RDECOM

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

.50 Caliber Limited Range Projectile
Informational Brief for NDIA Joint Armaments Conference

Presenter: Stephen McFarlane, US ARMY ARDEC, RDAR-MEM-I

BLUF

- The Small Caliber Ammo Development team was funded to investigate the feasibility of a pyrotechnically actuated disassembling Limited Range .50 Cal bullet

- Conceptual designs were evaluated via modeling and simulation

- Proof of concept test was performed

- Results indicate the need for concept refinement and pyrotechnic mix improvement

SMALL CALIBER MUNITIONS
PICATINNY ARSENAL
NEW JERSEY

Project Objective & Warfighter Benefits

Project Objective

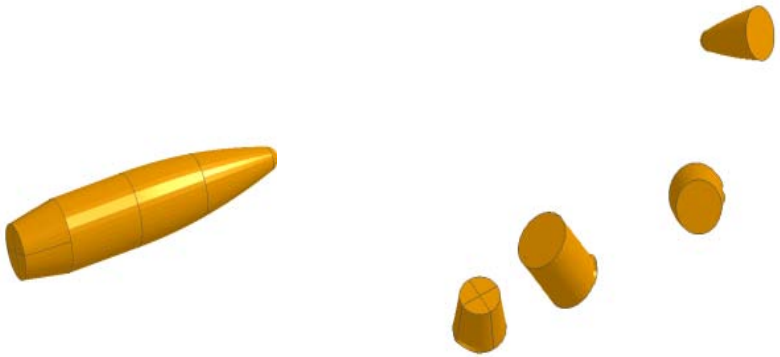
- Exploit recent advancements in structural reactive materials to create a projectile that dissembles at a predetermined time of flight

Warfighter Benefits

- Reduced risk of collateral damage
- Ballistic match with standard round to max effective range
- Decreased (design programmed) maximum range
- Caliber .50 training in range restricted areas

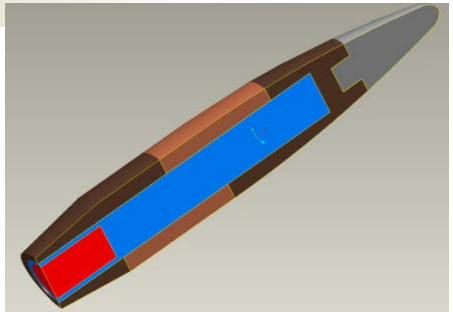
Briefing Overview

- Solid model development
- Ballistics Modeling and Simulations
- Proof of concept test and test results
- Phase 1 summary

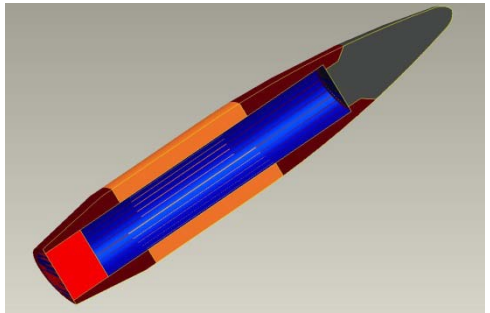


Concept 1

1st Iteration



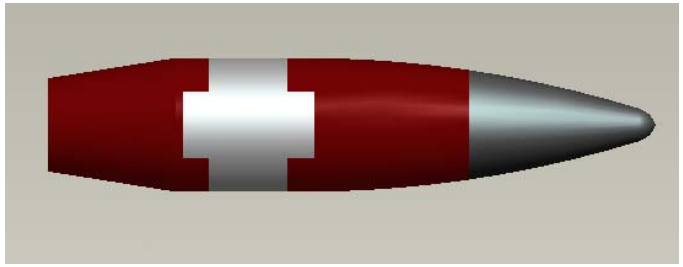
2nd Iteration

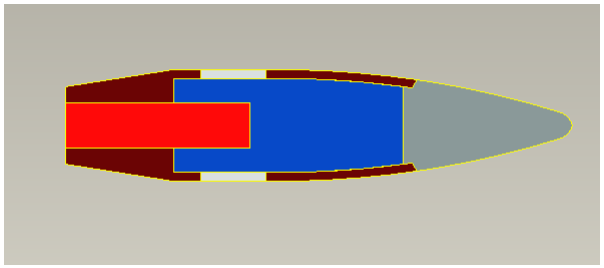


Design goal

- Initiate pyrotechnic mix with propellant during launch
- Pyrotechnic mix intended to ignite Structural Reactive Material (SRM) at predetermined position during flight
- Reacted SRM intended to result in disassembly of projectile sections

