Development of the Interceptor System for the Extended Area Protection & Survivability (EAPS) Gun System

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EAPS Tactical Concept “Demo Configuration”

1. Primer
   M115 percussion primer
   Black powder flashtube
2. 328mm steel cartridge case
3. Nitrochemie ECL propellant
4. Aluminum 6 vane fin
5. 7068-T6 aluminum aft-body
6. Nylon obturator
7. Nylon rotating band
8. Set-back initiated battery
9. Electronics package
   TA transceiver
   ATK fuze electronics
10. Course correction divert thruster
11. ATK safe and arm device
12. Warhead
   4340 Steel body
   140g PAX-2A HE charge
   PBXN-5 booster
   Tantalum-tungsten 12 MEFP liner
13. Aluminum spiked nose
Application of Technology and Scientific/Engineering Principles

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50mm System Study

Projectile Configuration Study

M&S Design Loop

Test Data

Detailed Modeling & Analysis

Zone 1 | Zone 2 | Zone 3

MEFP Data

Flight Data

MEFP Data
Projectile Design – Lessons Learned

- **Initial Ballistic Simulator Testing (100A)**
  - Four resulted in fin separation and windscreen damage (Typical example of X-ray shown, BS-001)
  - All showed evidence of obturation blow-by.
    » Down-bore video shows light leakage early on
    » Recovered band shows soot on exterior

Early Test Iterations Identified Design Challenges
Baseline Fin Boom Interface (section)

Swept Fin EAPS50015

Loctite Only

Aft Body, BS 28077509

Initial Testing Exhibited Tensile Shear Failures
Free Body Diagrams

Intuition: Increase Joint Strength  →  Analysis: Improve Assembly Process

Interior Ballistic Forces

Interior Ballistic Forces

Seal Hub Forces

Effective Hub Area

“Leaky” Hub Forces

Effective Hub Area

P*A_{HS}

M_{F/T} \times a

P*A_{HL}

M_{F/T} \times a

General P*A

M_B \times a

M_{F/T} \times a

P*A
Analysis of Boom Failure: Compressive vs. Tensile

**Forces acting on body**
- Pulling Force: \( M_{F/T} \cdot a \)
- Pushing Force: \( P \cdot A_H \)

- \( A_{min} \) = minimum diameter of supporting structure (assumes thread are adequate)
- \( M_{F/T} \) = Mass of Fin and Thread Spud
- \( P \) = Base Pressure
- \( A_H \) = Unbalanced Hub Area upon which pressure acts

For GP002
- \( M_{F/T} \cdot a \approx 0.093 \text{ kg} \cdot 39000 \text{ G’s} \cdot 9.8 \text{ m/s}^2 = 35,500 \text{ N} \)
- \( P \cdot A_H \)
  - Unsealed \( \approx 328 \text{ N/mm}^2 \cdot 47.78 \text{ mm}^2 = 15,700 \text{ N} \)  **Tension**  
  - Sealed \( \approx 328 \text{ N/mm}^2 \cdot 188.7 \text{ mm}^2 = 61,900 \text{ N} \)  **Compression**

Hoop Stress will reduce Compressive Margin, but based on FEA, not enough to cause a problem.

**Epoxy seal on fin joint sufficient to solve fin/boom failures**
Pressure & Muzzle Velocity

Test 100B
Propellant Sampling

Slow (FM4022)
Fast 1 (FM4033/21)
Fast 2 (FM4033/22)
Fast 3 (FM4034/22)

Test 100C
• New Formulation
• Charge Establishment
• Charge Verification

Avg. Pressure = 446 Mpa (65Kpsi)
Pressure St Dev = 15.6 Mpa (3.5%)
• Avg. Velocity = 987 m/s
• Velocity St Dev = 4.5 m/s

94% of Tactical Solution.
Remainder to be Achieved Through Future Optimization

10% Velocity Improvement on Conventional Propellant
Antenna Characterization Testing

Antenna Mounted on Near-Field Test Fixture in MRC Anechoic Chamber

Initial Testing Verified Significant Margin Under Most Conditions.
Excellent Directionality.

Measured Polar Plot at 0° Elevation and 15.950 GHz

Gain > +8 dBi at boresight
Requirement: Gain ≥ +6 dBi
VSWR < 1.6:1 over 15.7 – 16.2 GHz
Requirement: VSWR ≤ 2:1
Telemetry Data

X-cvr Boards

TR #25 – TM #005- XCVR #27 – High QE

- High rate of frame transmission/reception and tracking fidelity out to impact at 2200m
Warhead Development Summary

MEFP Lethal Against Rocket/Artillery/Mortar Threats
Accomplishments – Achieved Program Objectives

EAPS Development Testing:

✓ EAPS Projectile Gun Launch, Interior Ballistic, and Exterior Ballistic Feasibilities.
✓ Incorporate Advanced Propulsion (+10% Vm)
✓ Command Divert of a Course Correct Projectile.
✓ MEFP Warhead Static & Commanded Dynamic Functionality.

EAPS Concept Demonstrations:

✓ ATS Radar Integration for Tracking & Communication
✓ 50mm Lethality Flight Demonstration (“A” Round)
✓ 50mm Course Correction Flight Demonstration (“B” Round)
✓ Prototype EAPS 50mm Automatic Cannon on Hardstand Mount

Exceeded Goals:

✓ Demonstrated Integrated End-to-End Tactical Functionality in Single Cartridge
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