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PGK and the Impact of Affordable Precision on the Fires Mission

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ATK Advanced Weapons

Approved for Public Release, POA 299-08, 22 CFR 125.4(b)(13) applicable



“Affordable Precision” Possible Today



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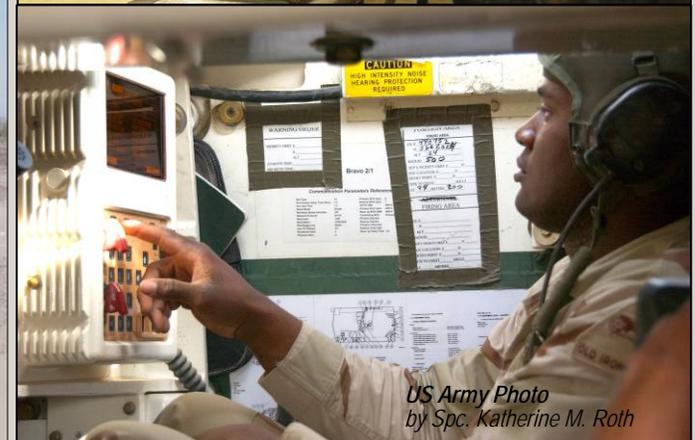
Discussion Topics:

- PGK Program and Status
- Impact on Conducting Fire Missions with PGK
- Ideas on Modern Battlefield Roles of Conventional and Precision Munitions

Technology



People



Strengthened Capability for the Warfighter

155mm Artillery Effectiveness Gap Defined

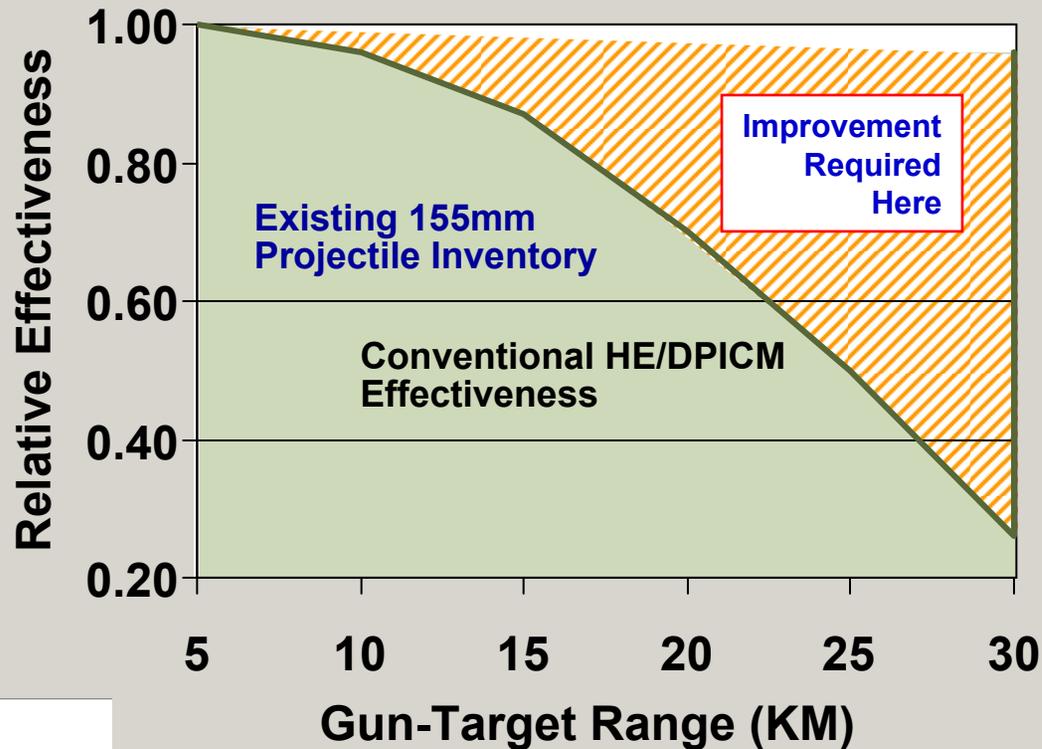


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2000

Why LCCM (Low Cost Competent Munition)?

Conventional Munitions are Less Effective at Longer Ranges



2004

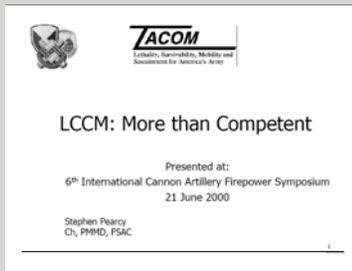
Why CCF (Course Correcting Fuze)?



"CCF capability...would significantly and economically enhance the accuracy of existing artillery projectiles both improving efficiency and decreasing the combat logistical burden."

"...we should energetically and aggressively pursue development, testing, procurement, and fielding of this capability for our Soldiers."

General Byrnes
Commanding General
of US Army Future Force

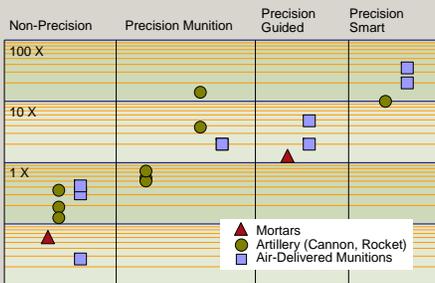


Stephen Percy (Ch, PMMD, FSAC), LCCM: More than Competent
6th International Cannon Artillery Firepower Symposium, 21 June 2000

Types of Precision Munitions



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Non-Precision (Area) Munition	Precision Munition	Precision Guided Munition	Precision Smart Munition
Munition/submunitions subject to all ballistic conditions on the way to the AIMPOINT .	Munition corrects for ballistic conditions using guidance and control up to the AIMPOINT or submunitions dispense with terminal accuracy less than the lethal radius of effects. Submunitions are subject to ballistic conditions to the AIMPOINT .	Munition senses coded energy reflected from a target and uses guidance and control to the TARGET . A laser designator in the loop is required for target designation.	Munition/submunitions autonomously searches, detects, classifies, selects, and engages TARGET(s) . Has a limited target discrimination capability.

1 X	10 X	10 X	100 X
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120mm Mortar Ammunition

M934



XM395 PGMM



155mm Cannon-Fired Artillery Ammunition

Unguided 155mm



GPS-Guided PGK

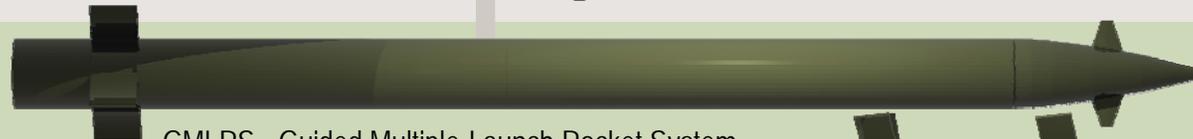


GPS-Guided Excalibur



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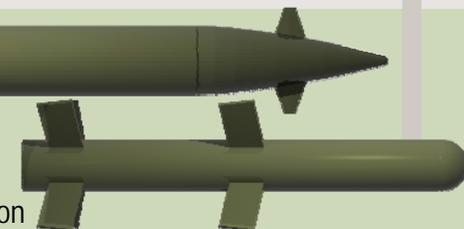
221mm Rocket-Launch Artillery Ammunition