3rd Iteration

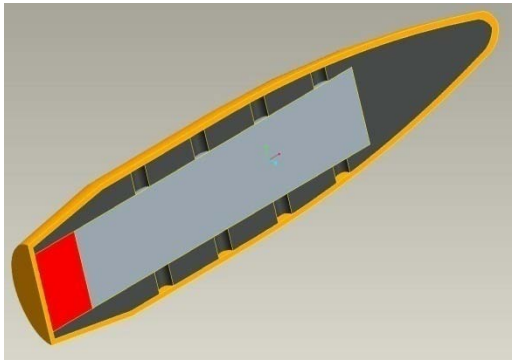




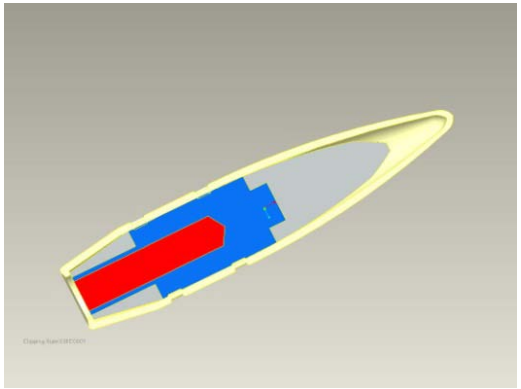
* Patent Pending

Concept 2

1st Iteration



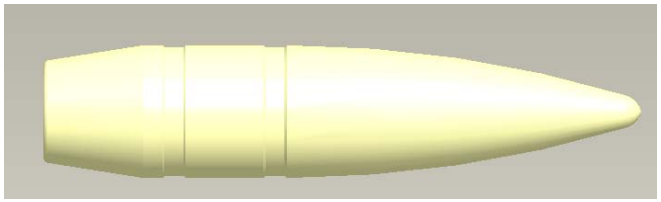
2nd Iteration

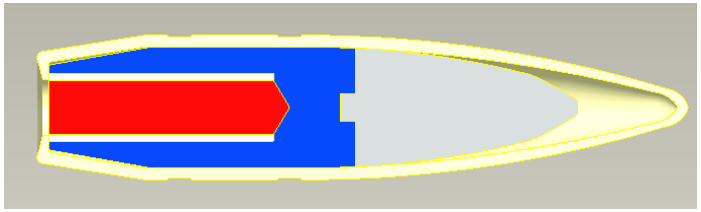


Design goal

- Initiate pyrotechnic mix with propellant during launch
- Pyrotechnic mix intended to ignite Structural Reactive Material (SRM) at predetermined position during flight
- Reacted SRM expected to melt copper jacket resulting in structural failure of the projectile

