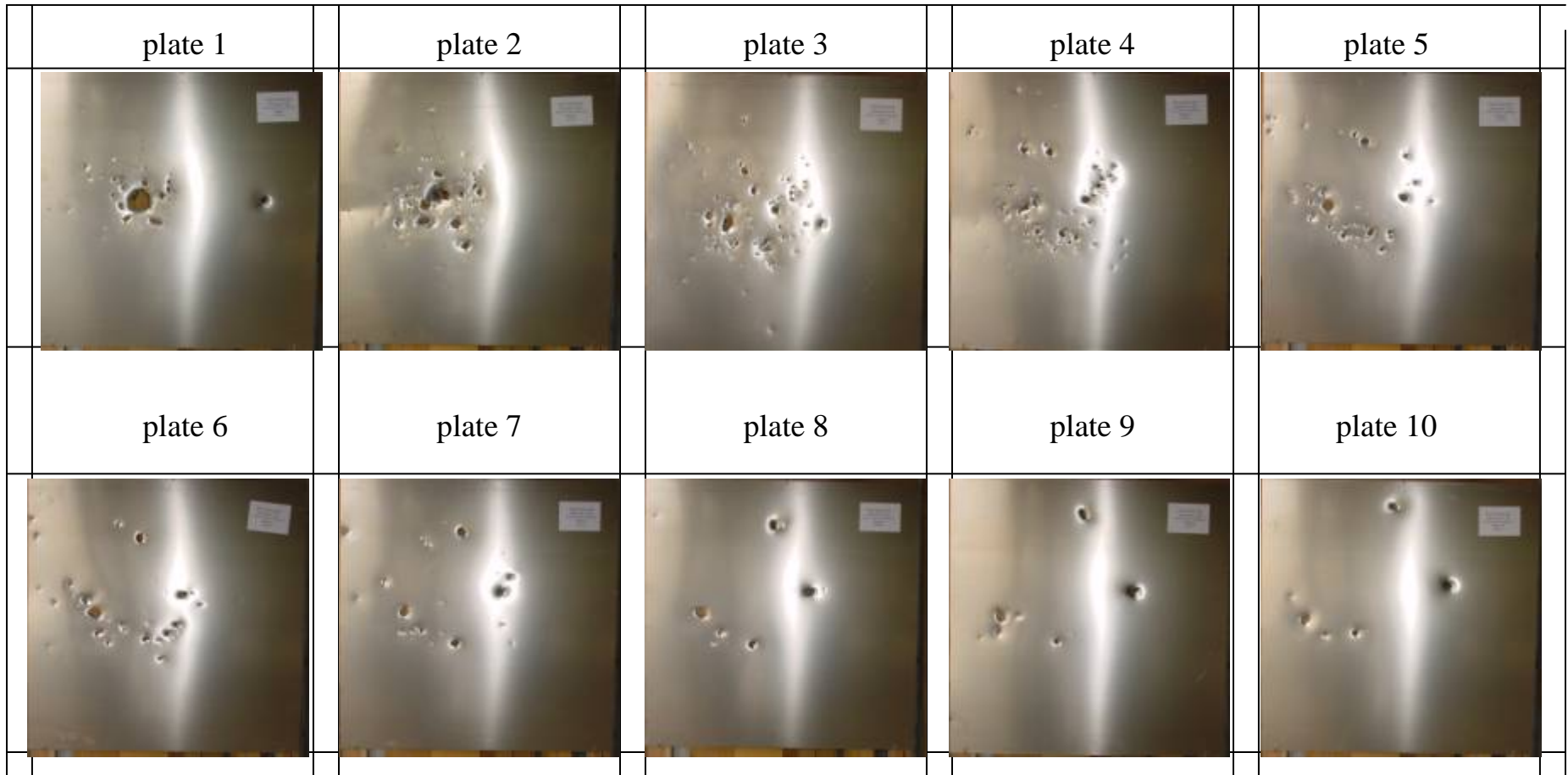


PELE[®] Delivers More Energy in the Target Compared to Other Tactical Ammunition

PELE[®] Performance on Multi-Plate Array



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

Few fragments leave the target – all the energy stays in the target.

