



U.S. Army Tank-automotive and Armaments Command

*U.S. Army Armament Research, Development
and Engineering Center (ARDEC)*



“Warhead Technology Advancements”

NDIA

Armaments for the Army Transformation Conference

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Presented by

Mr. Richard Fong

Warheads, Energetics & Combat-support Armaments Center



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Outline

- **Shaped Charges(SC)**
- **Explosively Formed Penetrator(EFP)**
- **Summary**



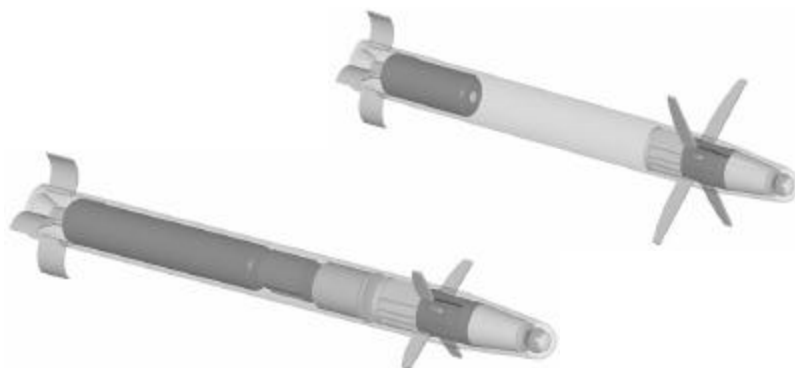
Enabling Warhead Technologies For FCS Munitions



3" SADARM



FCS Munitions



3" PGMM



Payoffs:

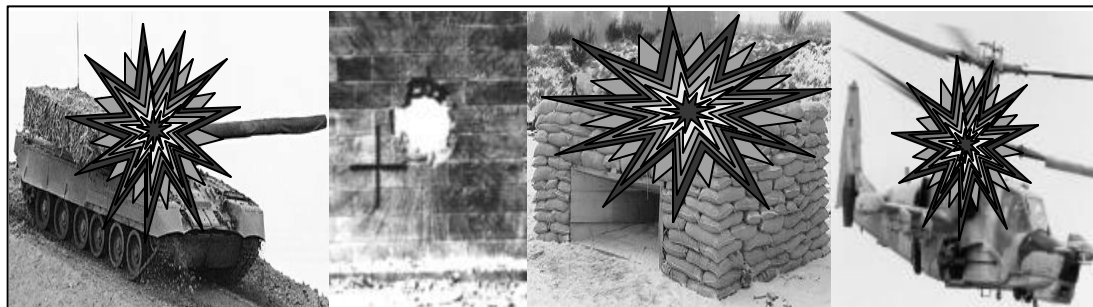
- **Smaller and lighter systems**
- **Multi-purpose capability**
- **Increased Lethality**
- **Counter APS**



TOW / FOTT



Common Missile



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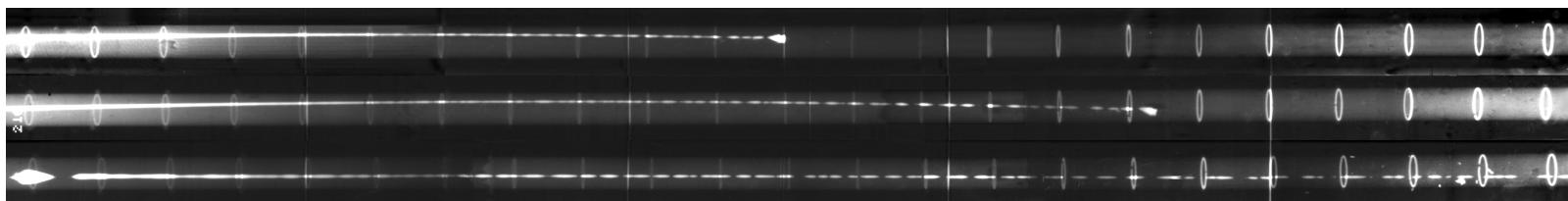
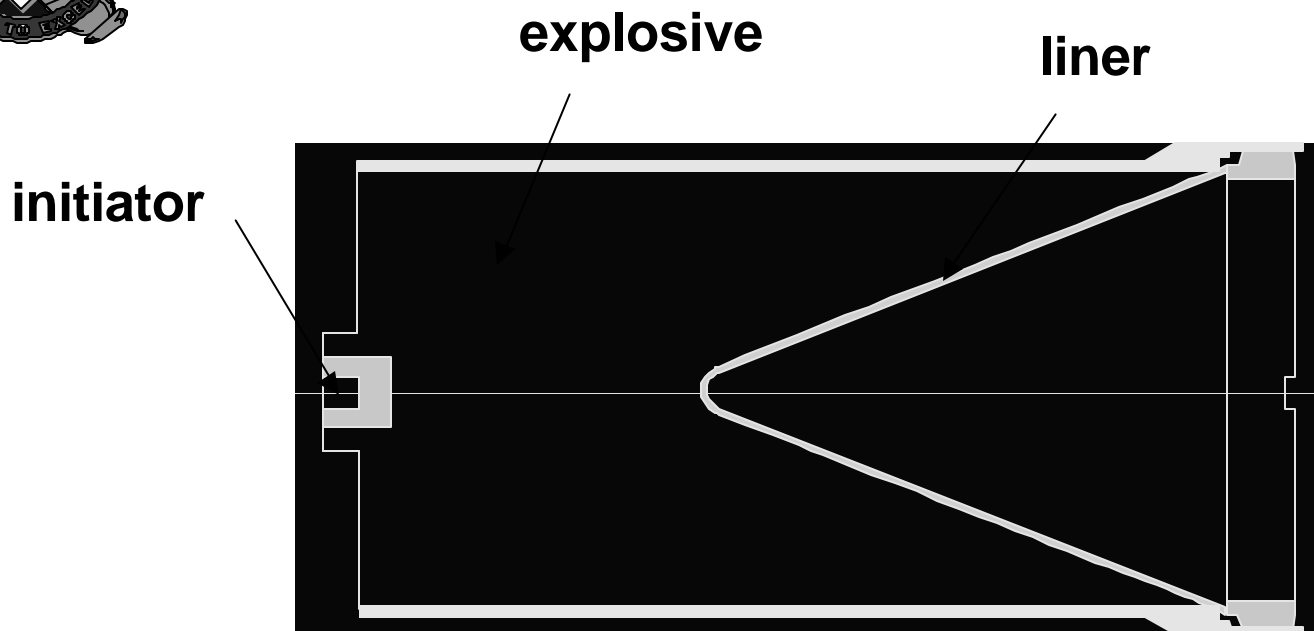
Shaped Charges (SCs)



- **Conventional SCs are employed in hit to kill systems such as Hellfire, Javelin**
- **High velocity gradient (for max length) and high tip velocity ~ 9 km/sec**
- **Produces deep penetration required for heavy frontal armor**
- **Copper conventionally used liner material, good ductility and tip velocity, Mo has higher tip velocity**