3rd Iteration

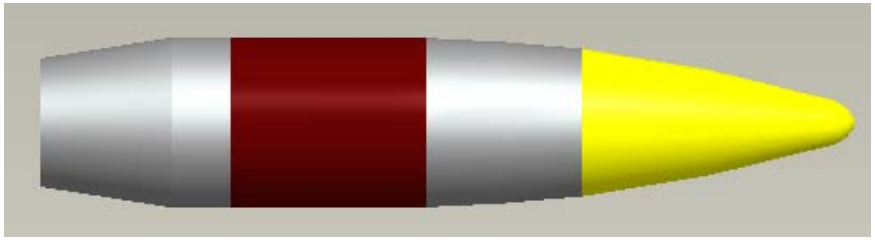


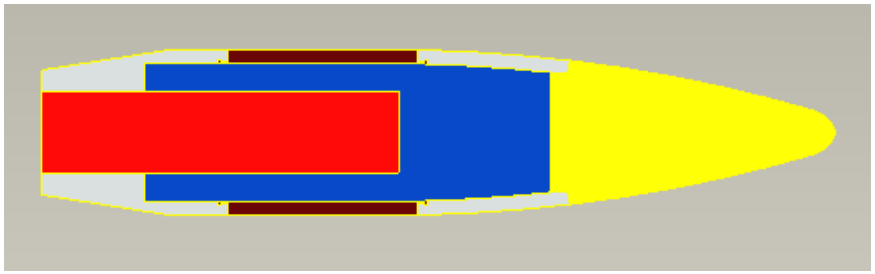


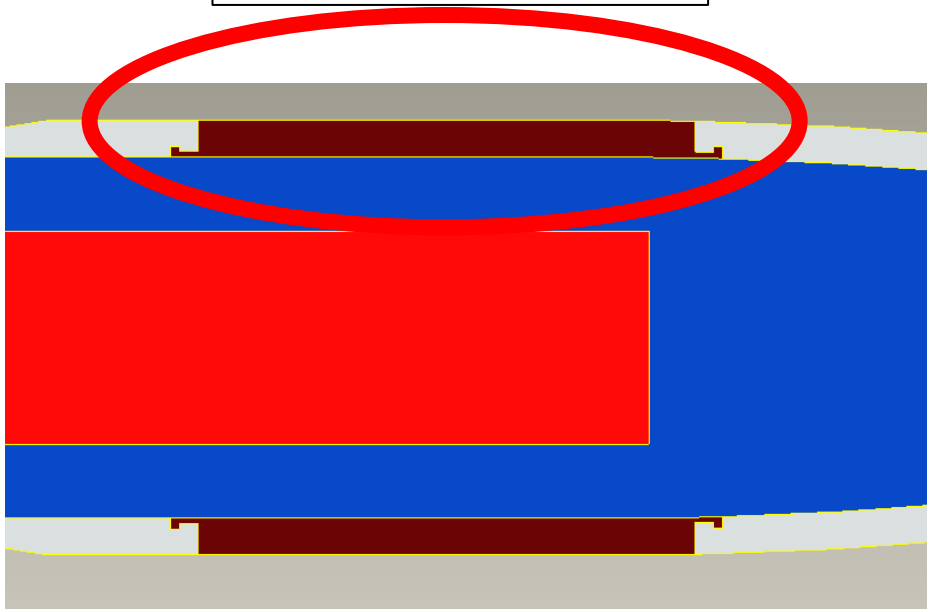
* Patent Pending

Concept 3

Snap-fit feature





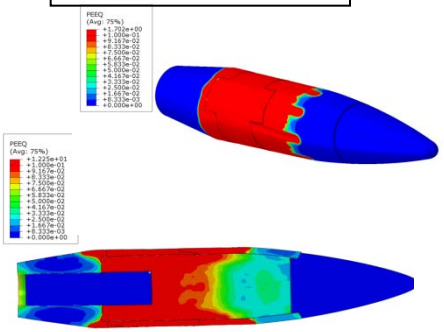


Design goal
- Similar to concept 1
- More robust interlocking feature

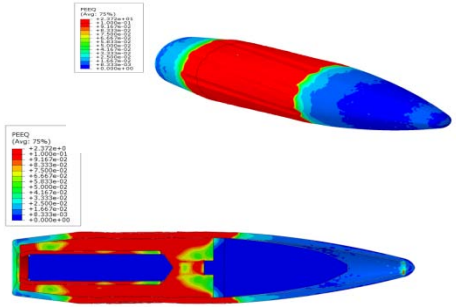
* Patent Pending