GMLRS - Guided Multiple-Launch Rocket System

178mm Rocket-Launch Artillery Ammunition

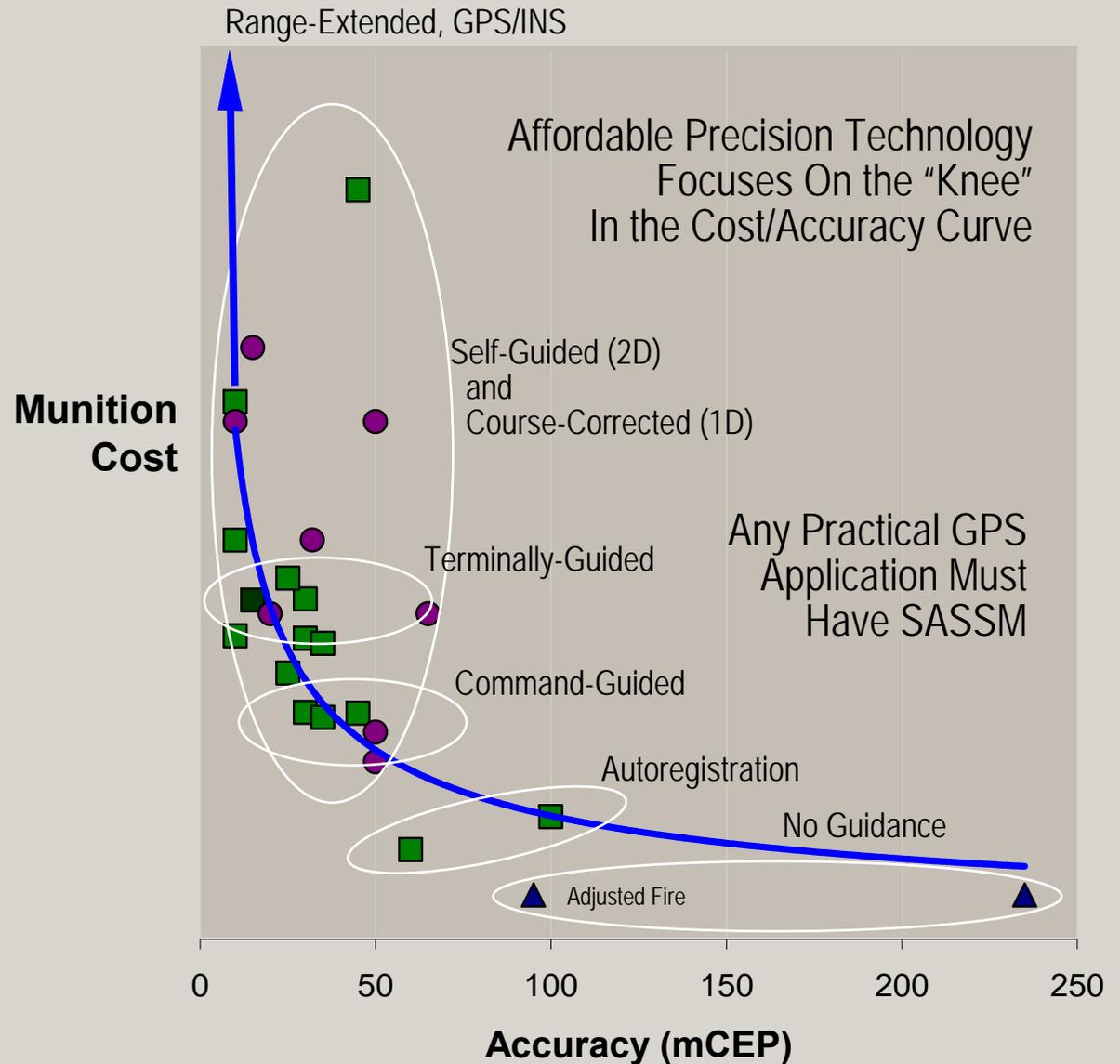
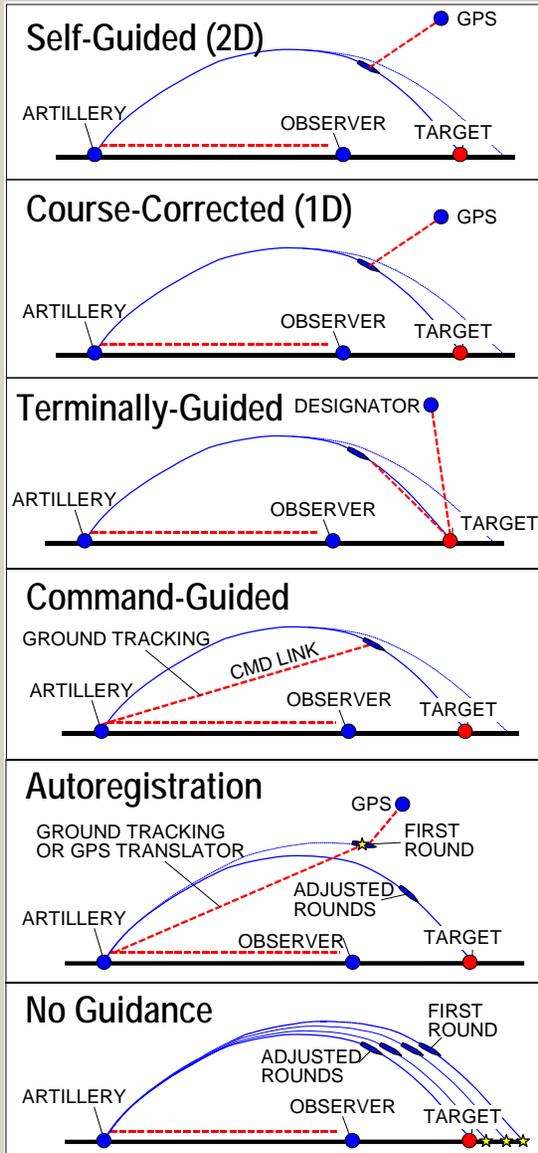
PAM - Precision Attack Munition



Affordable Precision Concept Studies



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Years of Technology Development Led to PGK



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CY93	CY94	CY95	CY96	CY97	CY98	CY99	CY00	CY01	CY02	CY03	CY04	CY05	CY06	CY07	CY08	CY09	CY10	CY11									
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

LCCM: More Than Competent, Percy, 6th International Cannon Artillery Firepower Symposium, June 2000

Development of a Course Correcting Fuze (CCF) Capability, US Army Memorandum, May 2004

PGK Down-Select, May 2007

PGK Production Decision, April 2009

1-D Course Corrector Concepts

Miniaturized GPS Receivers

UK Technology Demos

Demo At YPG

Course Correcting Fuze

1-D

ARL (Hollis)

UK Team STAR

1-D+

BAE Systems CCF





2-D Course Corrector Concepts

ONR Sponsored Demonstration

CM-ATD

Demo At YPG

NSWC-DD

ANSR

NSWC-DD

GIF

Draper

2-D

Draper ATK

MEMS Inertial Sensors

ATK IR&D

2D CCF

ACT II DAAE30-95-C-005

Canard Controlled 155mm

Demo At YPG

2-D

1-D+







Hybrid Course Corrector Concepts

LCCM Contracts

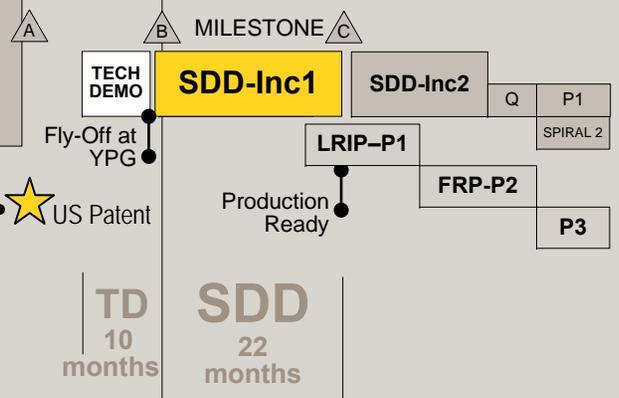
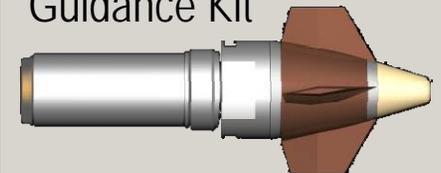
Autoregistration Fuze