Shaped Charge Warheads



Jet Flash X-Rays
132ms, 162ms and 262ms

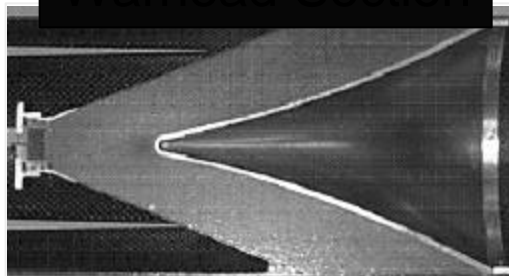
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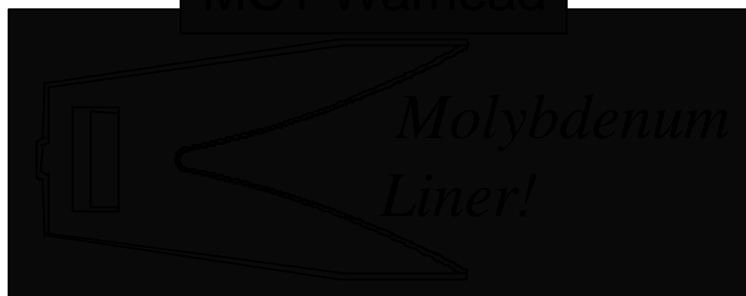
Heavy Armor SCs CL-20 & Mo Trumpets



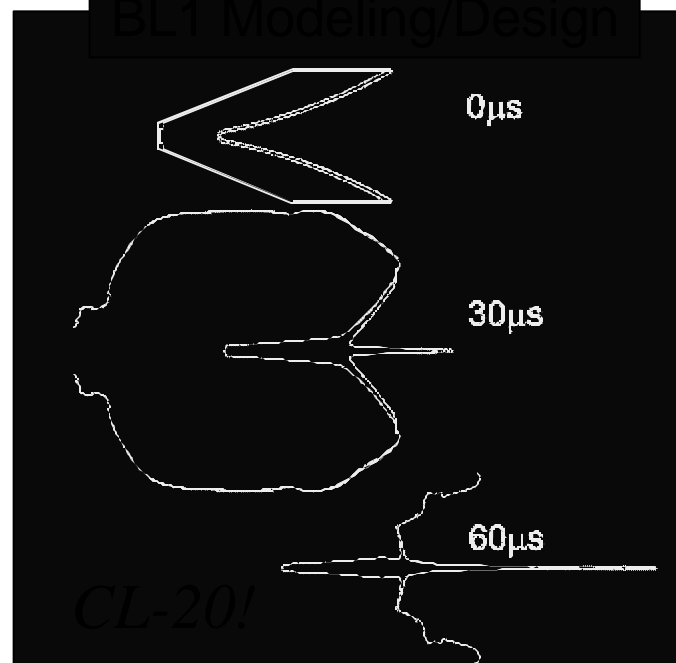
Warhead Section



MC1 Warhead



BLI Modeling/Design



RHA Penetration



Significant Performance Increases

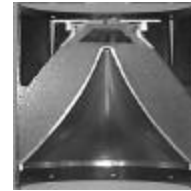


Warhead Technology Development Multi-purpose Shaped Charge



Armor Defeat

Bunker Defeat



Urban Warfare

**PENETRATION FOR
ARMOR TARGETS**



**PENETRATION/BLAST
FOR URBAN ATTACK**



**HIGH BLAST FOR
BUNKER COLLAPSE**



- *Selectable fuze*
- *High penetration provides high lethality against Armor*
- *Delay fuze provides high blast required for bunker defeat*
- *Pen/Blast combo provide increased Urban Capabilities!*
- *Inexpensive! Lightweight!*

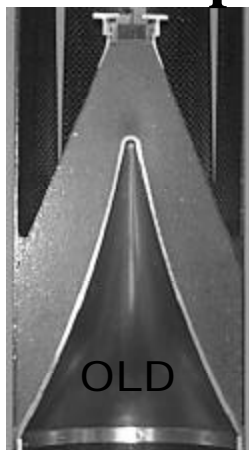
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Compact Multi-purpose SC Warhead Concept



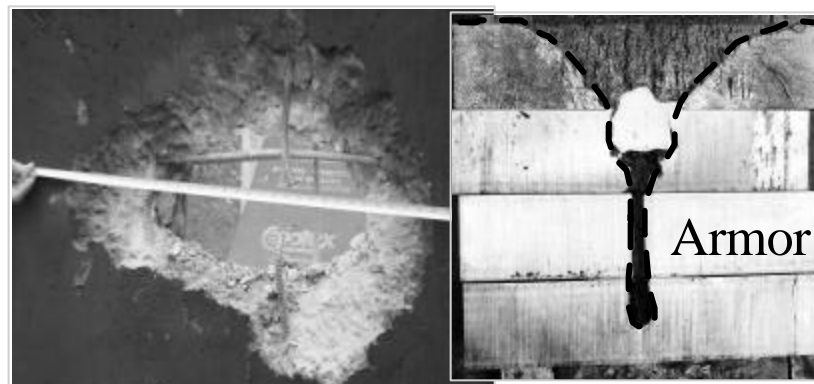
Compact Warheads



Shorter, lighter!

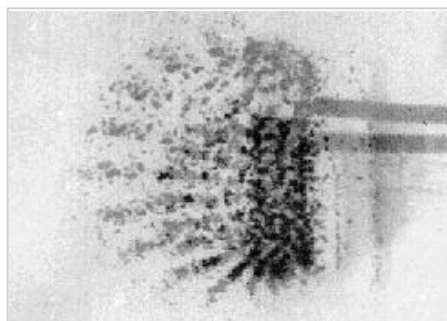


Wide Area Penetration



Defeat Walls & BMP!

Fragmentation/Blast



*Defeat Bunkers!
Defeat Helicopters!
Anti-personnel lethality!*

Multi-purpose

Deep Penetration *Defeat Tanks!*



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Explosively Formed Penetrator Warheads

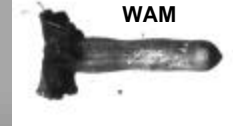


Current EFP Designs

SADARM



WAM



STAFF



**The Killer of Future Armored Target
used In Smart Munitions**

Why EFP ?

