

Precision Guidance Kit (PGK)

Lyle H Johnson, PhD
System Analysis
Armament Systems

Lyle.Johnson@atk.com
May 15, 2012

Approved for Public Release, PAO #20-12, 22 CFR 125.4(b)(13) applicable



PGK Concept Description

Challenges in Developing PGK

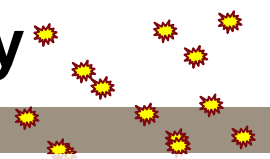
- Packaging
- Physics
- Do More without More

Results

POC information

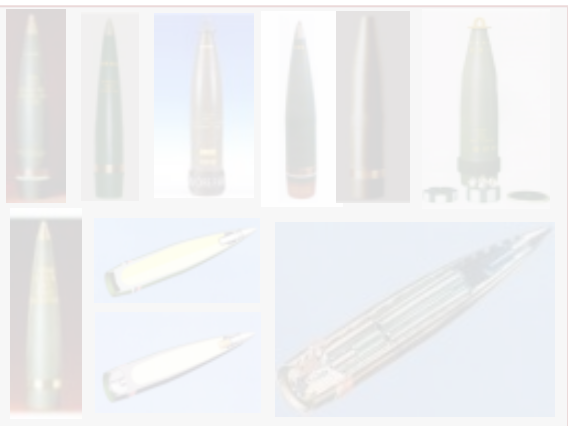


Legacy Artillery Capability and Inventory



**50m Threshold, 30m Objective
CEP at max range**

- Reduced Dispersion
- Improved Efficiency
- Greater Effectiveness



M777A2 (LW155)

M99A6 Paladin

M198 Towed

FH77BW Archer

Braveheart

AESAR



Replace standard fuze with GPS guidance kit

- Desire compatibility with all current US artillery inventory
- Significantly increase accuracy of current conventional artillery rounds
- Maintain current fuzing functions



Insert Guidance
Fuze Here

Requirement: Meet accuracy requirement of 50m (T) / 30m (O) CEP

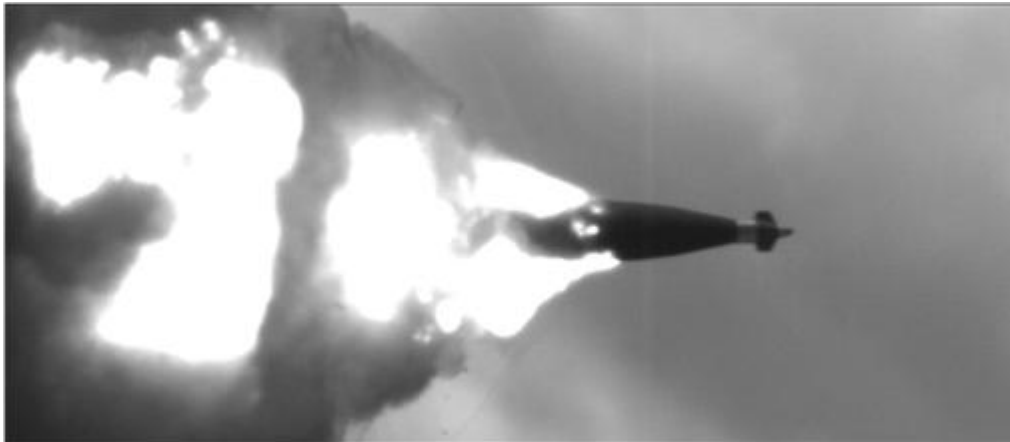
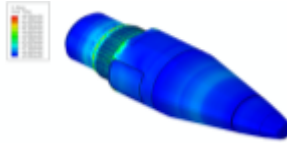
- CEP (Circular Error Probable – radius of a circle centered at the target that contains one-half (1/2) of the projectiles fired

Packaging – Primary Challenge for PGK



Packaging Drivers

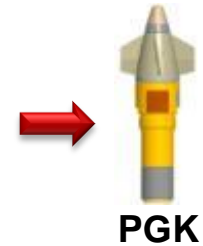
- Structural Survivability
 - Maximize Packaging Volume
- Electrical Design – Power Management
 - Extensive Use of Simulation
- DFA/DFM
 - Reduce Size & Maintain Producibility



And Then We Do This!