ATK IR&D

1D CCF




Precision Guidance Kit

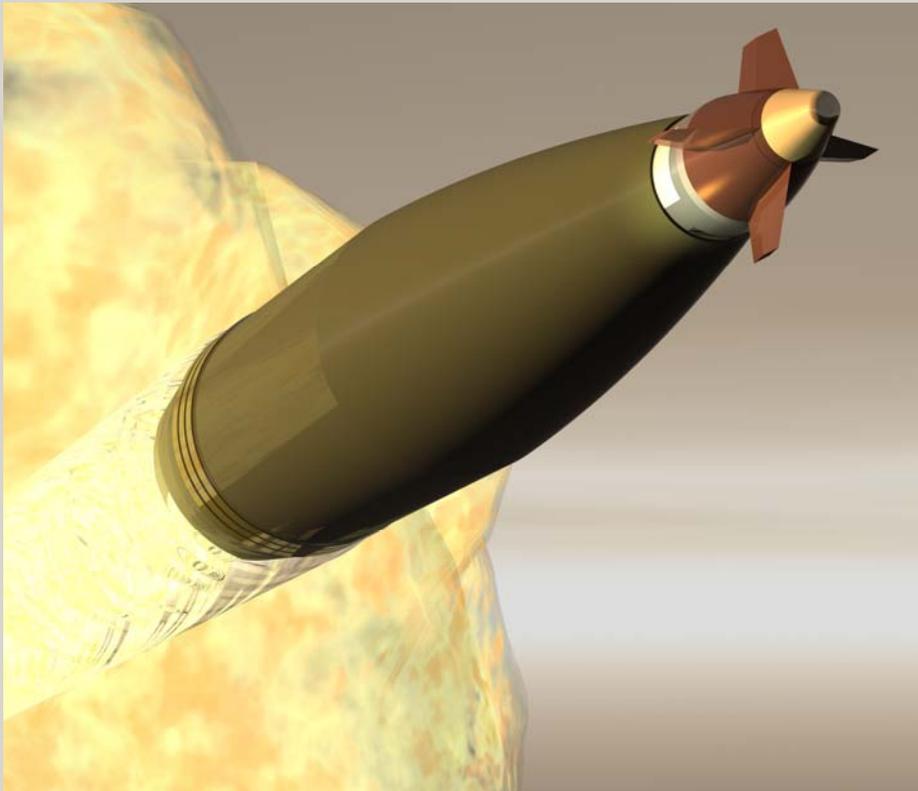


One Decade of R&D

Precision Guidance Kit (PGK)



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Operational Benefits

- Transforms existing artillery inventory into affordable precision weapons
- Improves combat effectiveness
- Reduces collateral damage
- Reduces logistics footprint

What is PGK?

- GPS Guidance Kit with Fuzing Functions
- Replaces the standard 155mm artillery projectile fuze
- PGK GPS guidance greatly improves the accuracy of conventional artillery in the inventory

50m CEP vs. 175m CEP

- Maintains >90% of range capability of conventional projectile
- Requires no battery
- Has no "one-shots" or canard deployments
- Reliable - one moving "part"
- Uses COTS inertial sensors
- Full 2D Guidance to Impact

PGK Precision Guidance Kit for 155mm Ammunition



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PGK Field Testing

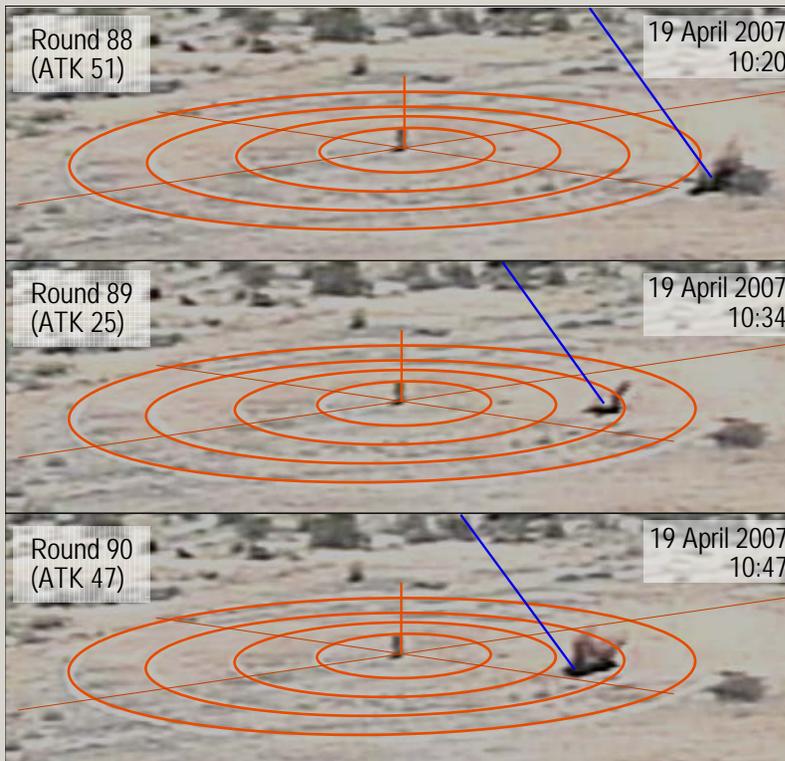


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Technical Demonstration Program

Competitive Fly-Off
18 M549A1 Rounds @ 20.5 km
Demonstrated < 50m CEP
83% Reliability

2D Guidance Has Potential
To Be Very Precise (Repeatable)



Early SDD Field Test Objectives:

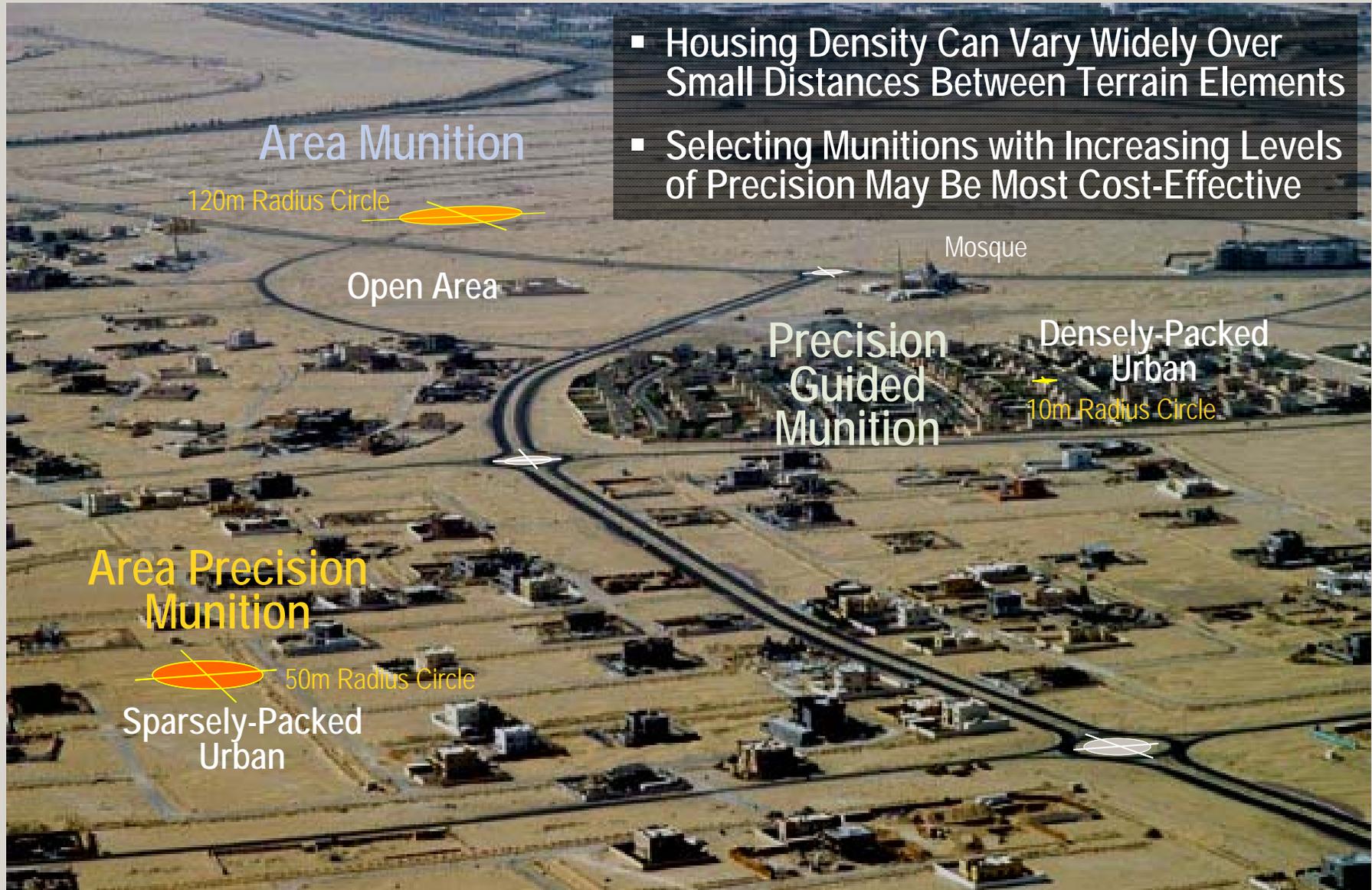
- Expand Aerodynamic and Guidance Characterization of PGK across family of 155mm Projectiles
- Validate Consolidation and Packaging to SDD-1 Electronics Form Factor
- Confirm System Performance of Second Source GPS Supplier

What Level of Precision is Needed?