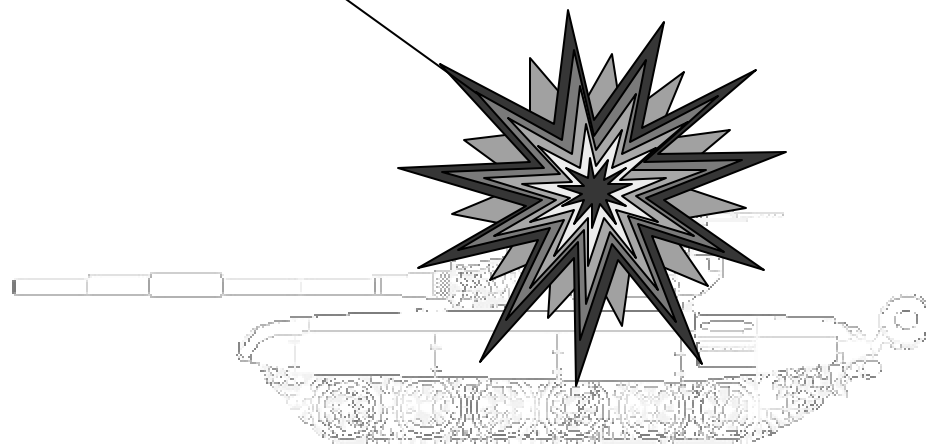
Potential Solution to Active Armor Threats

Long Standoff Target Defeat (Top Attack)

Less Affected by Reactive Armor

Large Hole / Increase Behind Armor Effects

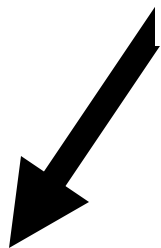
Lower System Cost (Shoot to Kill System)



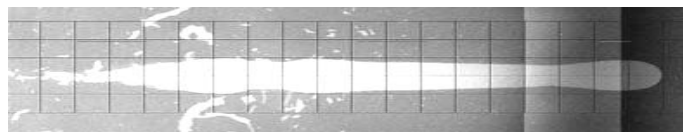
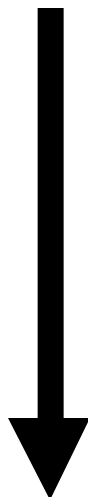
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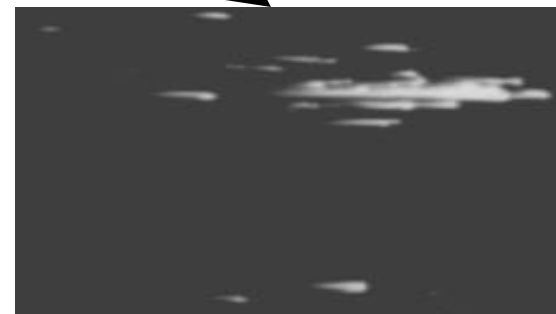
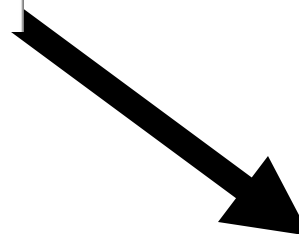
Explosively Formed Penetrator (EFP) Warhead



AEROSTABLE ROD

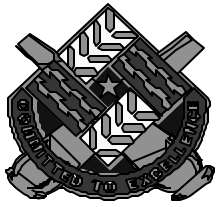


LONG STRETCHY ROD

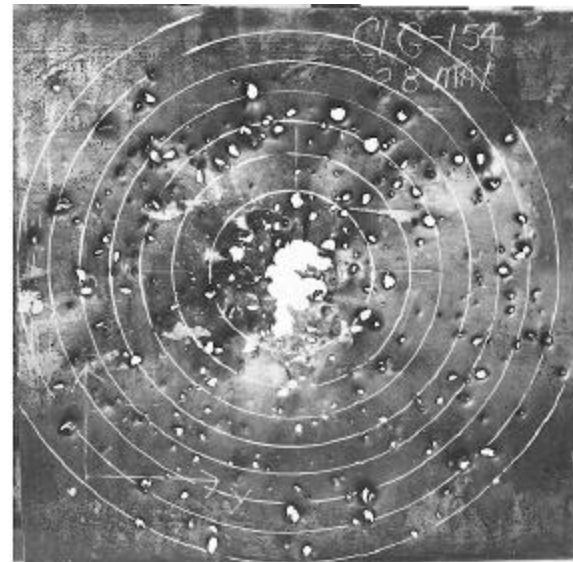
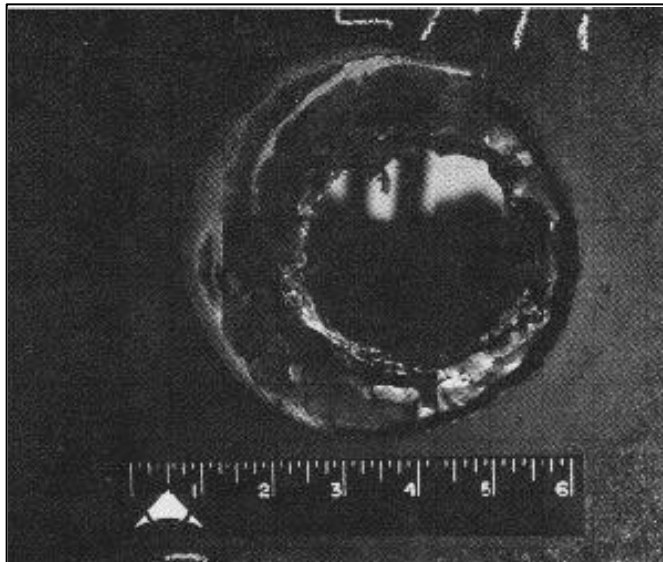
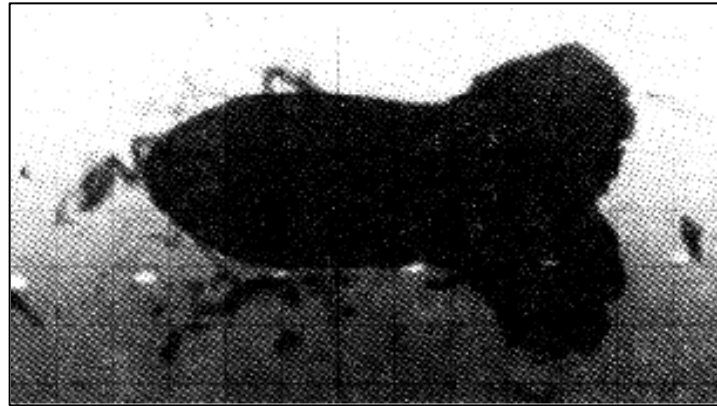