Complexity Comparison

Approx 100 Parts
30 Metal Parts, 25 Plastic Parts
~50 Electronics Boards/Assy's



**LG WM2233HD Front Load
Washing Machine with SenseClean
System for intelligent fabric care**

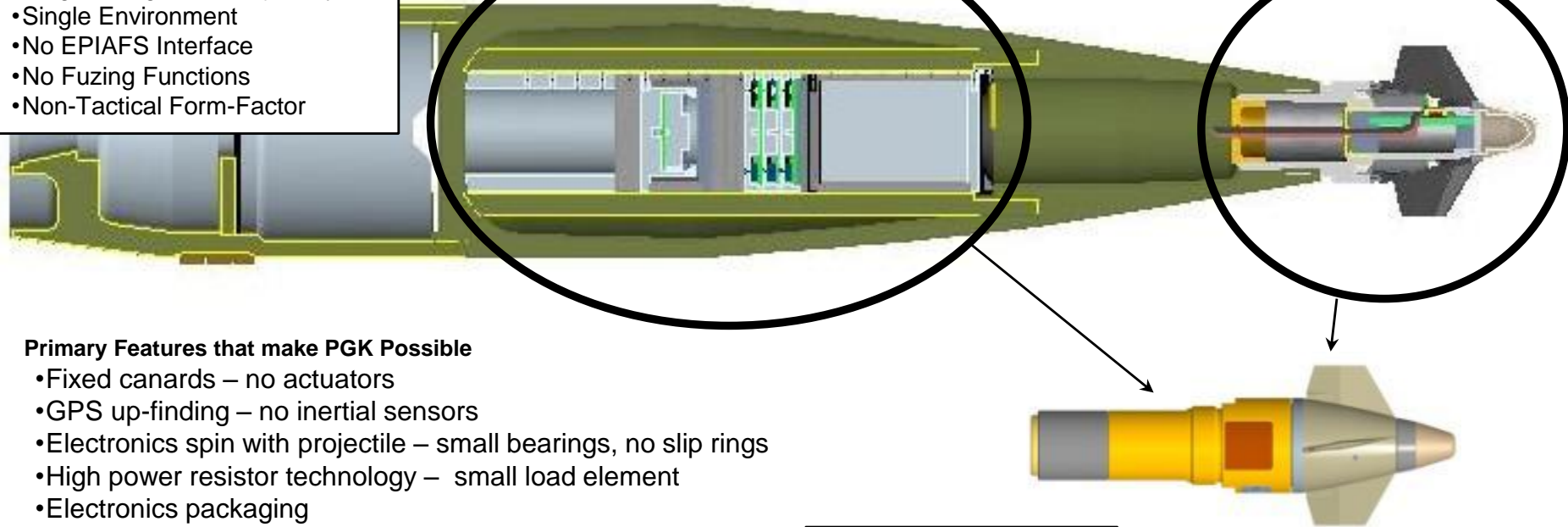


Packaging – Primary Challenge for PGK



TD Phase

- Single Projectile (M549)
- Single Range and Trajectory
- Single Environment
- No EPIAFS Interface
- No Fuzing Functions
- Non-Tactical Form-Factor



Primary Features that make PGK Possible

- Fixed canards – no actuators
- GPS up-finding – no inertial sensors
- Electronics spin with projectile – small bearings, no slip rings
- High power resistor technology – small load element
- Electronics packaging

Other Unique Features

- Super capacitor and alternator power – no battery required
- Innovative and simple G&C algorithms
- Small GPS Receiver with very fast acquisition
- Small patch GPS Antenna
- Built-in telemetry function