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- Housing Density Can Vary Widely Over Small Distances Between Terrain Elements
- Selecting Munitions with Increasing Levels of Precision May Be Most Cost-Effective



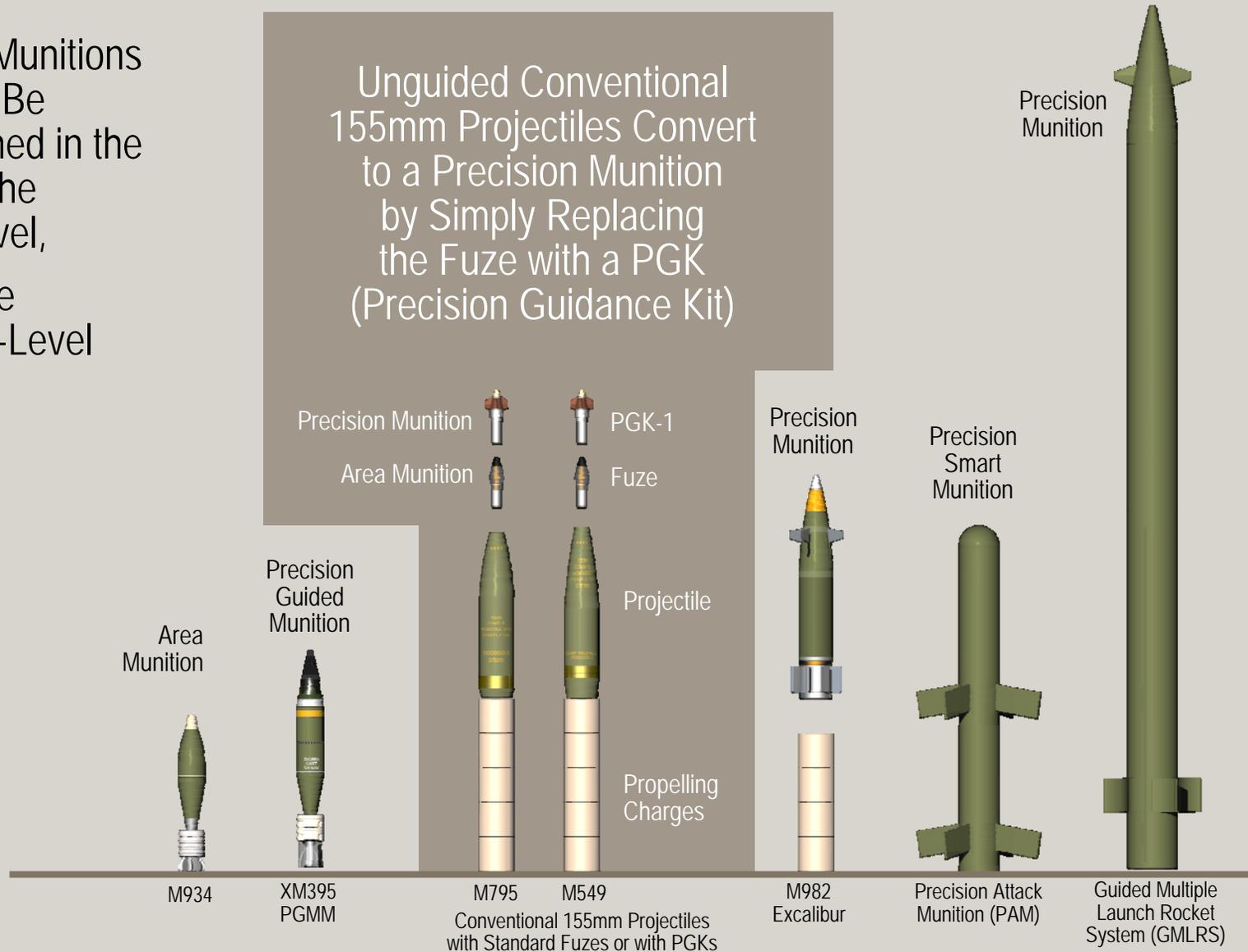
Logistics Cost is Driven by Tonnage/Volume



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155mm Munitions Mix Can Be Established in the Field at the Fuze-Level, Not at the Munition-Level

Unguided Conventional 155mm Projectiles Convert to a Precision Munition by Simply Replacing the Fuze with a PGK (Precision Guidance Kit)



Non-Precision Conventional Mission



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Planning the Mission

US Army Photo



Preparing the Round – Setting the Fuze

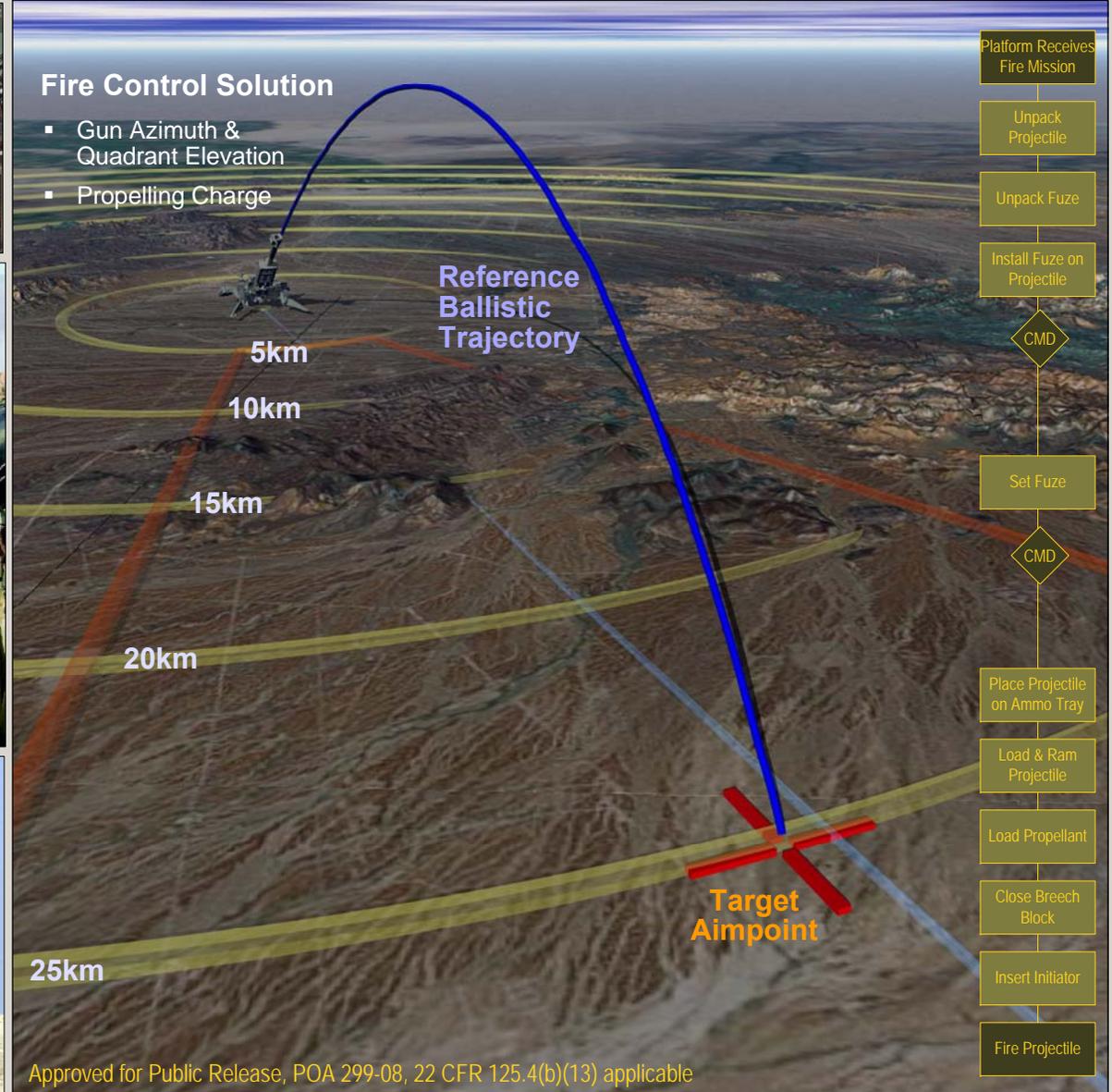
Firing the Round From M777A2



US Army Photo

Fire Control Solution

- Gun Azimuth & Quadrant Elevation
- Propelling Charge



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Non-Precision Conventional Mission