MEFP

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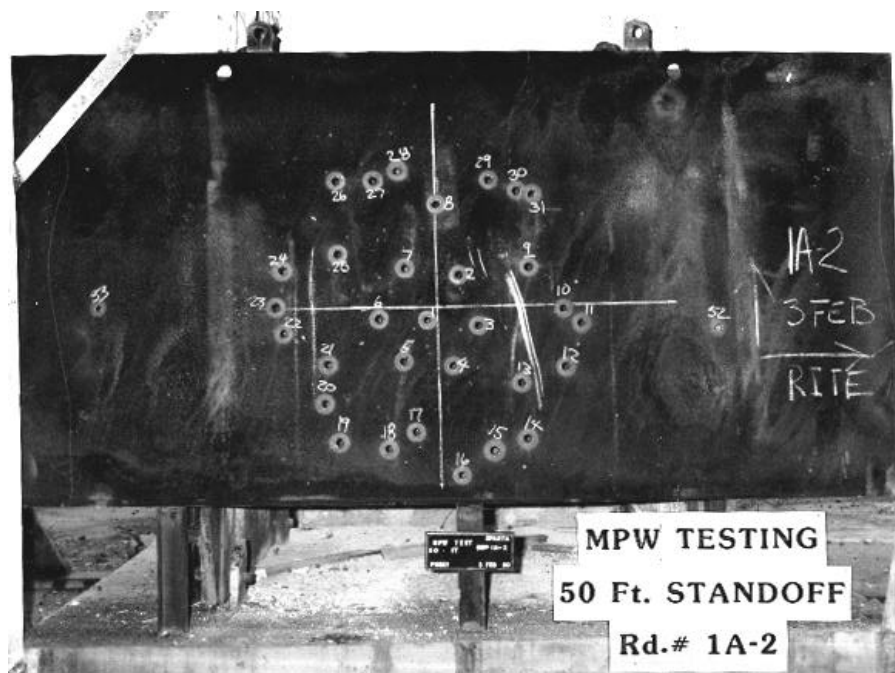
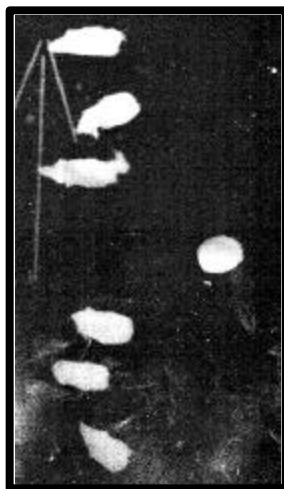
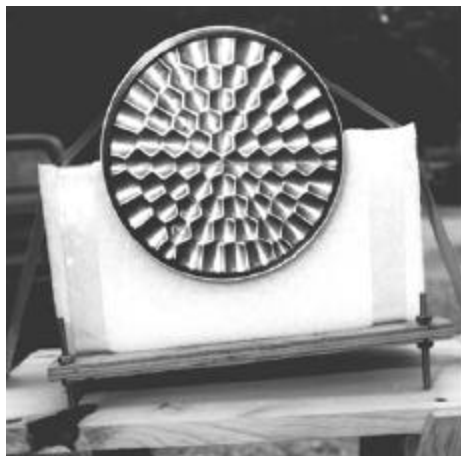
EFP Test Results



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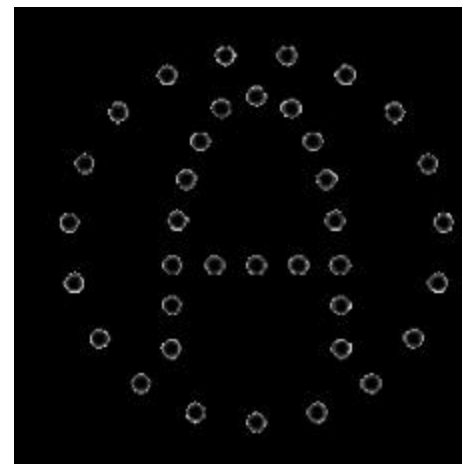
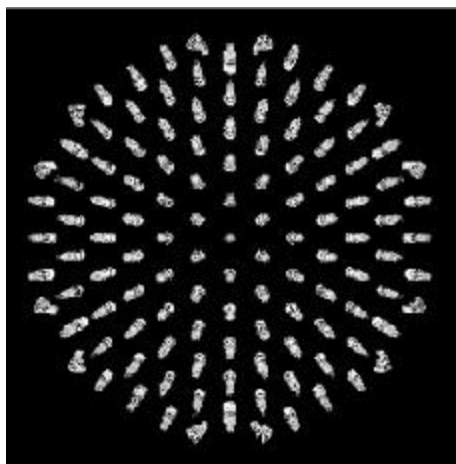
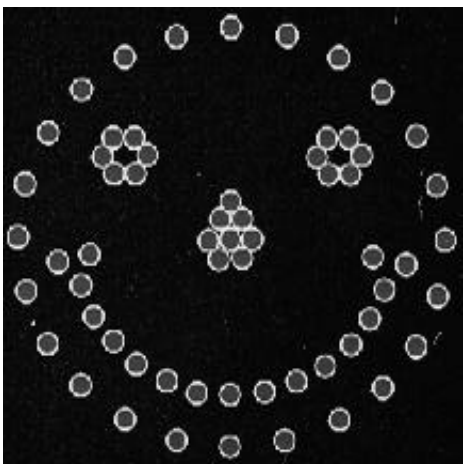
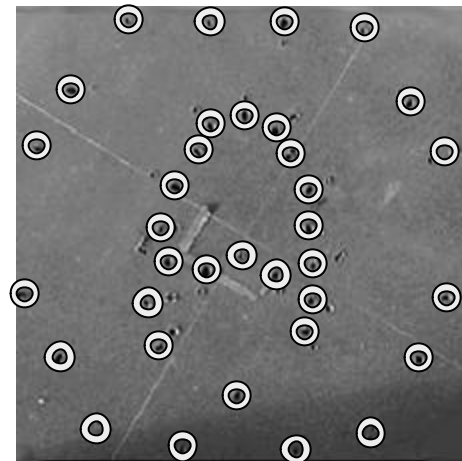
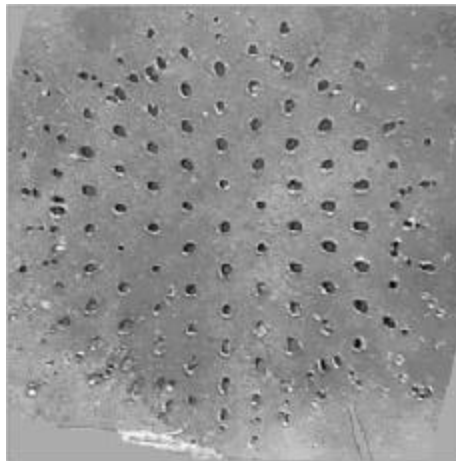
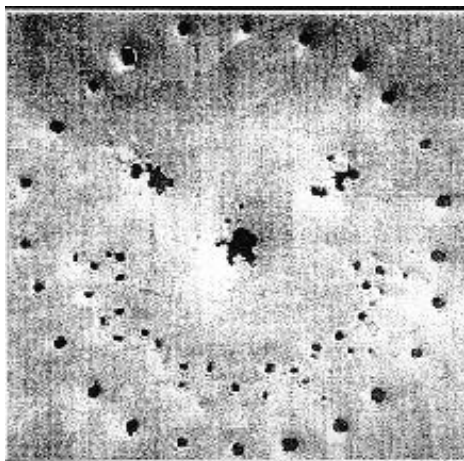
Multiple EFP Warhead