M&S Results, Interior Ballistics

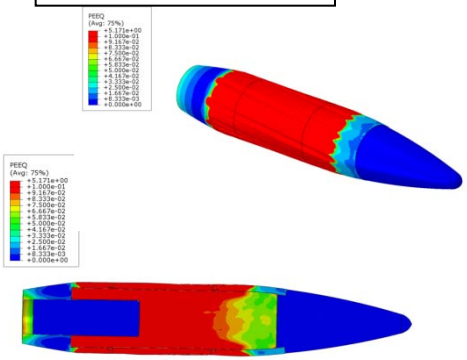
Concept 1



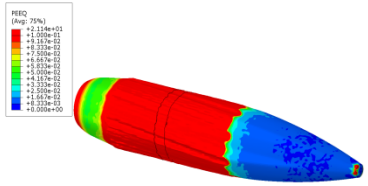
Concept 2



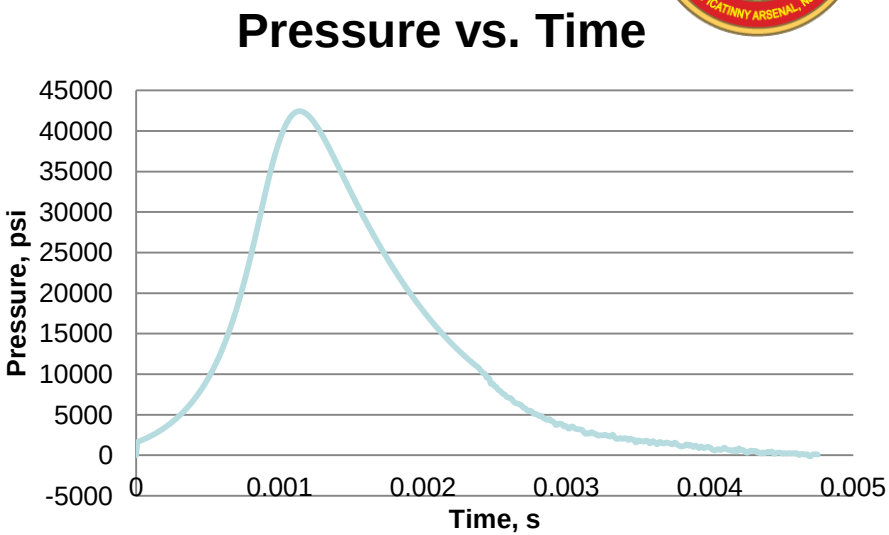
Concept 3



M8-API



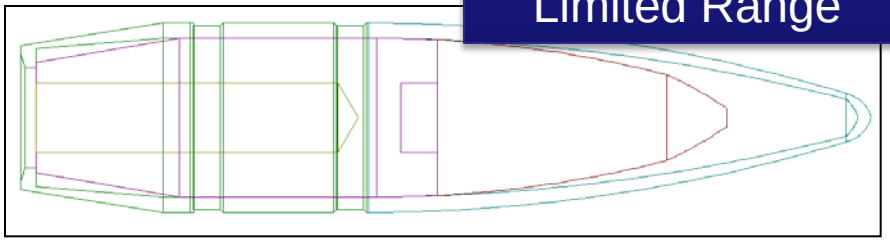
36in Barrel

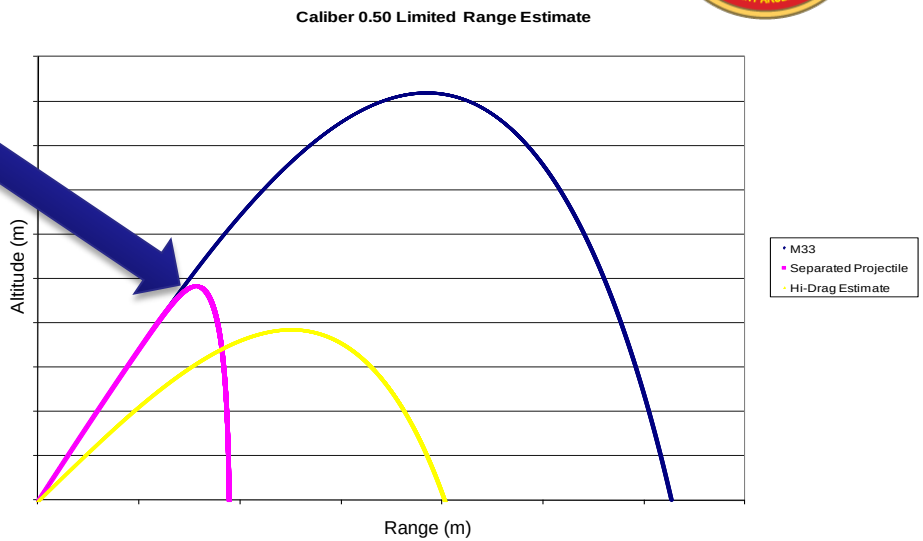


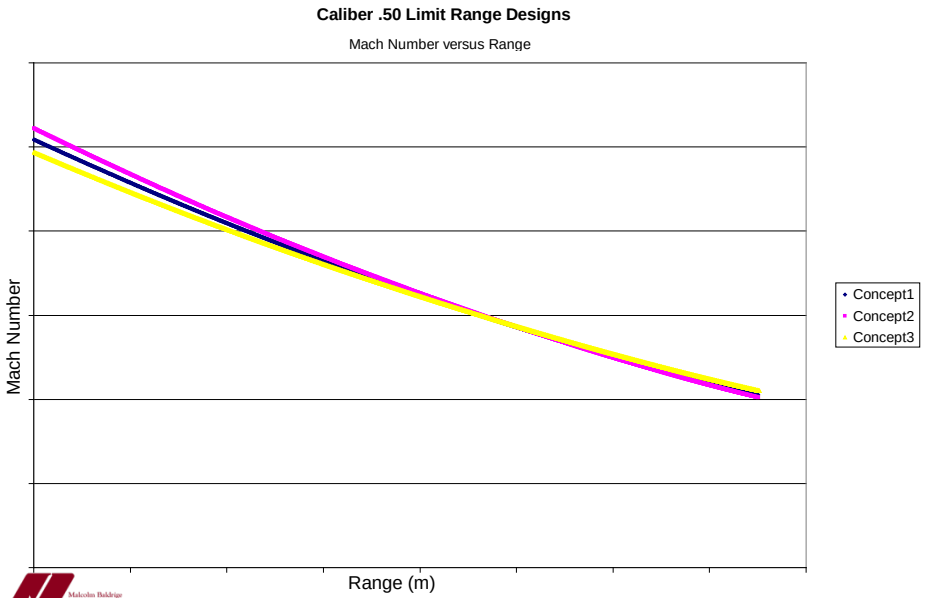
- Used theoretical M8 PT curve for 36in Barrel
- Compared the plastic strain and engraving
- Deformation evident
- All concepts will survive gun launch and have similar plastic strain as the M8
- Theoretical muzzle velocities, assuming powder charge varied to achieve PT similar to that of M8
  - Concept 1, 2910ft/s
  - Concept 2, 3096ft/s
  - Concept 3, 2620 ft/s
  - M8, 2700 ft/s