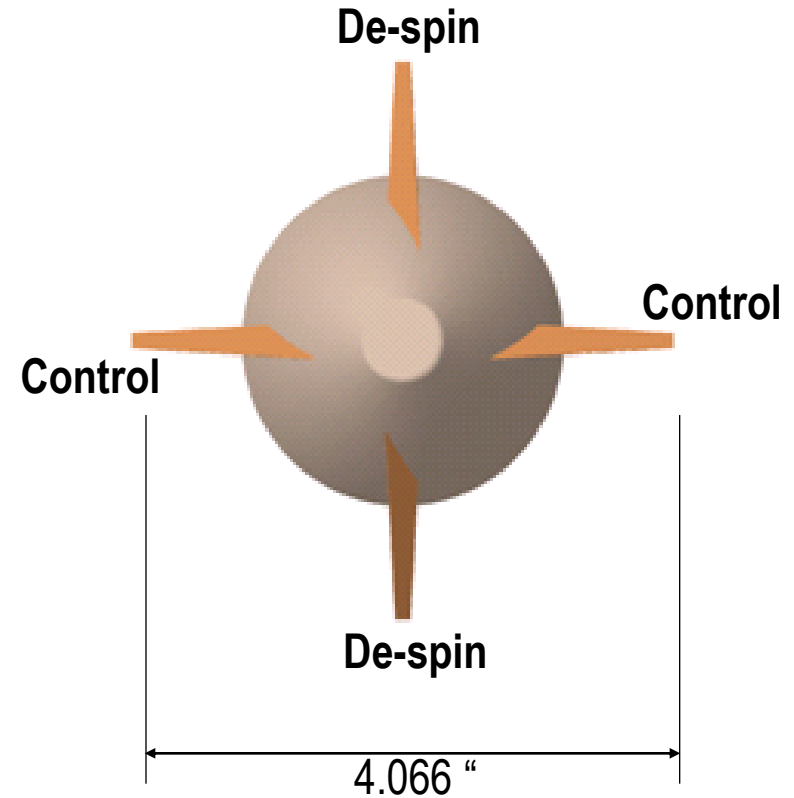
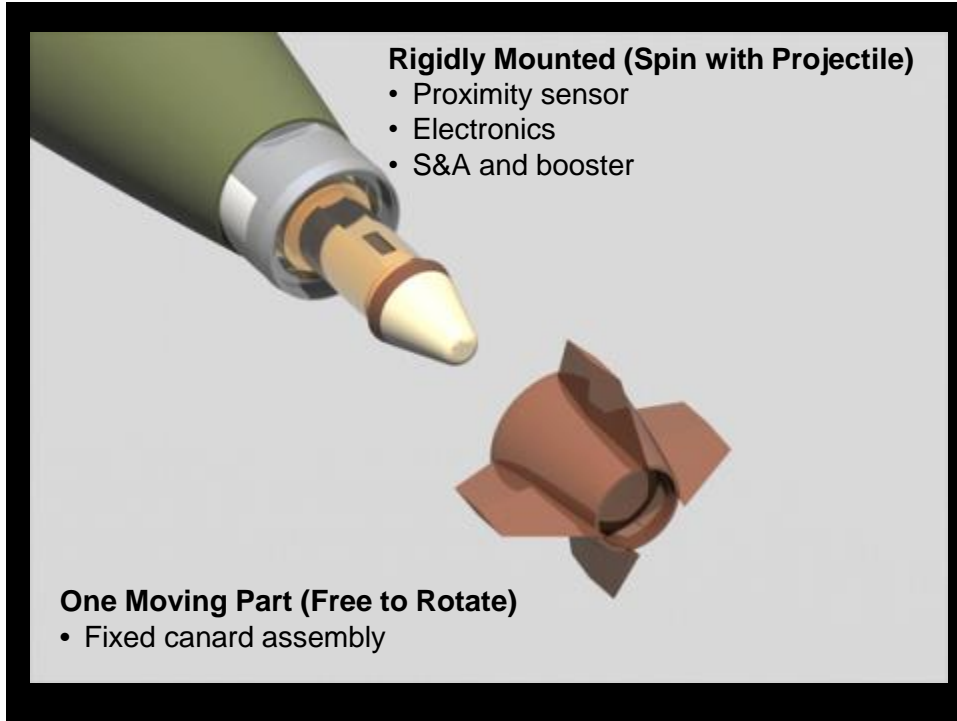
EMD Phase

- Two Projectiles
- All Ranges
- All Environments
- EPIAFS Interface
- All Fuzing Functions
- Tactical Form-Factor