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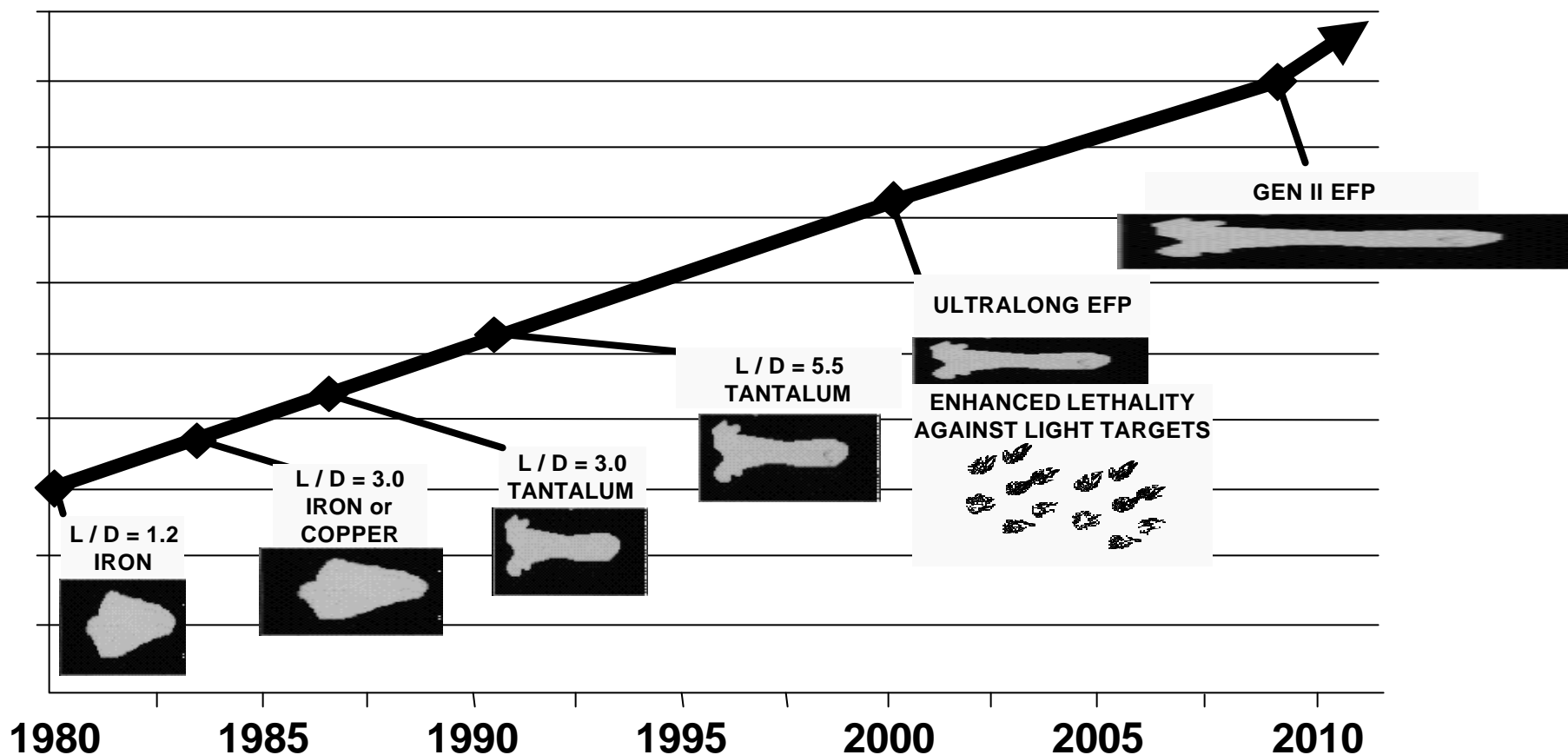
MEFP Warhead Pattern



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Lethality Growth of EFP Warheads



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EFP WARHEADS FOR FCS MUNITIONS

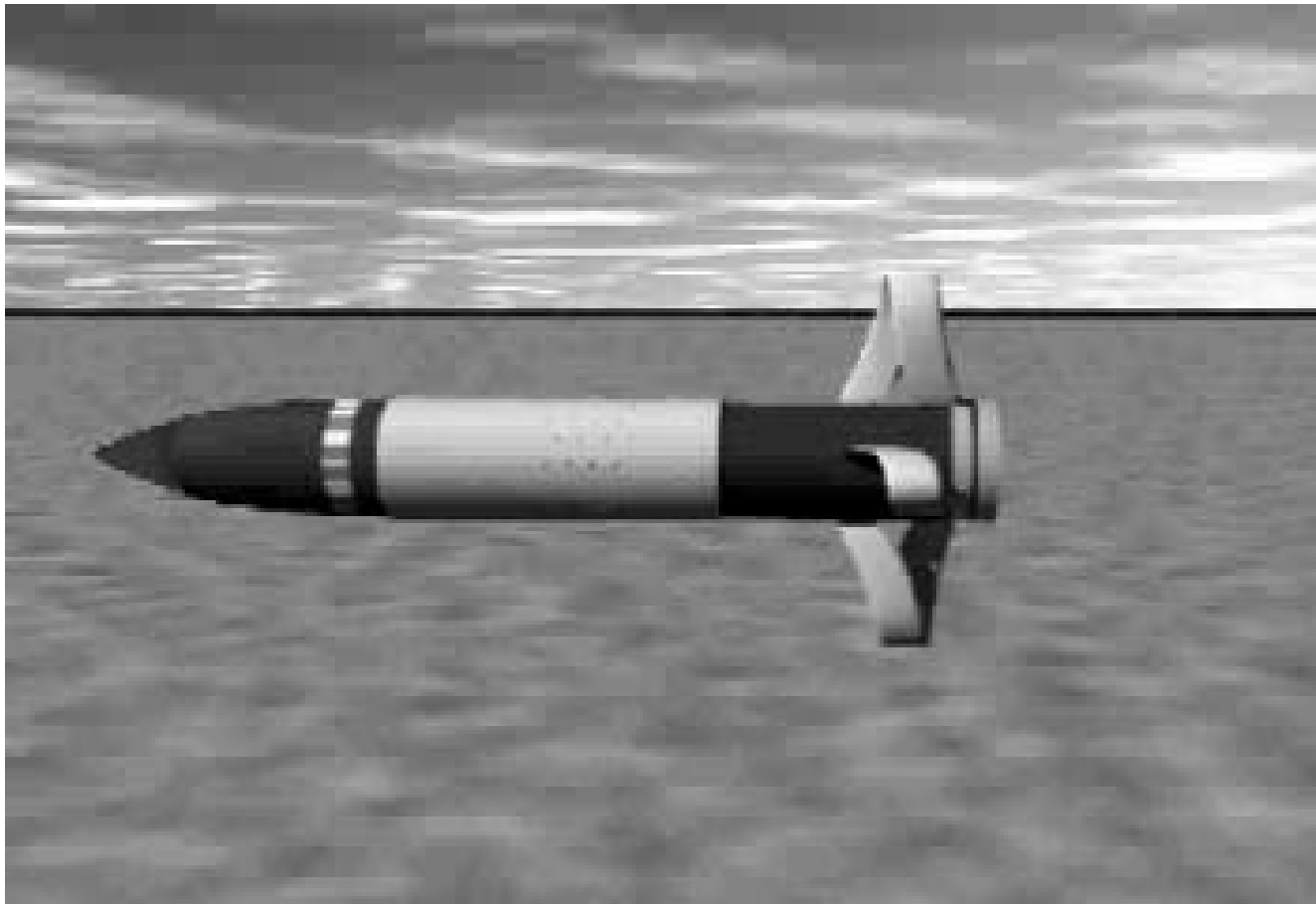
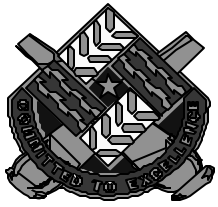


GOALS: Develop Smaller, More Lethal, Multi-Purpose, Longer Standoff EFP warheads to defeat Full Spectrum of Targets.

