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LW30mm (30 x 113mm) Spotter Charge Prototype

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APPROVED FOR PUBLIC RELEASE – OSR# 08-S-1194
- Background and Need
- Technical Approach
- ATK Testing
- Testing at Ft. Rucker
- Acknowledgements/Contacts
- Questions & Answers
LW30 Ammunition – 30mm X 113mm

M789 HEDP
- High Explosive Dual Purpose

Length (max): 113 mm
Weight: 343 g
Projectile Mass: 234 g
Muzzle Velocity: 805 m/s
Max Range: ~ 3000 m
Dispersion: 1.35 mils

M788 TP
- Training Projectile matched to M789

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M230 Weapon System

30mm M230 Chain Gun Automatic Cannon

- **Caliber**: 30mm X 113mm - LW30 Linkless
- **Max Range**: ~ 4000 meters
- **Rate of Fire**: 625 ± 25 Shots per Minute

- **Platforms**:
  - AH-64 / AH64A Apache Attack Helicopters
  - MH-60 Variants - SOAR

- **Targets**:
  - Light Armored Vehicles
  - Deployed Infantry
The anticipated timeframe of demonstration is in the September-October 2007 timeframe, the demonstration will last approximately 3 days. The desired performance of a 30mm TP-spotter is for the projectile to have an impact signature which is:

1. Visible day and night unaided human eye.
2. Visible through the Apache FLIR.
3. Visible through night vision goggles.
4. Ballistic trajectory similar to the M788 cartridge.
5. Non-hazardous to personnel and unarmored vehicles if it does not function as intended (e.g. dud)

The technology demonstration is intended to demonstrate items 1-3 for crews in Apache helicopters while in flight from ranges up to 3000m. Items 4 & 5 should be considered but demonstrating these attributes is not necessary for this spotter technology demonstration. It must be noted that this is not a "traced" cartridge, but a cartridge with a visible signature only upon impact with a target. A ground or tower mounted 30mm cannon will be used for the demonstration. Demonstrations of the 30mm ammunition will be fired from this stationary weapon while being observed from helicopter(s) in positions closely related to training scenarios.

Helicopter(s), flight crews, weapon, test equipment, test facilities and test personnel will be provided by the US Army OPM-TMAS, the US Army Aviation War-fighting Center, the US Army Armament Research Development and Engineering Center (ARDEC). This contractor participation in the demonstration. Participating contractors will be required to provide a sample of 200 TP-spotter cartridges delivered to Ft. Rucker, AL at by the end of August 2007. The Contractors will be responsible for obtaining shipping hazard classification for the ammunition. Contractors will be required to supply ammunition design details sufficient to obtain safety clearance at the test site. It is expected that the contractor(s) participating in the demonstration will provide the above ammunition at no cost to the Government.

**Visibility requirements:**

- "...Visible 0 to 3000m"
- **Day - Unaided eye, FLIR, DTV**
- **Night - Unaided eye, FLIR, NV goggles**

**Target media**

- "...packed soil, cement, 3/4 plywood, hard metal targets,....."

- **Ammunition should be non-dud producing**
- **Expected to be a NDI (Non-Developmental Item) solution**
- **Demonstration testing to be conducted at Ft. Rucker late ’07 timeframe**

Customer includes:

- Ft. Rucker – Army Aviation Training Center/ Training and Doctrine Command (TRADOC) TCM (Trado Capabilities Manager)
- US Army Office of the Project Manager Maneuver Ammunition Systems (OPM-MAS)
- Armament Research, Development and Engineering Center (ARDEC)
LW30mm Spotter Charge IRD – Schedule Challenge

Approx. 8 month schedule from Concept Definition to Gov’t Demo

Phase 1 – Preliminary Design (Test 2457)

Phase 2 – Detailed Design (Test 2465)

Phase 3 – Build and Test (Ft. Rucker Demo)
LW30 Spotter Charge – ATK Team

ATK Medium Caliber Systems (Ammunition & Gun Design, Chem/Met Lab)

ATPГ (Load, Test and Evaluation)

ATK Launch Systems (Spotter Material / Candidate Selection)

ATK Tactical Propulsion and Controls (ABL) ( Projectile Hardware)

ATK – Advanced Weapons (CTH modeling, ANSYS, Rapid Prototype)

Ammunition Systems – Radford (Cartridge Hardware)
Impact velocity and target media are key parameters for Spotter Design.
Material Selection – Approach

- **Technical:**
  - Approach driven by the desired capability requirements
  - Key challenges: Spotter material sensitivity against soft ground target and reaction against plywood

- **Schedule**
  - “Off the shelf” material currently in use at ATK-LS
  - Castable material due to time constraints of load tooling and integration with projectile geometry changes

- **Selection**
  - Identified 3 initial material candidates to be evaluated in ballistic capability testing
  - Down selected to most viable materials for highest probability of success on target media

<table>
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<tr>
<th>ID</th>
<th>Description</th>
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| X-9 | Magnesium powder  
|     | Strontium Nitrate (Red marker)  
|     | ATK-LS proprietary binder |
| X-5 | ATK-LS proprietary Flare formulation  
|     | Potassium perchlorate |
| X-8 | Magnesium powder  
|     | Sodium Nitrate (White marker)  
|     | ATK-LS proprietary binder |
To address the aggressive schedule for demonstration, existing M788 or M789 projectile hardware will be used or altered to accommodate spotter material cast loading.