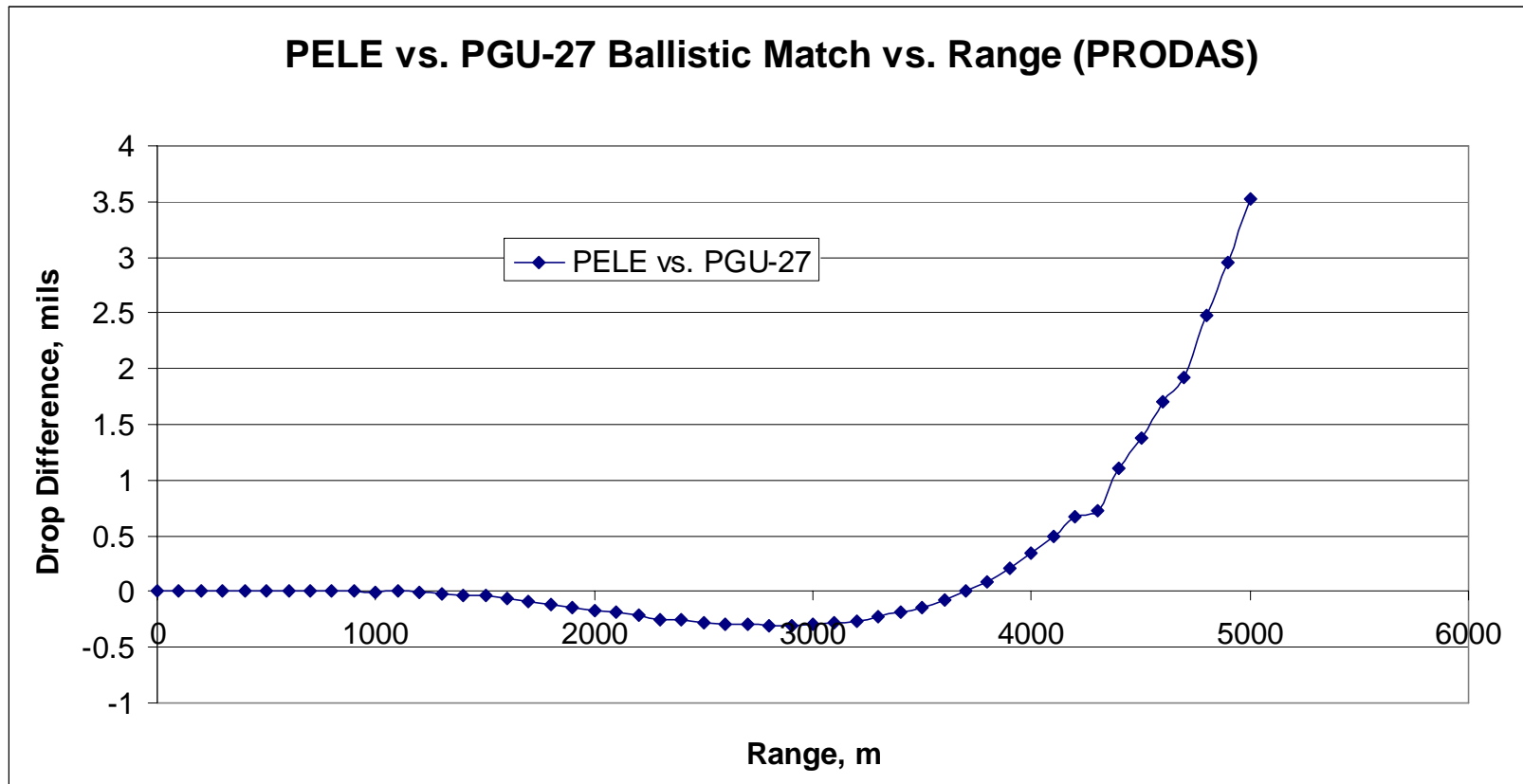


PELE[®] able to penetrate 10 mm Rolled Homogeneous Armor (RHA)

PELE[®] vs PGU-27 Ballistic Match



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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



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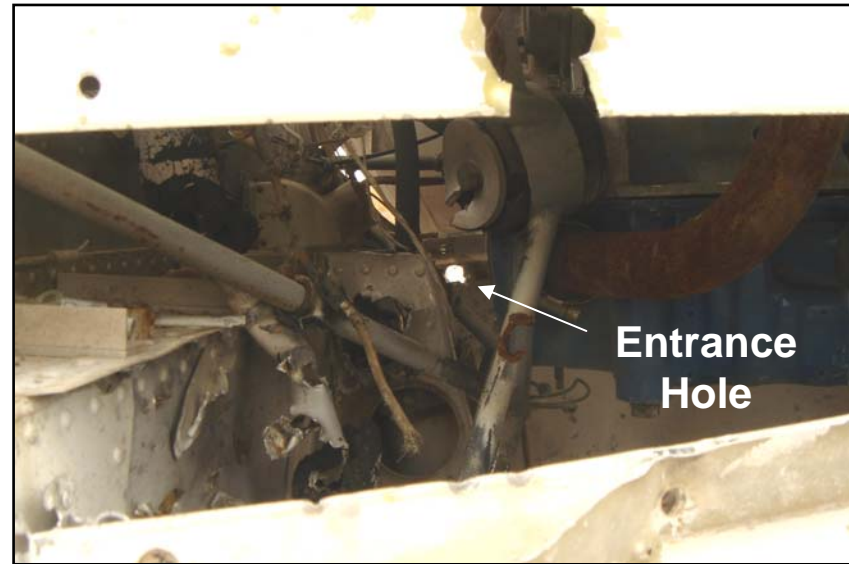
Target Set	1 Cessna Cardinal 1 Pilot / 1 Co-pilot 2 Passengers
PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s)	3444.9 / 3169.23
PRODAS Ground- Ground Target Location (ft)	535