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Planning the Mission

US Army Photo

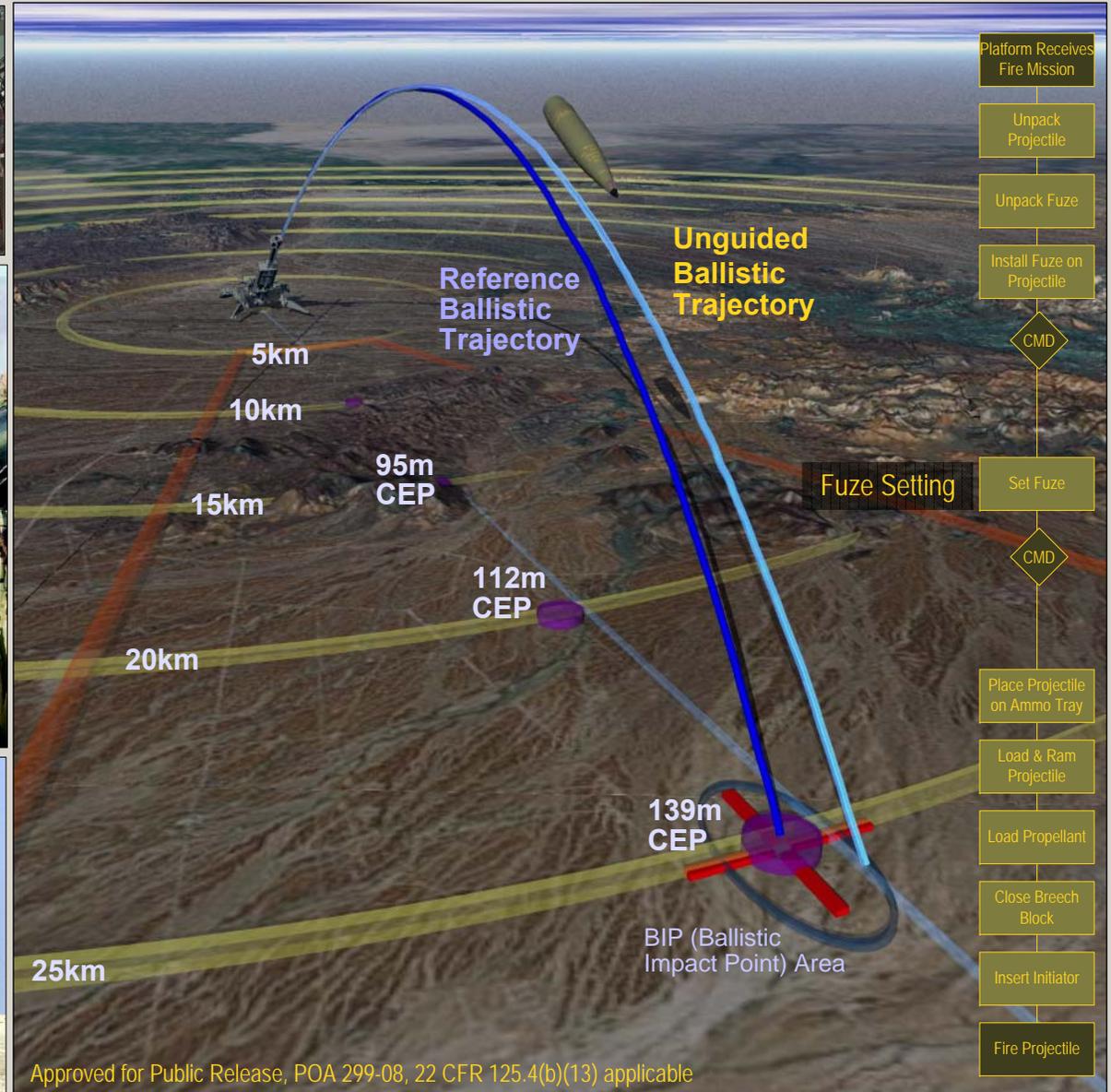


Preparing the Round – Setting the Fuze

Firing the Round From M777A2



US Army Photo



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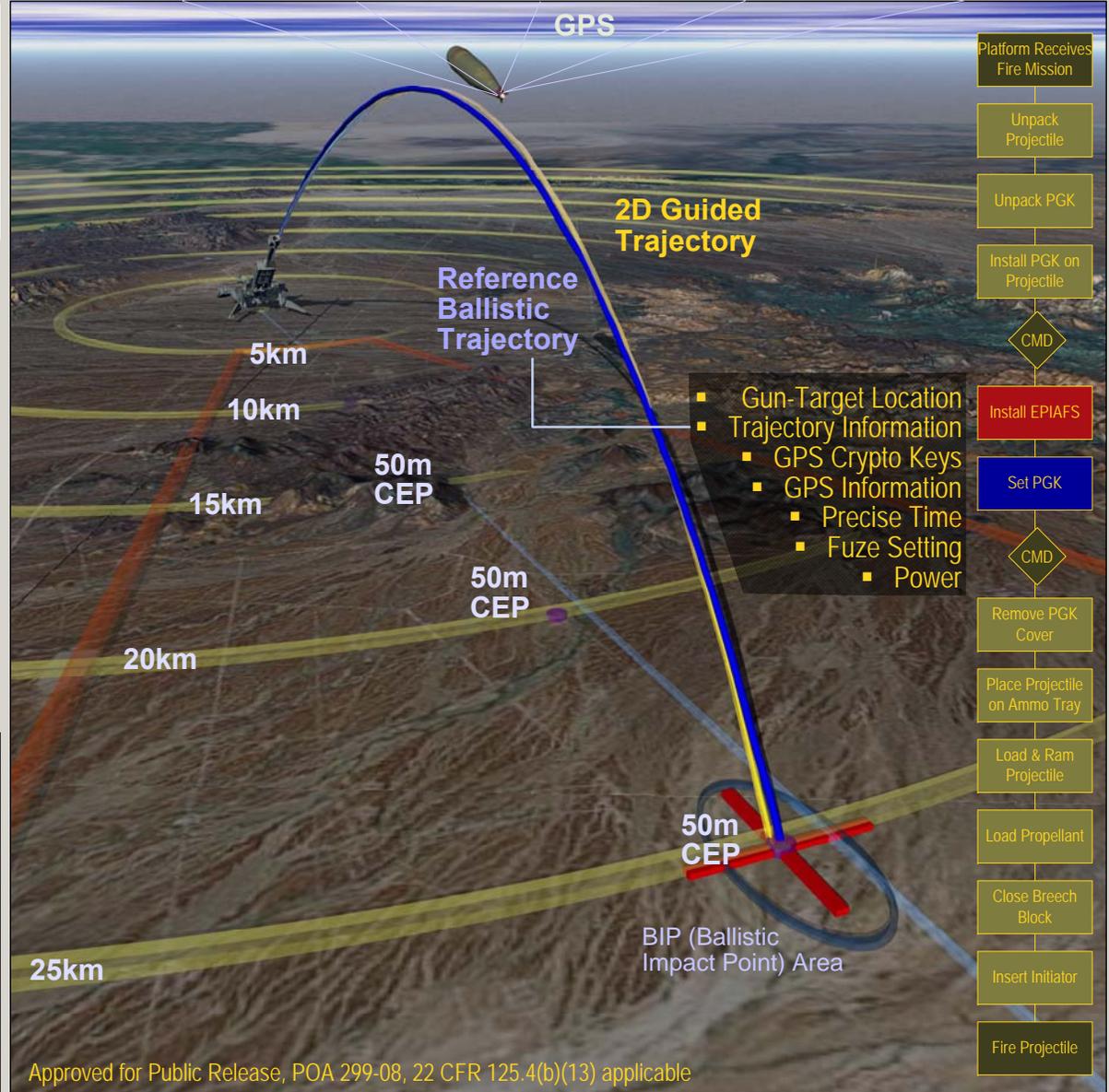
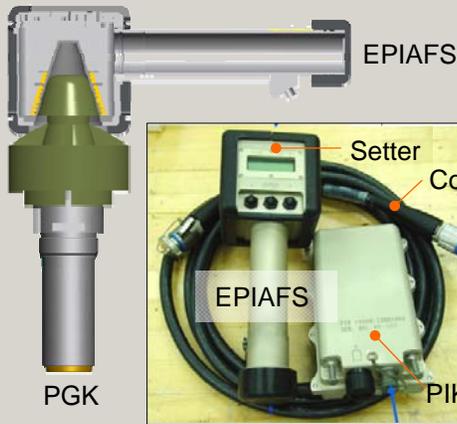
Precision PGK Mission