APPROACHES:

- **Penetration** - Collinear EFP
 - Enhanced Single Liner (ESL)
 - Gen II EFP
- **Multi-Purpose** - Selectable EFP
 - Combined Effects EFP

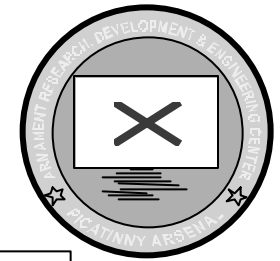
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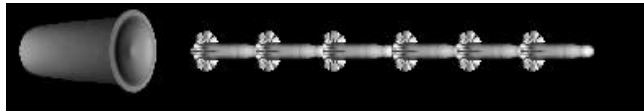
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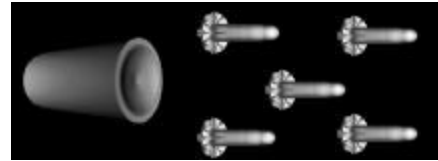
Multimode/Multiple Target EFP Warhead



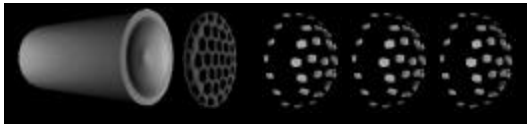
Mode 1: Main Battle Tanks (MBT)



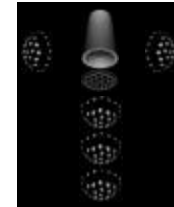
Mode 2: Armored Personnel Carriers (APC)



Mode 3: Helicopters



Mode 4: Anti-personnel

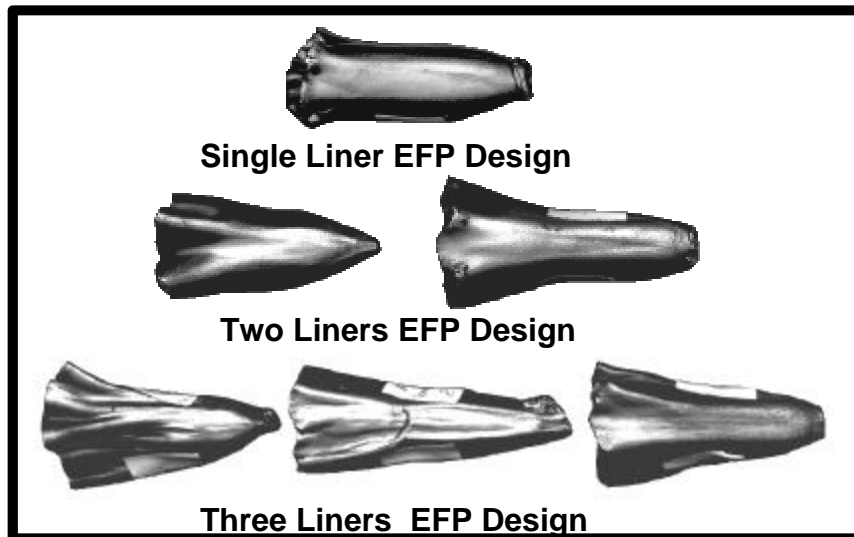
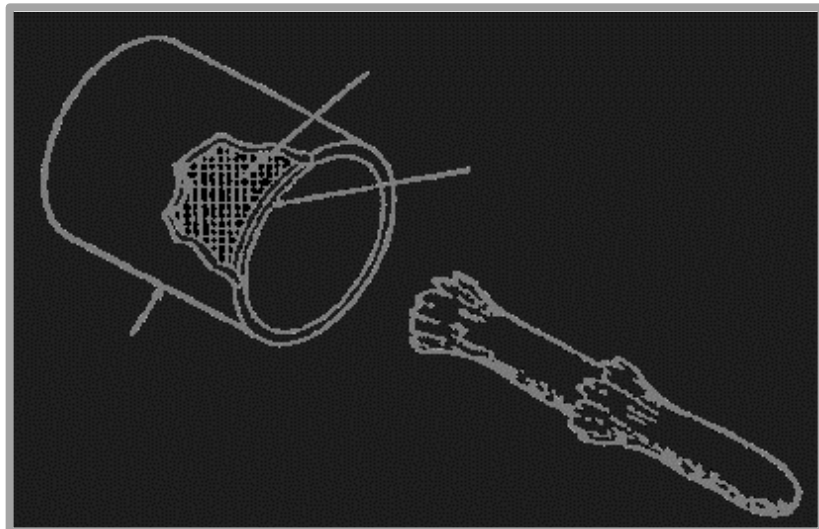


Mode 5: Anti-obstacle- Tank traps, concrete and masonry structures

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Collinear EFP Warhead



Time = 200 μ s

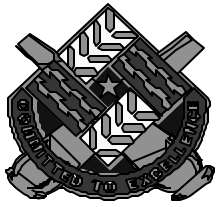


Time = 500 μ s



Time = 850 μ s

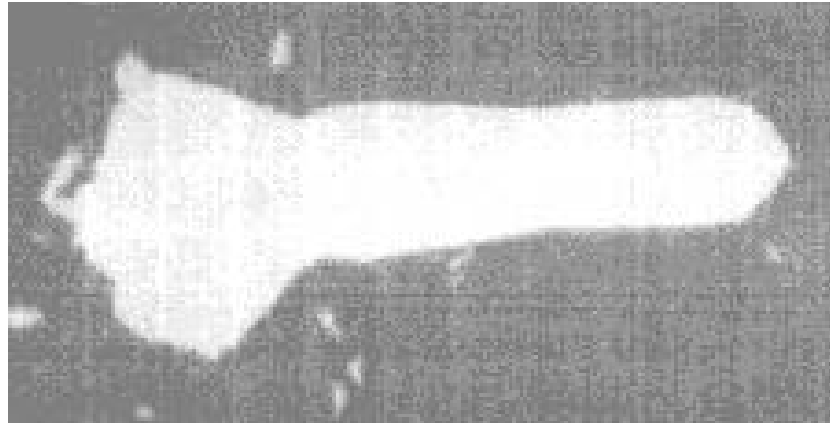
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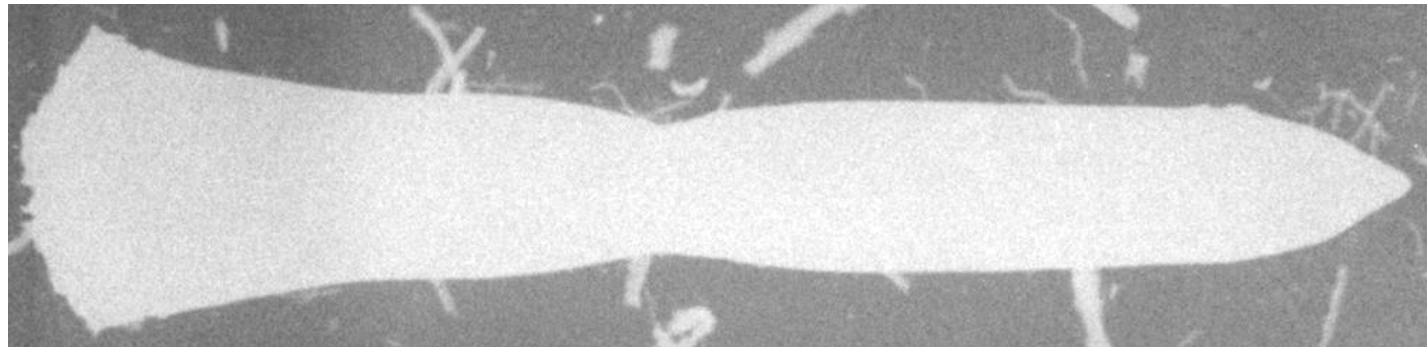
Enhanced Single Liner (ESL) EFP Warhead