Design Verification Testing
Aug 2011

48 PGK Units Fired
100% Safe
All accuracy and range requirements met

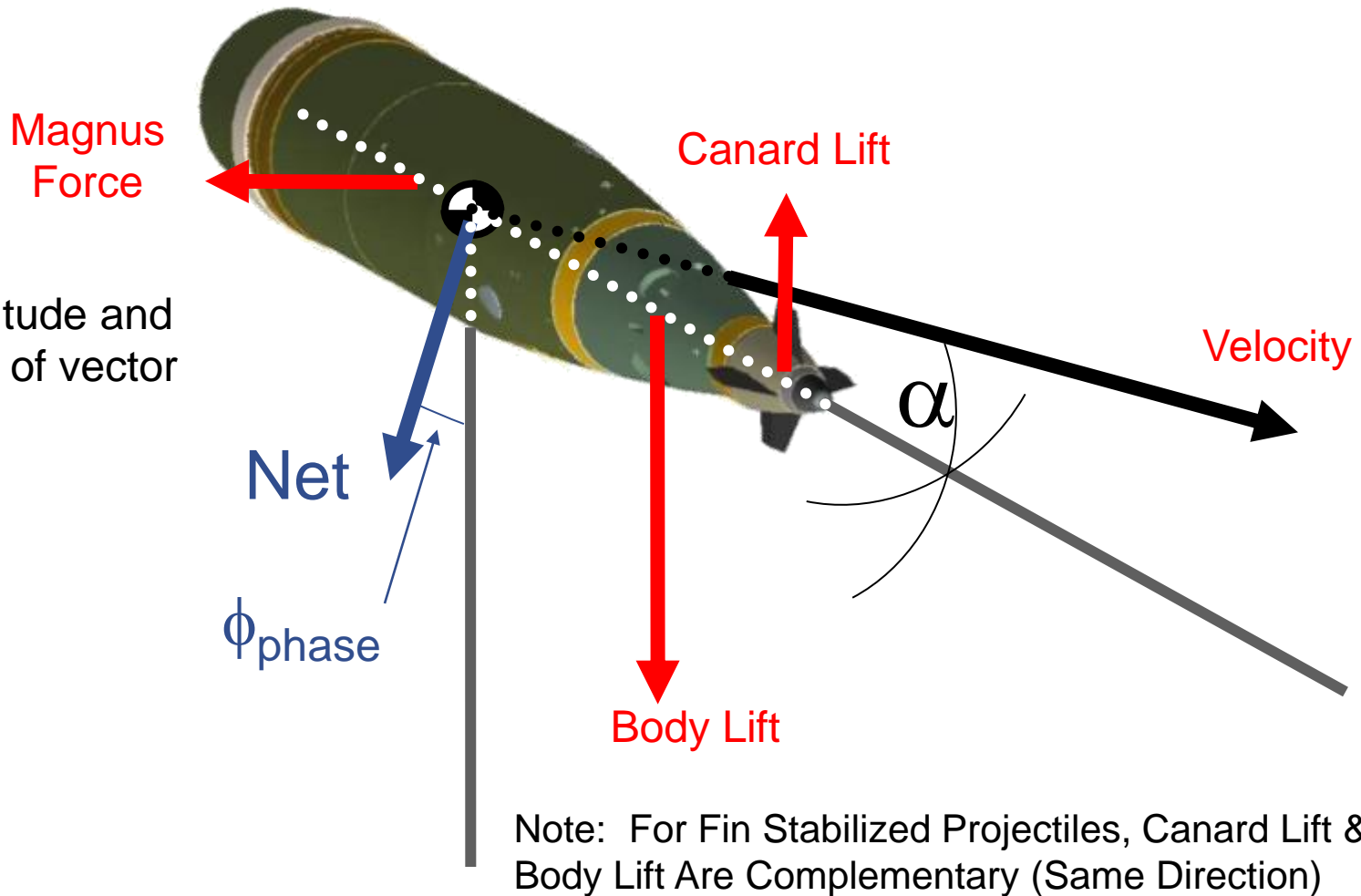




Fixed Canard Assembly Produces Nose Lift and Counter-Rotation Torque

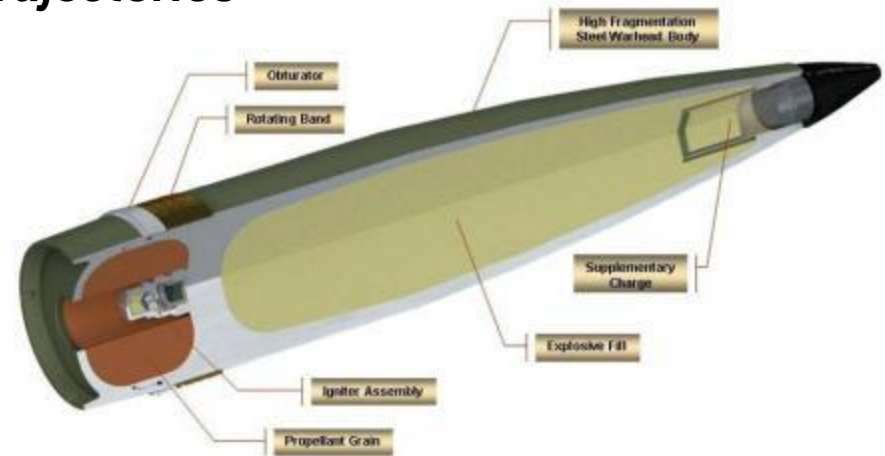
Maneuver magnitude and direction a result of vector addition of:

- Canard Lift
- Body Lift
- Magnus



**Artillery Aerodynamics Are Complex
Once Understood They Are Very Repeatable And Manageable**

- **Approach:** Fly like a projectile, only make minor corrections to trajectory
- **Reference Trajectory** - the predicted ballistic flight path before shooting the round using
 - Expected launch conditions (gun QE, gun AZ, muzzle velocity)
 - Environment predictions (MET, gravity, Coriolis, etc.)
 - Aerodynamic model
- **Robust solution for all indirect fire trajectories**
 - Artillery or mortar
 - Different zones (muzzle velocities)
 - Different projectiles
 - Different QEs (trajectory shapes)