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Planning the PGK Mission



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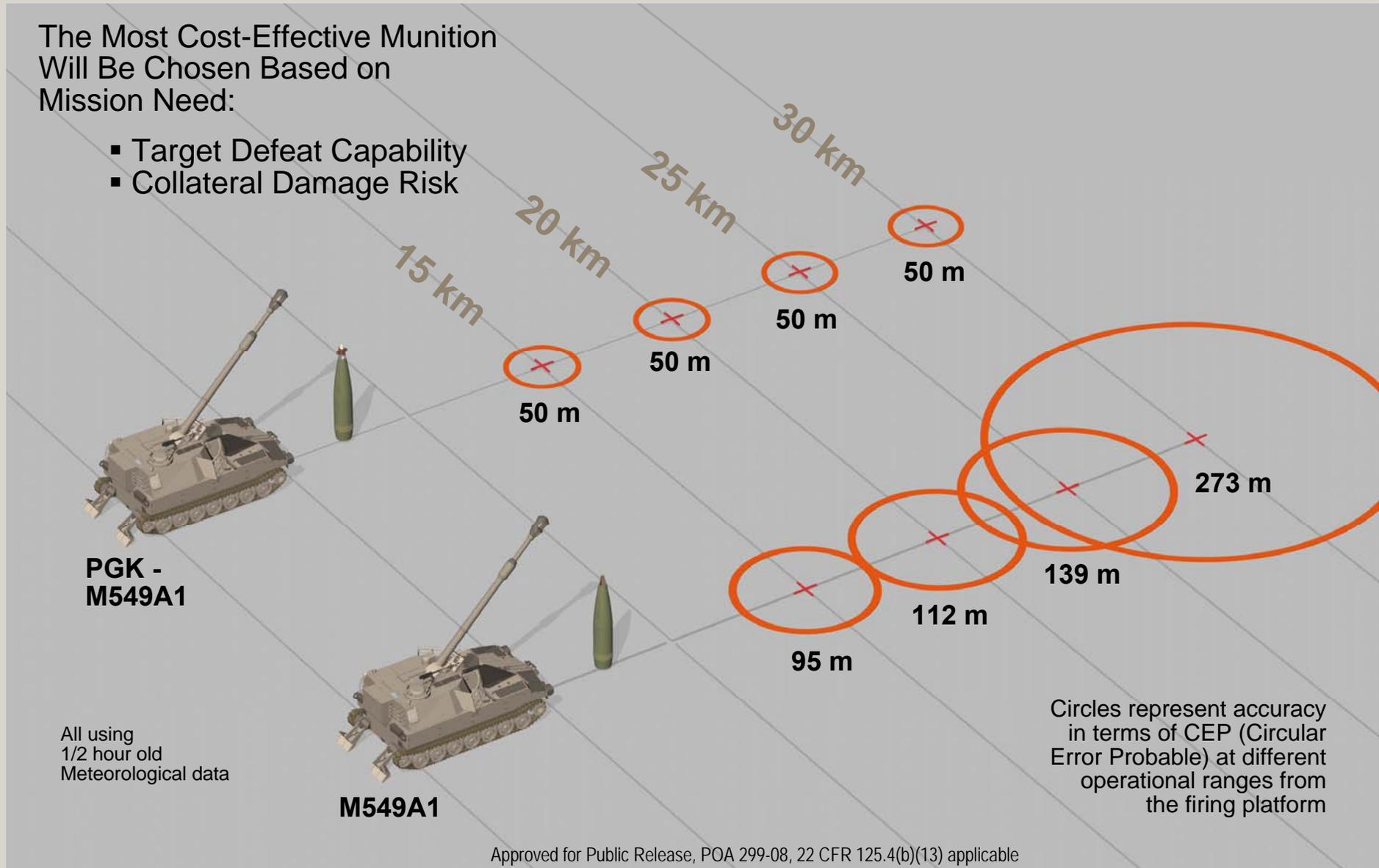
Comparative 155mm Projectile Accuracies



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The Most Cost-Effective Munition Will Be Chosen Based on Mission Need:

- Target Defeat Capability
- Collateral Damage Risk



Circles represent accuracy in terms of CEP (Circular Error Probable) at different operational ranges from the firing platform

All using 1/2 hour old Meteorological data

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Operational Benefit



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Today's Capability: 183m CEP*



PGK: \leq 50m CEP



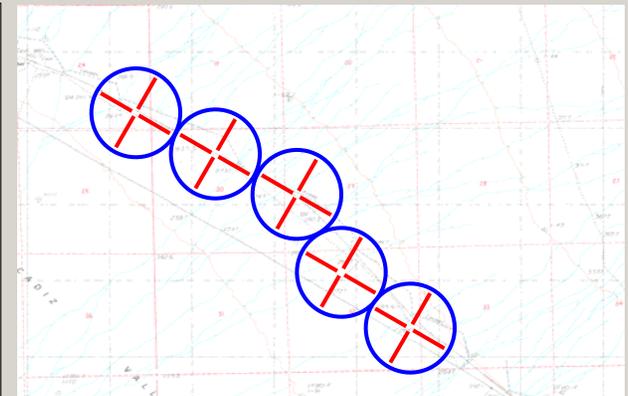
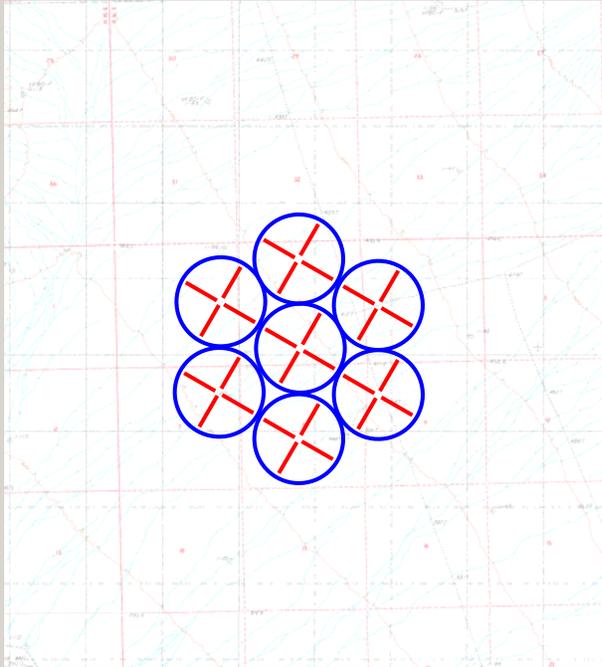
* M109A6 (Paladin) at 27km: 155mm (HE) M549A1

- Improves Munition Accuracy
- Greatly Reduces Possibility of Collateral Damage
- Increases Number of Kills per Basic Load of Ammunition

PGK Missions



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PGK performs the same missions as conventional 155mm HE munitions, but with better effectiveness consistent with a 50m CEP accuracy.