Spotter Charge Projectile Assy Configurations –Phase 1

Spotter Material in Projectile Body & Nose Assembly

Spotter Material in & Nose only

As-mixed

Dispensing gun into Projectiles
An advanced weapon and space systems company

PRODAS Modeling for Ballistic Match to M788/M789

Baseline M789 Model in PRODAS Library

Baseline M788 Model in PRODAS Library

Initial LW30 Spotter Charge Model

**Trajectory at 3000m short for same QE and 805 m/s muzzle velocity; increase MV to attain match for spotter to 3000m**

PRODAS Trajectory Comparison for 1500m & 3000m
- 1500m: QE 31.4 Gunners Mils
- 3000m: QE 148.8 Gunners Mils

**M788 / M789 Projectile**
- Mass 234 grams typical

**Spotter Charge**
- Prototype Projectile
- Mass ~222 grams
PRODAS modeling used to establish muzzle velocity needed to attain match to 1500m and 3000m.

For same QE set for M788, trajectory of spotter if targeting same muzzle velocity

M788 at Standard temp conditions, QE#1

Spotter at Standard temp conditions, same QE#1, increased Muzzle Velocity
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ANSYS Stress Analysis for Ogive

Von Mises Stress (psi)  
Max. Principal Stress (psi)  
Max. Shear Stress (psi)  
Plastic Equiv. Strain

Ogive wall thickness will survive gun launch loads

C

L

Initial Geometry

73.834
8333
16592
24850
33109
41368
49627
57886
66145
74403
-5098
4090
13278
22465
31653
40841
50029
59217
68405
77592
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4467
8895
13322
17749
22176
26603
31031
35458
39885
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0.005234
0.007851
0.010468
0.013085
0.015702
0.018319
0.020936
0.023553

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Ground Impact – Trajectory Plots
1500m / 2000m / 3000m – Gun at 0 vs. Altitude

Firing from Altitude

Firing at Ground Elevation (Ft. Rucker Demo)

Angle of impact at 3000m similar for both ground and altitude firing scenarios

Shallow Angle of impact at 1500m for ground firing
CTH Modeling of Ground Impact – 1500m

1500m test at Ft. Rucker fired from ground-mount will produce shallow angle of impact that will make it difficult to initiate spotter fill.
Increased angle of impact at 3000m may provide increased shear or thermal stress upon impact; however the impact velocity is reduced.
2000m Test Range at ATPG

Aerial View
Source: Google Earth

View from high-speed camera to target

Target Area

2000m Gun Pad
ATPG Test Setup Photos – Gun to Target

500m Gun Firing Position Viewpoint

LW30mm Spotter Charge IR&D
M788 TP Drift vs. Range - PRODAS Eval for Cross-Wind
Firing at 2000m vs 16’ wide RHA plate

2000m Observation Viewpoint

PRODAS Modeling for cross-winds showed risk for missing test target at 2000m; therefore conducted initial capability testing at 500m
ATPG High Speed Video – 500m testing against steel target

Serial Number: n/a
HEDP baseline/ Cart
Lot NRE07B001S908
9/4/07 (Frame 150)

Serial Number: 2-101-1
Material:X5
Projectile Config: Nose only
9/4/07 (Frame 100)

Serial Number: 2-102-1
Material:X-8
Projectile Config: Nose only
9/4/07 (Frame 140)

Serial Number: 2-103-1
Material:X-9
Projectile Config: Nose only
9/4/07 (Frame 50)
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<td>6-103-2</td>
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• These 2 tests were conducted at 500m with full propellant load and show reaction on plywood in high-speed video, but not visible to unaided eye at gun (500m).

• When fired at 500m with 40% propellant load (simulating 1500m impact) there was no reaction seen on high speed video.
## Demonstration Test Plan – Example of 27-Round test block

**Total of 170 cartridges shipped for Demo**

<table>
<thead>
<tr>
<th>Day or Night</th>
<th>Firing Distance</th>
<th>Viewing Distance</th>
<th>Apache Gunner View</th>
<th>Apache Pilot View</th>
<th>Target</th>
<th>ATK Projectile Config</th>
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**3 Target Types**

**3 viewing scenarios**

**1500 & 3000m firing range**

**Day & Night firing**
LW30 Spotter Charge - Ft. Rucker Demonstration Test Setup

Source: Google Earth

Fixed Gun Pad Location

Apache viewing

Control tower

1500 m

1500 m Target Area

3000 m

3000 m Target Area

Apache

Target Area

Target Area

Control tower

Source: Google Earth
Recon Optical's RAVEN R-400 is used for common remotely operated weapon station (CROWS) program.
Example of Steel Impact – Day and Night Testing

Day Testing

Camera #54

Night Testing

Camera #54
A prototype spotter charge for the 30x113mm LW30mm Ammunition family was evaluated against multiple target media and ranges of trajectory.

Modeling tools were used for analysis of mass properties, aeroballistic performance, stress analysis and impact thermal stress.

- PRODAS modeling provided ballistic match that was verified with radar tracking in ATK test.
- CTH hydrocode modeling indicated that predicted reaction of spotter material on ground impact would be marginal depending on impact angle and velocity.
- ANSYS stress analysis modeling provided design safety that was verified in structural integrity ballistic tests.

Demonstration testing conducted at Ft. Rucker tracked with the results from ATK testing:

- Reliable visible reaction when impacting Steel target, day and night at 1500m, and night at 3000m. Day impact at 3000 not available.
- Impact on Plywood target showed delay reaction behind target; at times was evident and scored by pilot as sufficiently visible allowing for adjustment. More evident at night.
- Limited frequency / Marginal short duration visible day / night when impacting ground at 1500m.
- 3000m testing did not reliably impact visible target area due to drift from cross winds (PRODAS)

Further development efforts on hold pending government evaluation of the demonstration testing and updated User need assessment.
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Rick Tanner
Steve Glaittli

ATK – ABL
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ATK – AW
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Dave Darden

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