Cessna Cardinal Test Damage



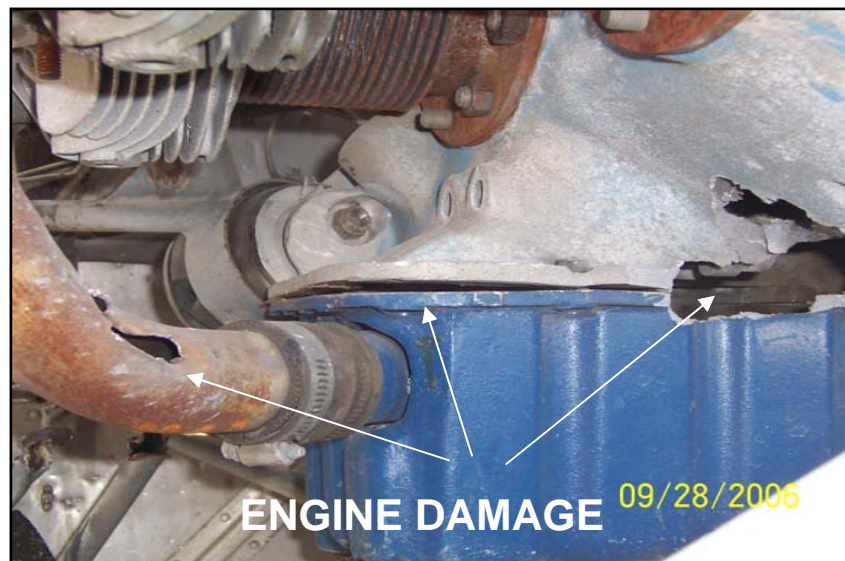
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Cessna Cardinal Test Damage



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F-16/C-130 Wing Section Test Set-up



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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



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C-130 Wing / 'Troop' Damage



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**Residual Fuel
in Wing Foam
Burning**



F-16 Tail Section Test



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Target Set	1 F-16 Tail w/ 3 dummies
PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s)	3444.9 / 2978.13
PRODAS Ground-Ground Target Location (ft)	915