Precision Mmunition Analysis



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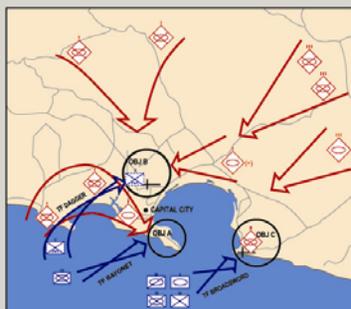


2006 Precision Mmunition Analysis Issues:

For the modular Brigade Combat Team:

- What are the cost and logistics impacts of using precision?
- How do these munitions affect force effectiveness?
- What is the relative collateral damage from these munitions vice "dumb" munitions?

Precision munitions: PGK, Excalibur, PGMM



Open desert scenario example



Collateral Damage example

Case 1: Conventional Munitions:

- Conventional 155mm and 105mm artillery munitions
- Conventional 120mm mortar munitions

Case 2: Precision Munitions:

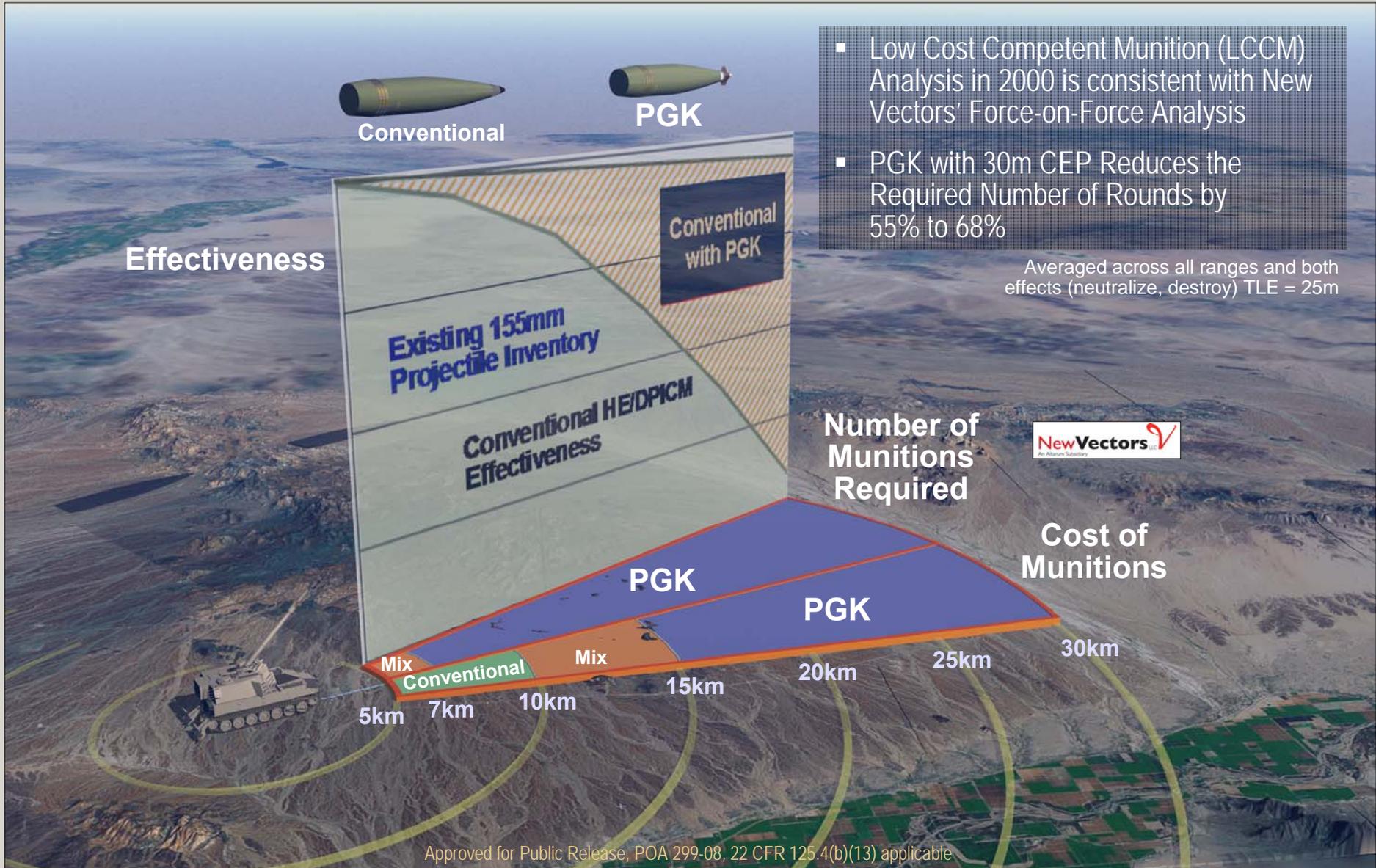
- 155mm Excalibur
- 155mm PGK Munition (30m CEP capable)
- 105mm PGK Munition (30m CEP capable)
- 120mm PGMM and conventional mortar munitions

Factor	Impact to HBCT
Operational Effectiveness	<ul style="list-style-type: none"> ▪ Increased war-fighting capability by 48% ▪ Reduced US losses by 36%
Cost Effectiveness	Increased overall cost of munitions expended by 7-18%, but this will be significantly reduced due to 2 nd and 3 rd order effects (logistics)
Logistics Effectiveness	<ul style="list-style-type: none"> ▪ Reduced number of munitions by 38% ▪ Reduced tonnage of Army munitions expended by 19%

PGK Fills the Effectiveness Gap



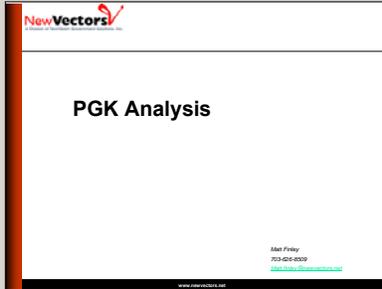
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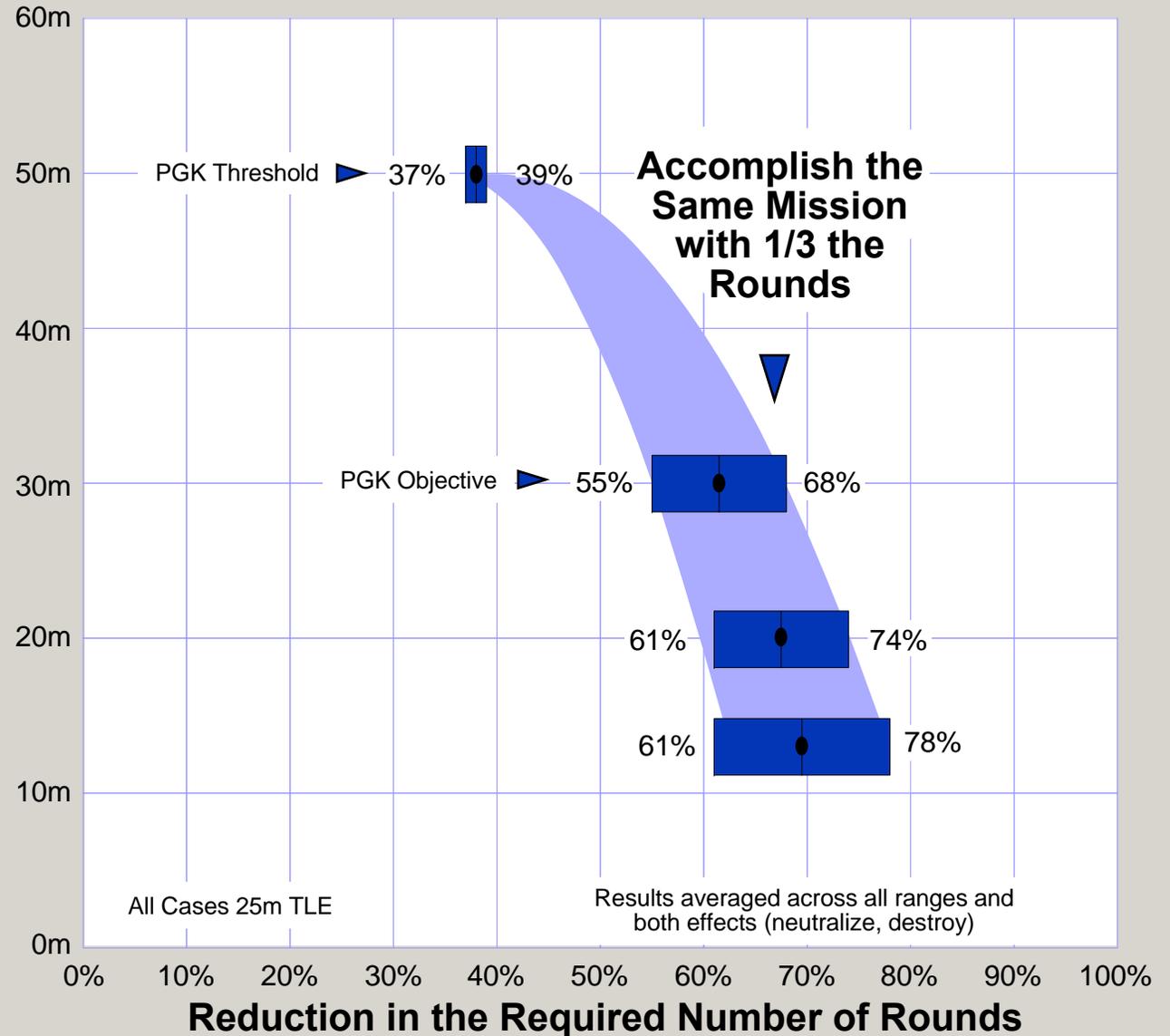
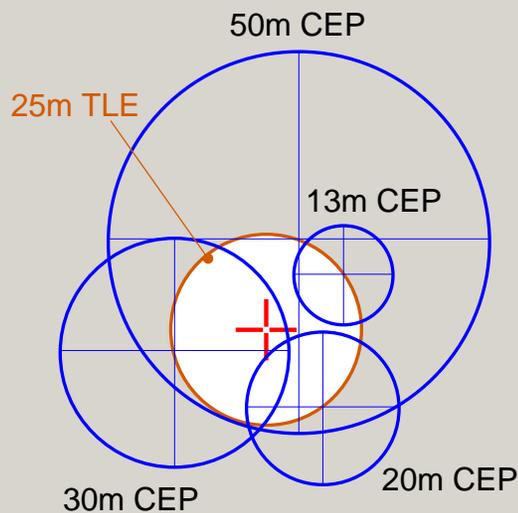
Precision Reduces the Number of Rounds