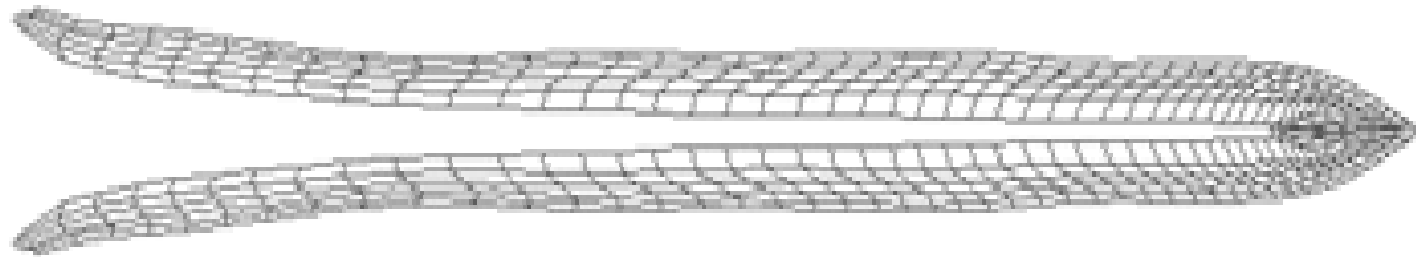
Current



ESL



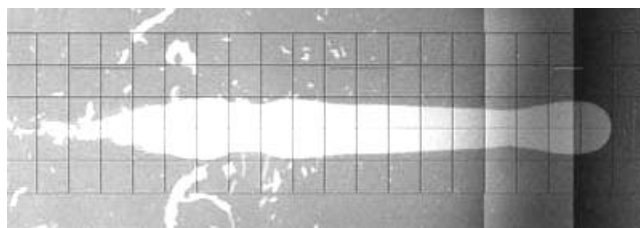
**COMPUTER
SIMULATION**



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Silver EFP Design



Entrance

Exit



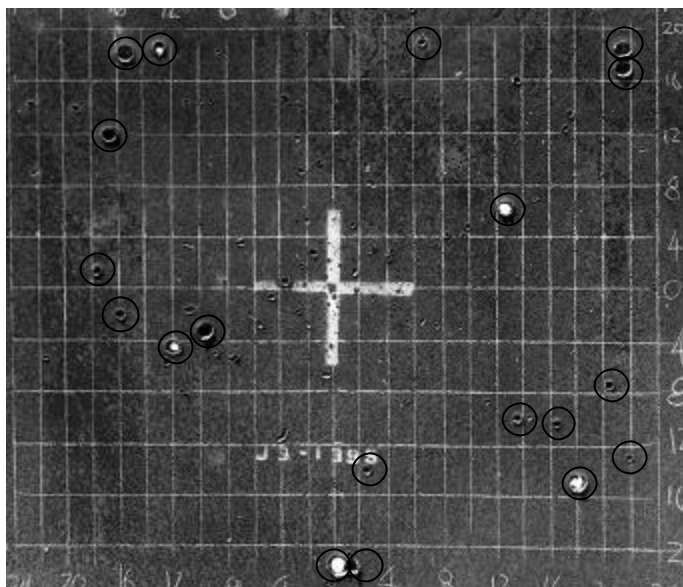
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Selectable EFP Warhead



Long Standoff EFP



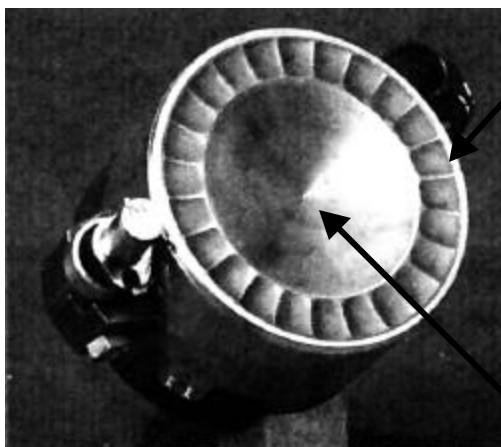
Multiple EFP Test Results



Short Standoff EFP

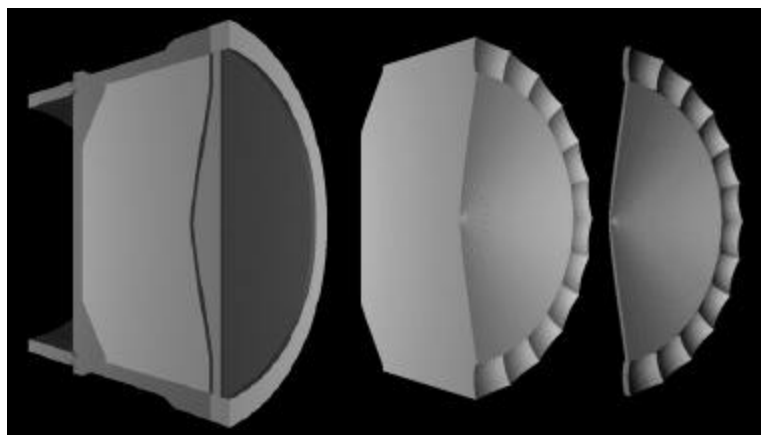
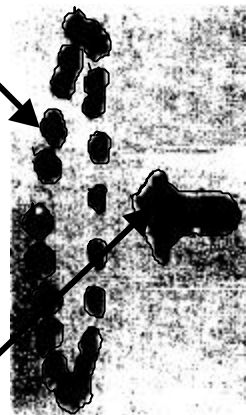