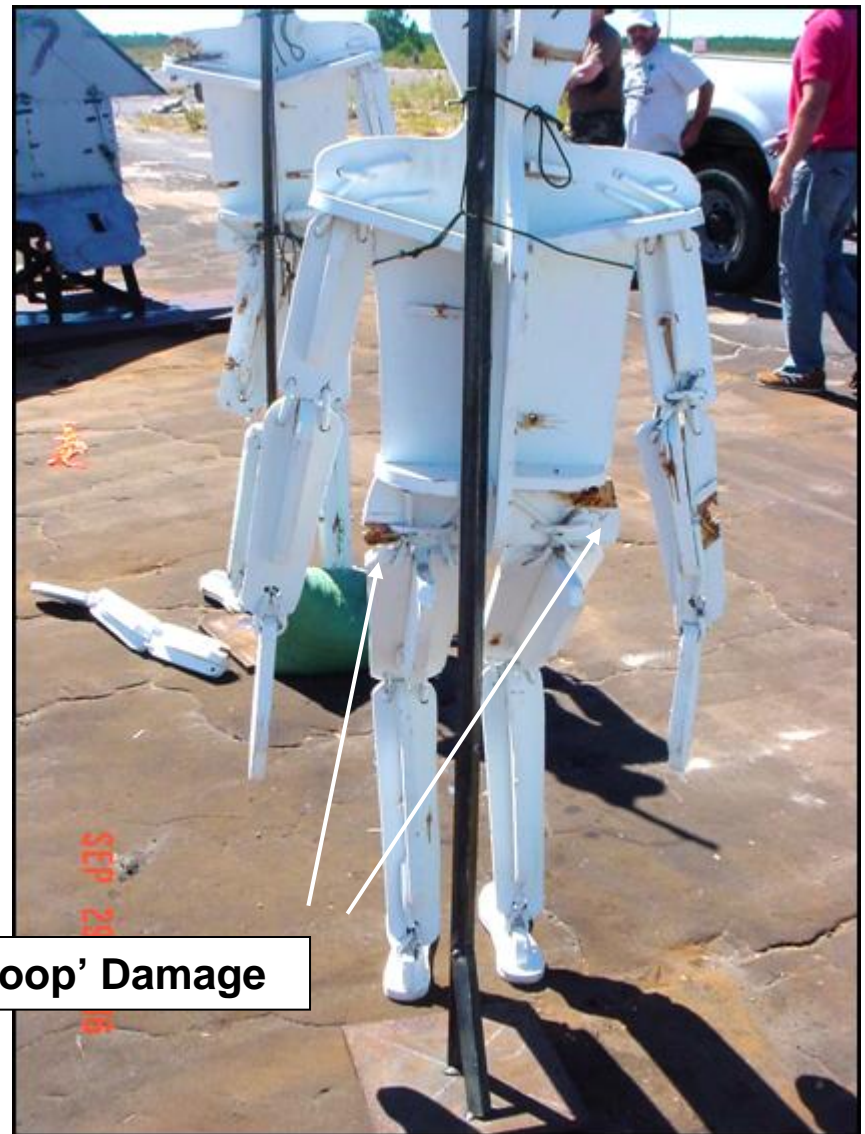


Significant damage to exit surface with composite skins.

F-16 Tail Section Test



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M577 APC Test Set-ups



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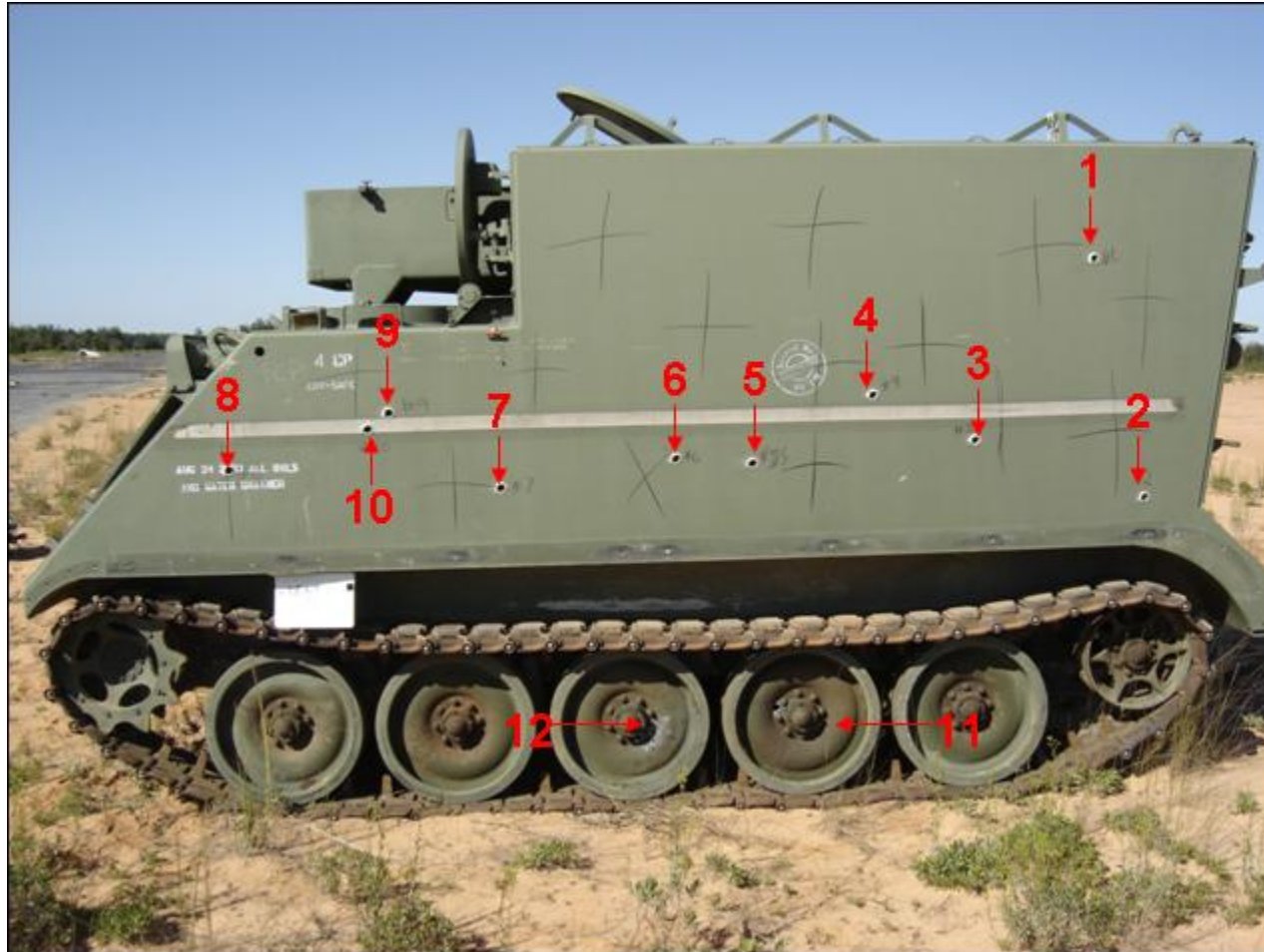
Target Set	1 M577 APC w/ 5 passengers 6 dummies in hasty cover
PRODAS Muzzle / Impact Velocity (ft/s)	3444.9 / 2808.94 2460.36
PRODAS Ground-Ground Target Location (ft)	1210 2000