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Accuracy of PGK Round (CEP)



What Does This Mean to the Mission Cost?



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- Round Cost is Only a Small Percentage of Mission Cost
- Reduced Round Savings Has Multiplying Effect on Mission Savings



New Vectors'
Study Only
Considered The
Round Cost

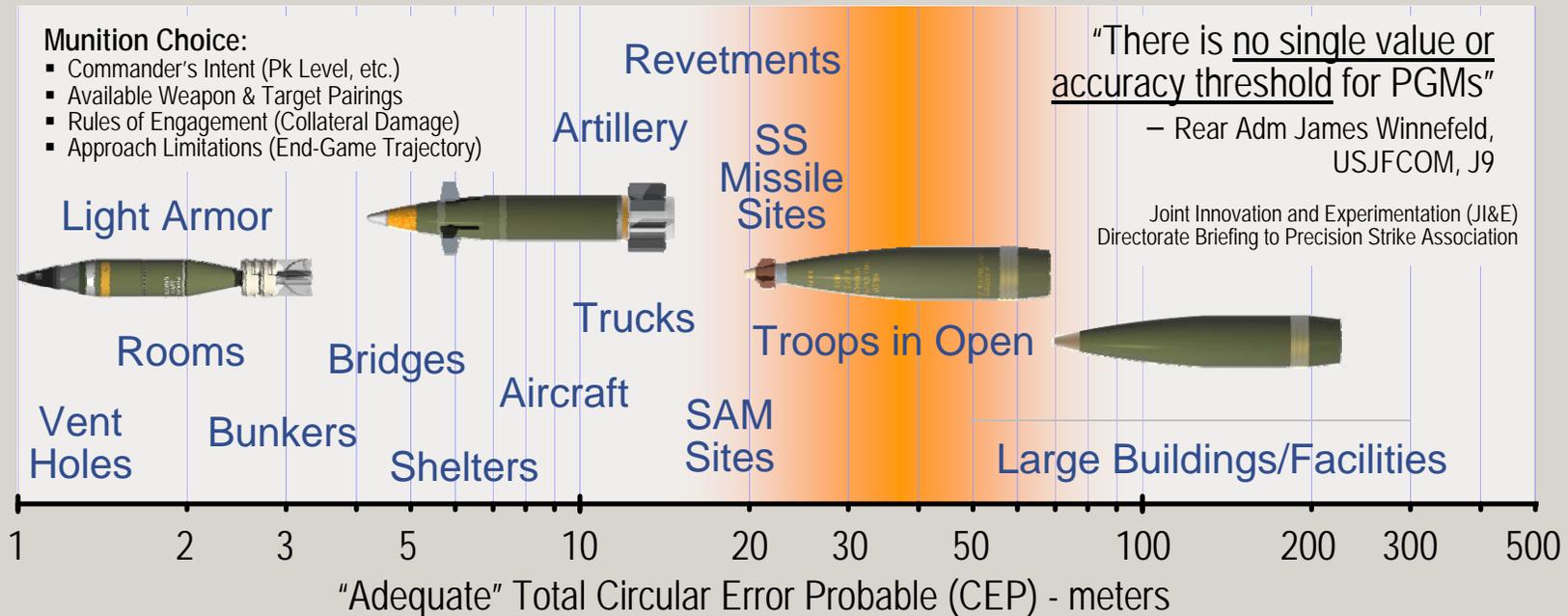


When the system and logistics costs are added to the cost of the rounds fired, a reduction of 55% to 68% in rounds fired makes an **all-precision stockpile a realizable goal.**

Affordable PGK Fills an Effectiveness Gap



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Affordable Precision Solutions Will Change the Fires Paradigm from an Inventory of

“Conventional and Precision Munitions”

to

“Precision and Very High Precision Munitions”

Precision

Very High Precision

Number of Missions

Conventional with Precision Guidance Kit

- GMLRS
- NLOS-PAM
- Excalibur
- PGMM

Mission Munition Mix Is Integral to FCS (Future Combat System) Vision

Precision Mmunition Analysis – Study Findings



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PGMM (1km – 7km)

- PGMM is the most cost and logistically effective munition
- Provides the least collateral damage



Personnel protected by point target structures



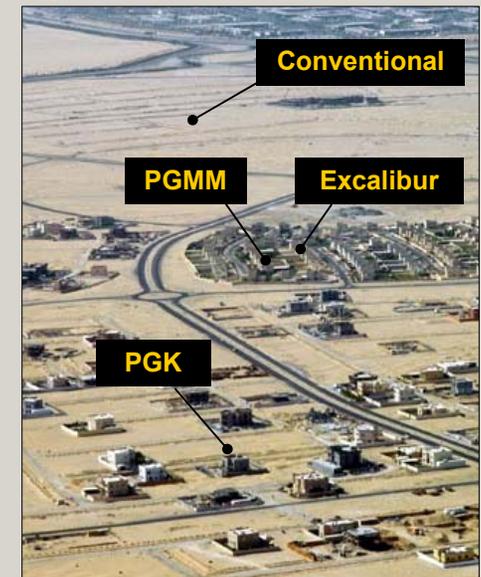
Conventional Projectiles (2km – 30 km)

- Cost effective at shorter ranges where delivery accuracy is good and collateral damage is not a concern



PGK (8km – 27 km)

- Is generally the most cost effective munition beyond 10km
- Requires only 12-51% of the number of conventional rounds
- At most ranges is cost effective and reduces logistical burden



Personnel protected by buildings, command posts, urban warfare targets



Excalibur (8km – 40km)

- Is only tube-launched capability beyond 30km
- Is the only artillery round accurate enough to reduce collateral effects
- Is most logistically effective over 155mm operational range with a significant improvement in effectiveness

“Affordable Precision” Possible Today



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Technology



People



U.S. Army photo

Soldier of the 2-4 Infantry, 4th Brigade Combat Team, 10th Infantry Division operates AFATDS



US Army Photo

by Spc. Katherine M. Roth

An artilleryman plans to launch a 155mm round from a howitzer of the 1st Armored Division's 4th Battalion, 27th Field Artillery Regiment.

Strengthened Capability for the Warfighter