Successfully Conducted Initial Flight with 155mm XM 1128
- Verified preliminary stability and maneuver authority

Doing More Without More



PGK developed during volatile defense budget environment

PM CAS leading the charge



OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

SEP 14 2010

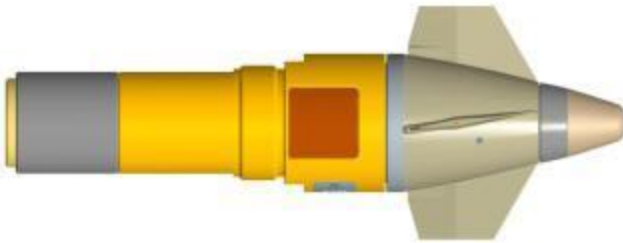
ACQUISITION,
TECHNOLOGY
AND LOGISTICS

MEMORANDUM FOR ACQUISITION PROFESSIONALS

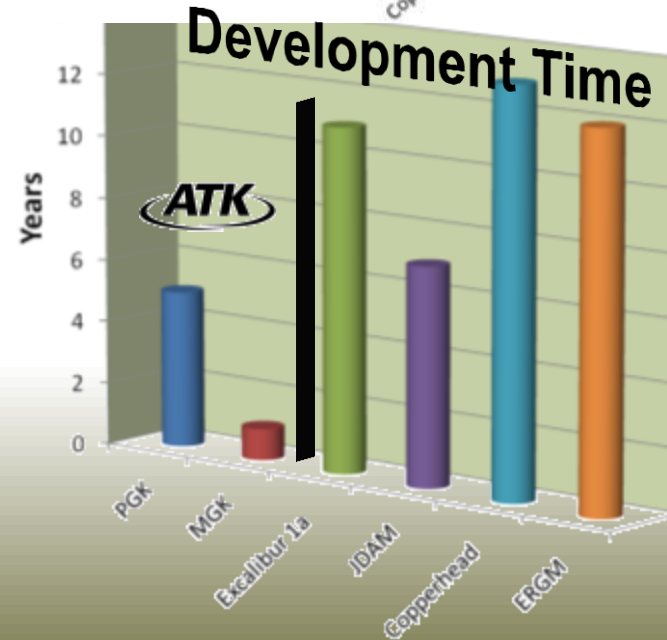
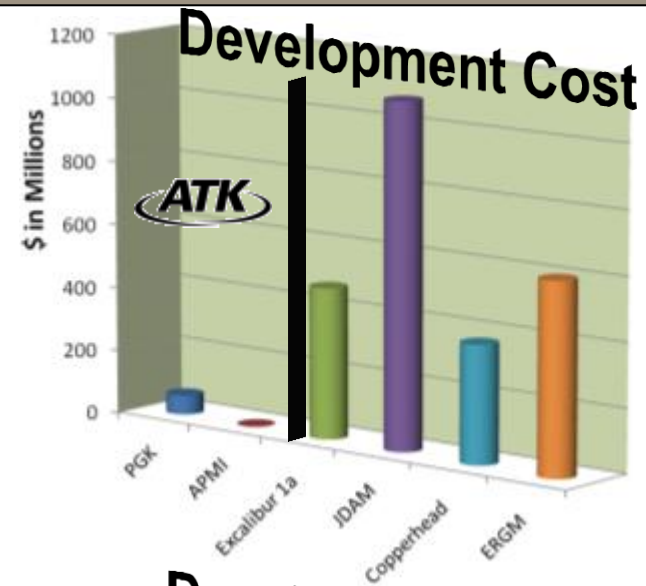
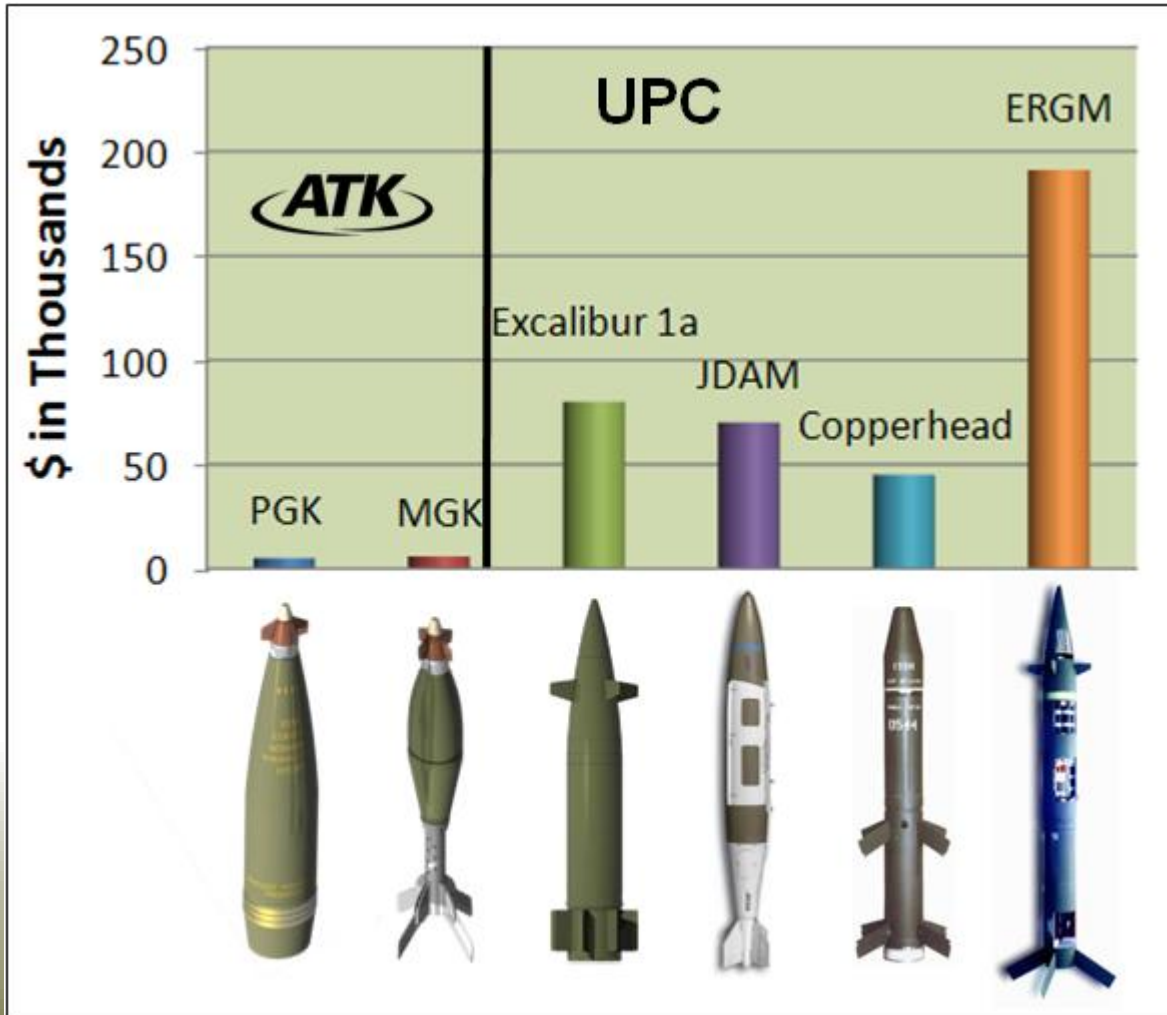
SUBJECT: Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending

On June 28, I wrote to you describing a mandate to deliver better value to the taxpayer and warfighter by improving the way the Department does business. I emphasized that, next to supporting our forces at war on an urgent basis, this was President Obama's and Secretary Gates' highest priority for the Department's acquisition professionals. To put it bluntly; we have a continuing responsibility to procure the critical goods and services our forces need in the years ahead, but we will not have ever-increasing budgets to pay for them. We must therefore strive to achieve what economists call productivity growth: in simple terms, to **DO MORE WITHOUT MORE**. This memorandum contains specific Guidance for achieving the June 28 mandate.

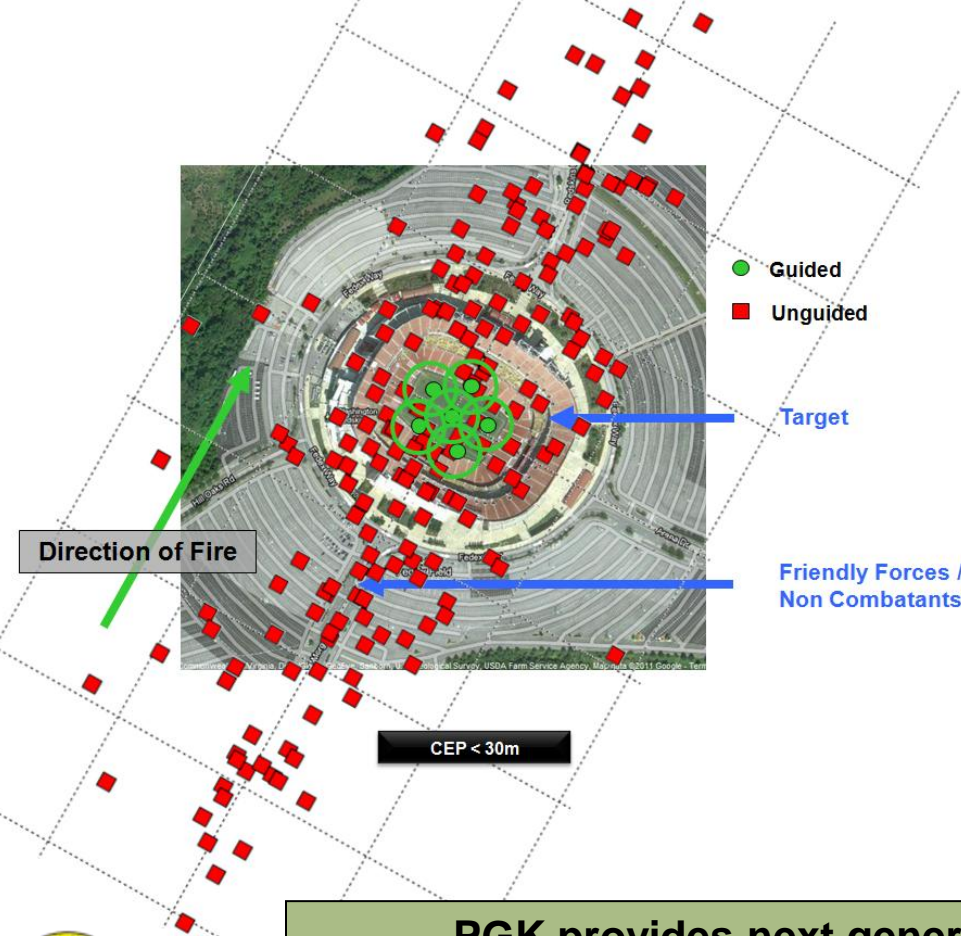
"Do More Without More" – US Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L)



Affordable Precision

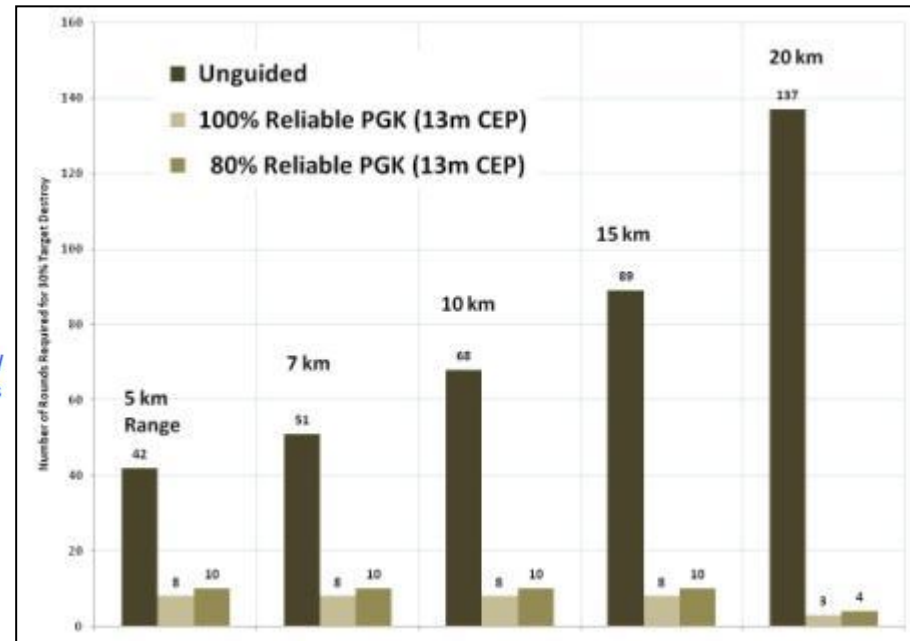


- **Minimize collateral damage**
- **Improved Logistics**
- **Do More without More**