Multi-Mission/Multi-Purpose “Combined Effects” Warhead



Ring of compact secondary EFPs

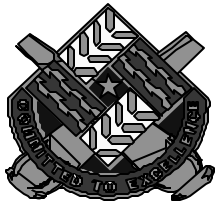
Center main EFP



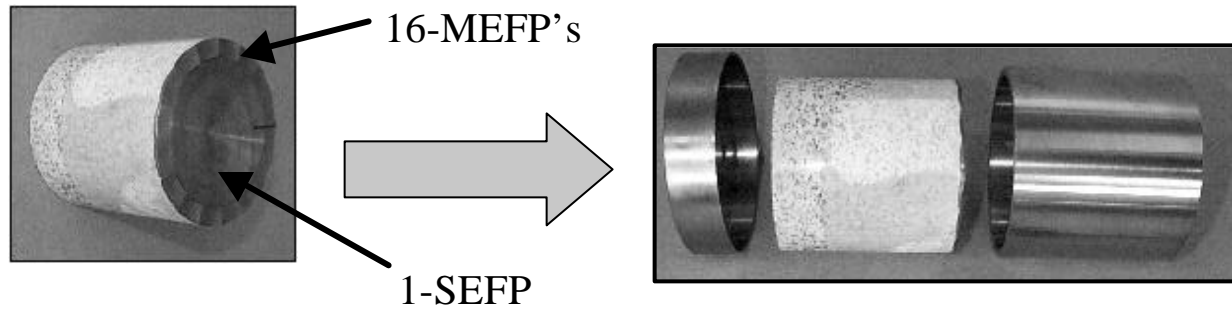
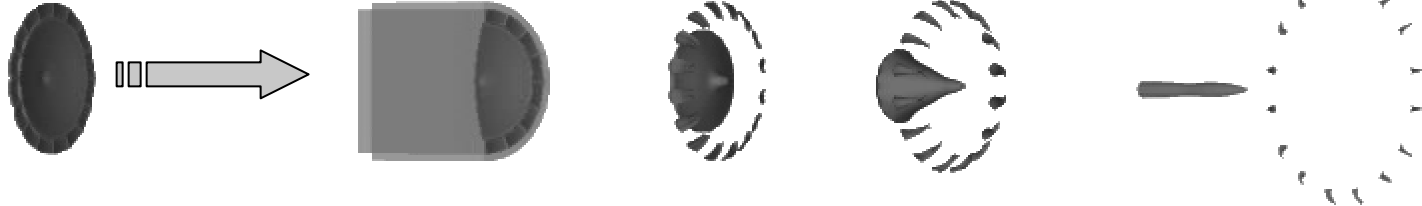
Computer Model

- **Combined Effects Warhead**
 - **Subcaliber main EFP for the defeat of primary target**
 - **Ring of smaller secondary EFPs for increased effectiveness against secondary targets**

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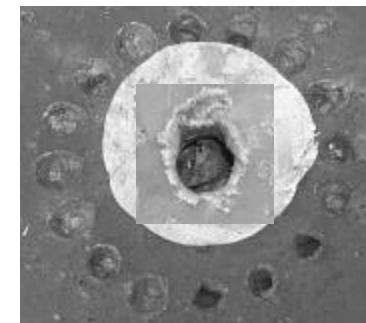
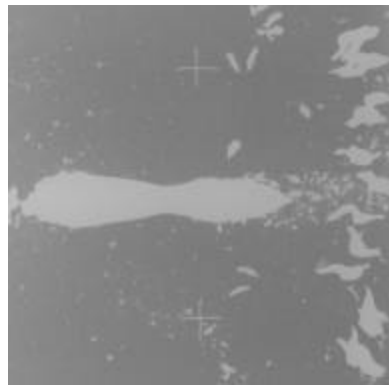
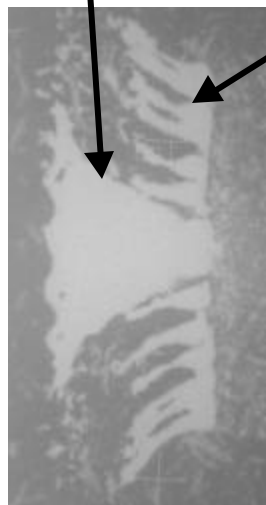


Mult-Purpose Combined Effects Warhead



SEFP

MEFP

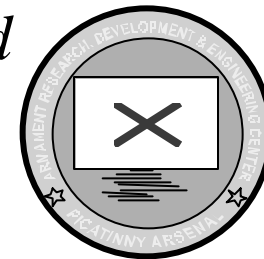


Target
Photograph

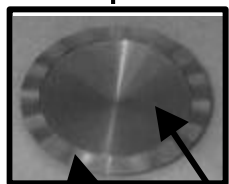
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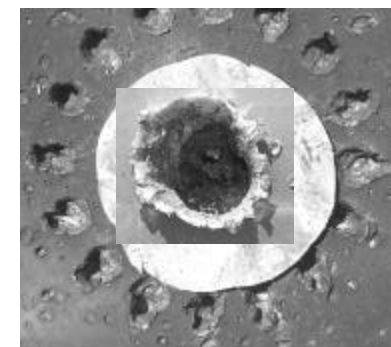
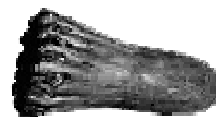
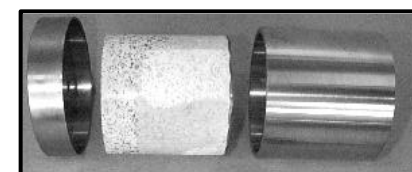
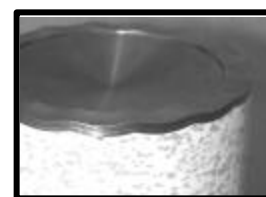
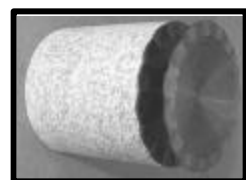
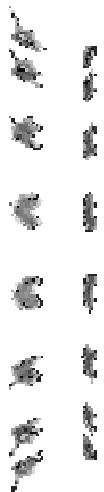
Collinear Mult-Purpose Combined Effects Warhead



+



16-MEFP's SEFP



Target Photograph

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Special Operation Forces Demolition Kit Warhead

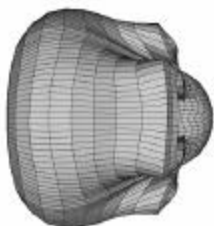


Baseline Medium Size EFP Warhead

Hit Point Accuracy



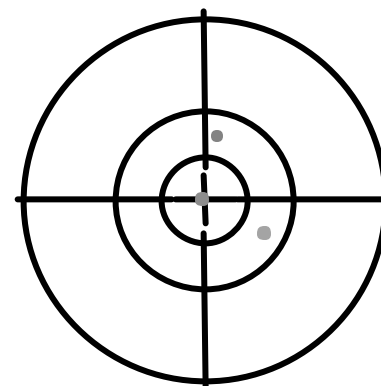
3D Computer Simulation



Cordin Photo of EFP in Flight

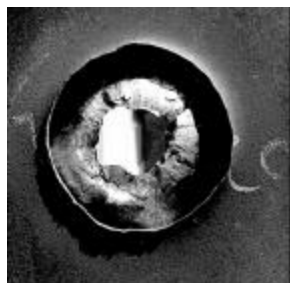


Flash X-Ray



24-inch Radius
12-inch Radius
6-inch Radius

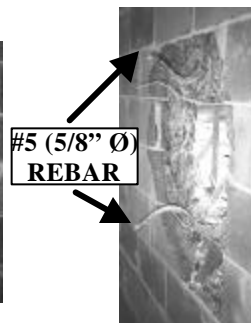
- 50 ft.
- 100M
- 150M



RHA Target (Exit)



Concrete Wall (Exit)



Brick Wall (Exit)

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Summary



- **Major Advances in Shaped Charge & EFP Warheads**
 - **Innovative Warhead Concepts**
 - **Improved Modeling Capabilities**
 - **Improved Designs**
- **Developing Enabling Technologies & Advanced Warheads for FCS Munitions**
(smaller, lighter, more lethal)