M577 APC Test Damage



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20mm PELE[®] is effective against light armor.

M577 APC Test Damage



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**'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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Projectile Type	Muzzle Velocity (ft/s)	Impact Velocity (ft/s)	Impact Range (ft)
PELE [®]	3388.406	2472.430	1966.881
	3429.776	2505.556	1968.057
PGU-27A/B	3405.015	2432.786	1968.880
	3402.988	2405.282	2021.135
	3424.768	2347.559	2212.883
	3412.408	2253.949	2359.837
	3418.592	2435.984	1965.469
	3415.898	2426.698	1972.231



PELE[®] penetrates vs PGU-27

Light Truck Test Set-ups



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Target Set	2 Light Utility trucks w/ passengers 6 dummies in hasty cover
PRODAS Muzzle / Impact Velocity @ 1000 ft SR (ft/s)	3444.9 / 2460.36 1262.07
PRODAS Ground- Ground Target Location (ft)	2000 5000



Light Truck Test 'Troop' Damage



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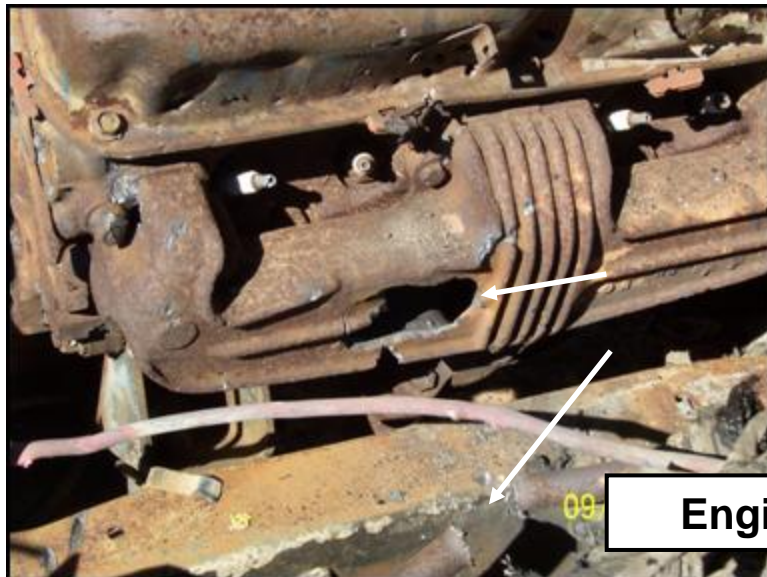
Light Truck Test Damage



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



Engine Damage



- **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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- **Diehl BGT Defence GmbH & Co.**
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- **Mr. Larry Douma, ATK Medium Caliber Systems**
- **Mr. Dan Delaney, ATK Medium Caliber Systems**
- **Mr. Duane Bjorlin, ATK Medium Caliber Systems**

Contacts



An advanced weapon and space systems company



Bob Schmitz (ATK 20mm Program Manager)

(763) 712-7724

Bob.schmitz@atk.com

Don Gloude (ATK 20mm Design Engineer)

(763) 712-7710

don.gloude@atk.com

Rodney Ward (ATK Medium Caliber Systems Business Development)

(480) 324-8608

Rodney.ward@atk.com

Mark Weron (Program Engineer - Hill AFB)

(801) 777-7803

Mark.Weron@Hill.af.mil