PGK Delivering Accuracy Beyond Expectation

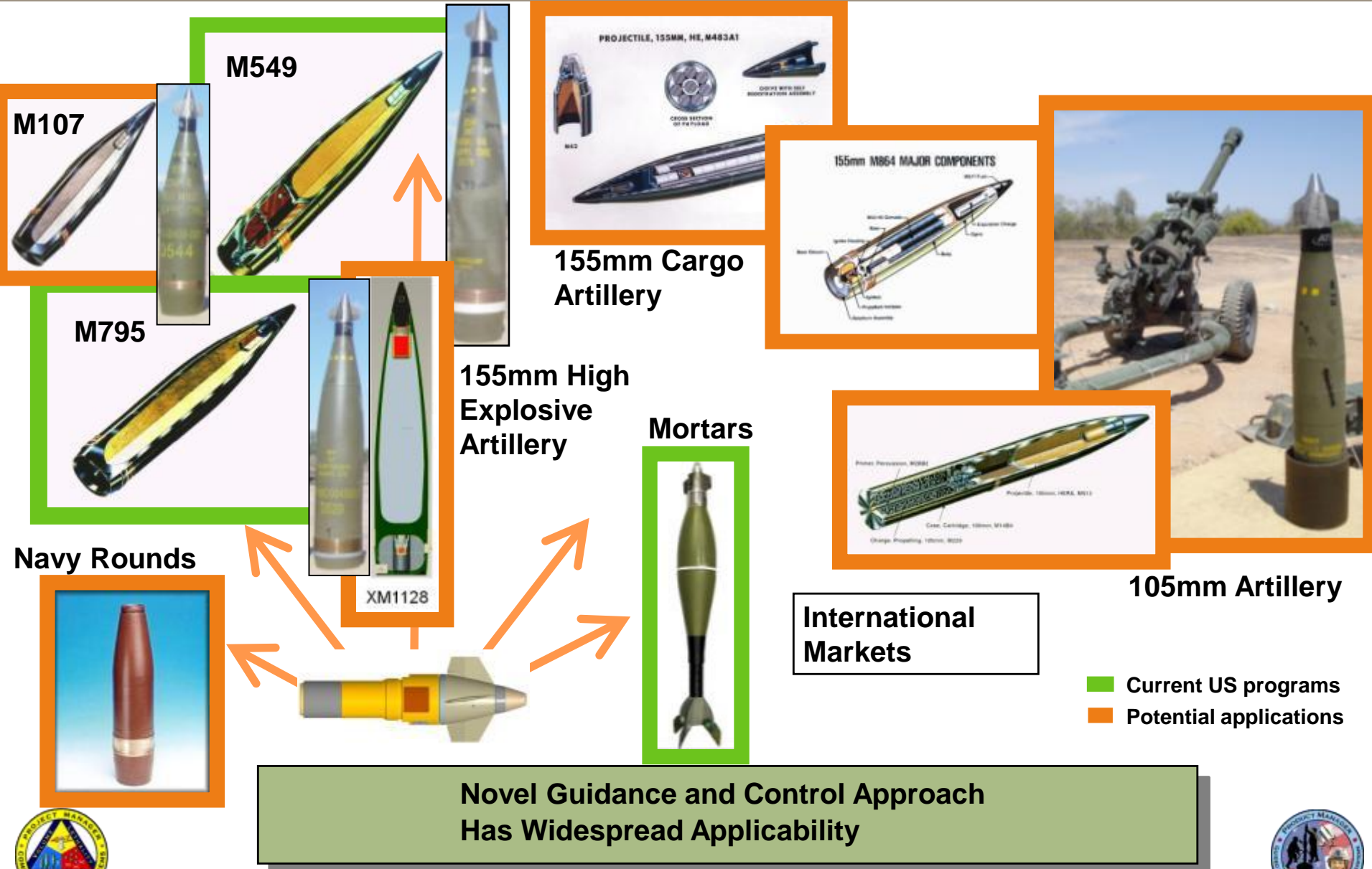
- PGK – Performance on M549A1 and M795 rounds meeting Circular Error Probable (CEP) requirements through Engineering, Manufacturing, Development (EMD) Phase
- Accuracy Requirement = (T) 50m (O) 30m
- M549A1 > 200m CEP at max range



Reference: New Vectors, "ATK 155mm Analysis - Individual Round Analysis," October 2007

PGK provides next generation dispersion reduction for yesterday and today's ammunition stockpiles





Program Contact Information

Jay Annis
Director – Precision Guidance Systems
ATK Advanced Weapons
+1-763-744-5019
jay.annis@atk.com

Russ Hill
PGK Project Management Engineer
Guided Precision Munitions and Mortar Systems
US Army
+1-973-724-2236
Russell.d.hill@us.army.mil



Innovation ... Delivered.

Precision Guidance Kit (PGK) for Artillery