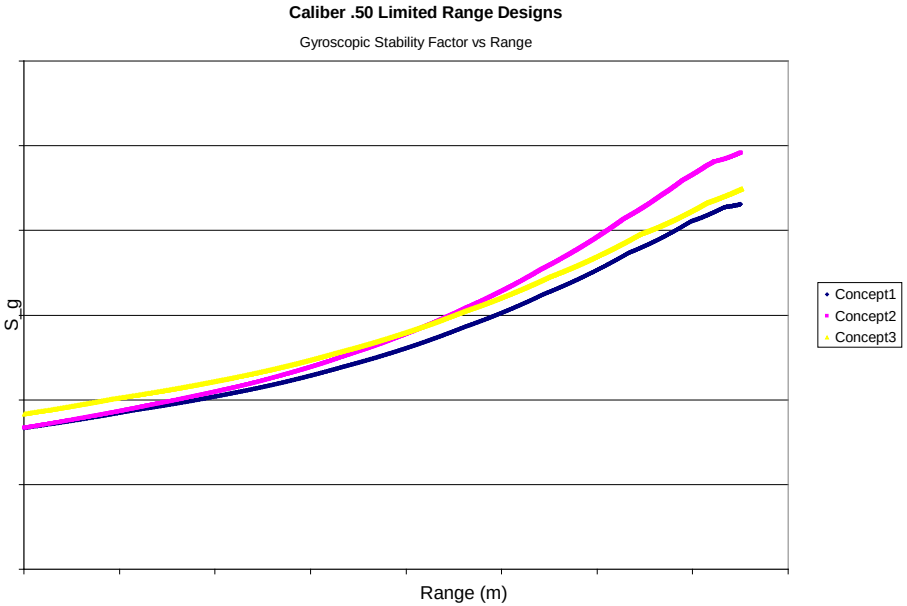
M&S Results, Exterior Ballistics

Trajectory Match
AND
Limited Range







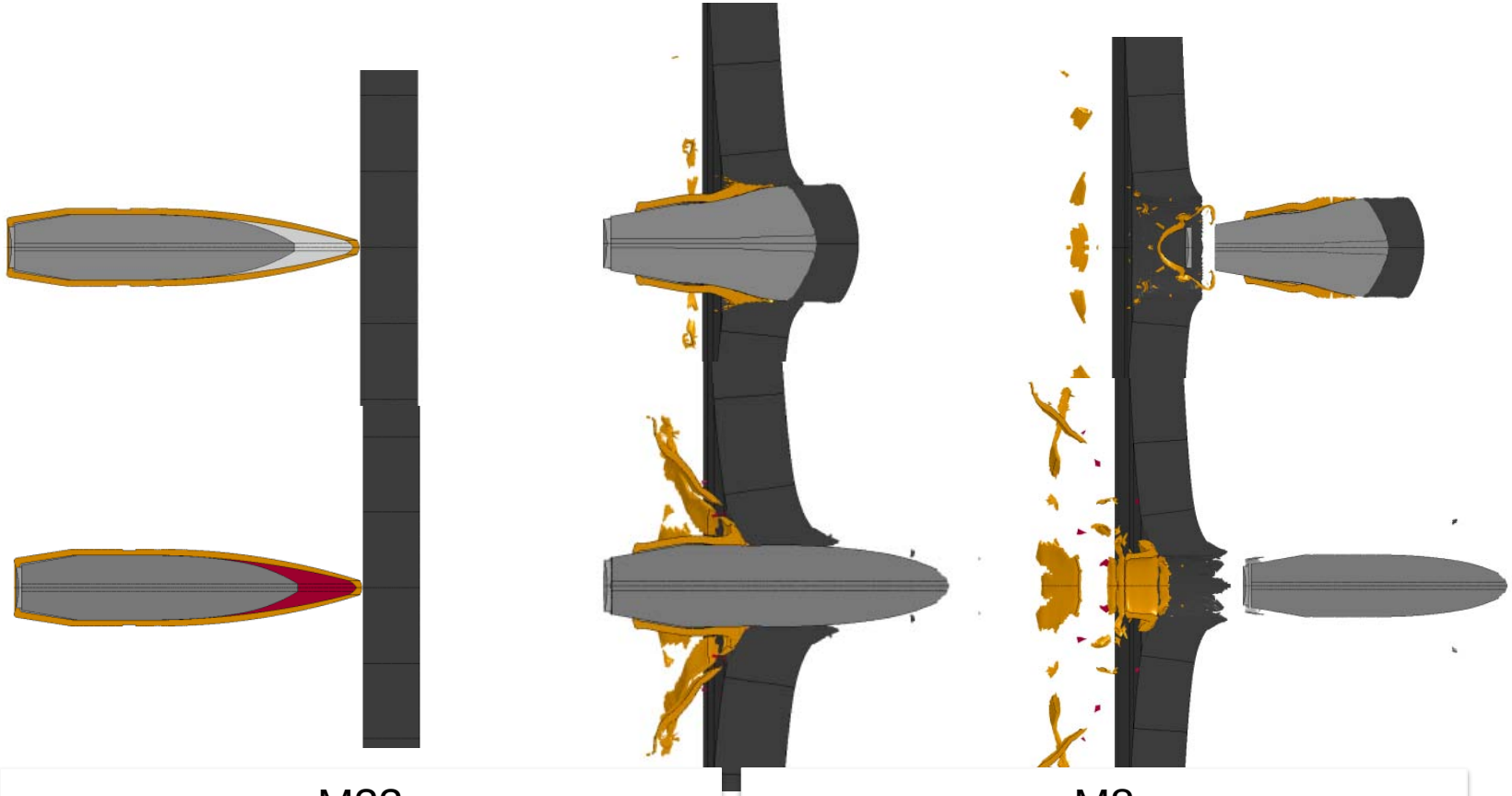


M&S Results, Terminal Ballistics M33 Cal 50 Ball

- **Penetration simulation of impact with 3/8” RHA at approximately 200m**
- **Validated penetration models with historical data (Francis Mascianica)**

M33

M8



<u>M33</u>

- Impact Velocity, Vs = 2500 ft/s
- Residual Velocity, Vr = 1297 ft/s

<u>M8</u>

- Impact Velocity, Vs = 2500 ft/s
- Residual Velocity, Vr = 1696 ft/s

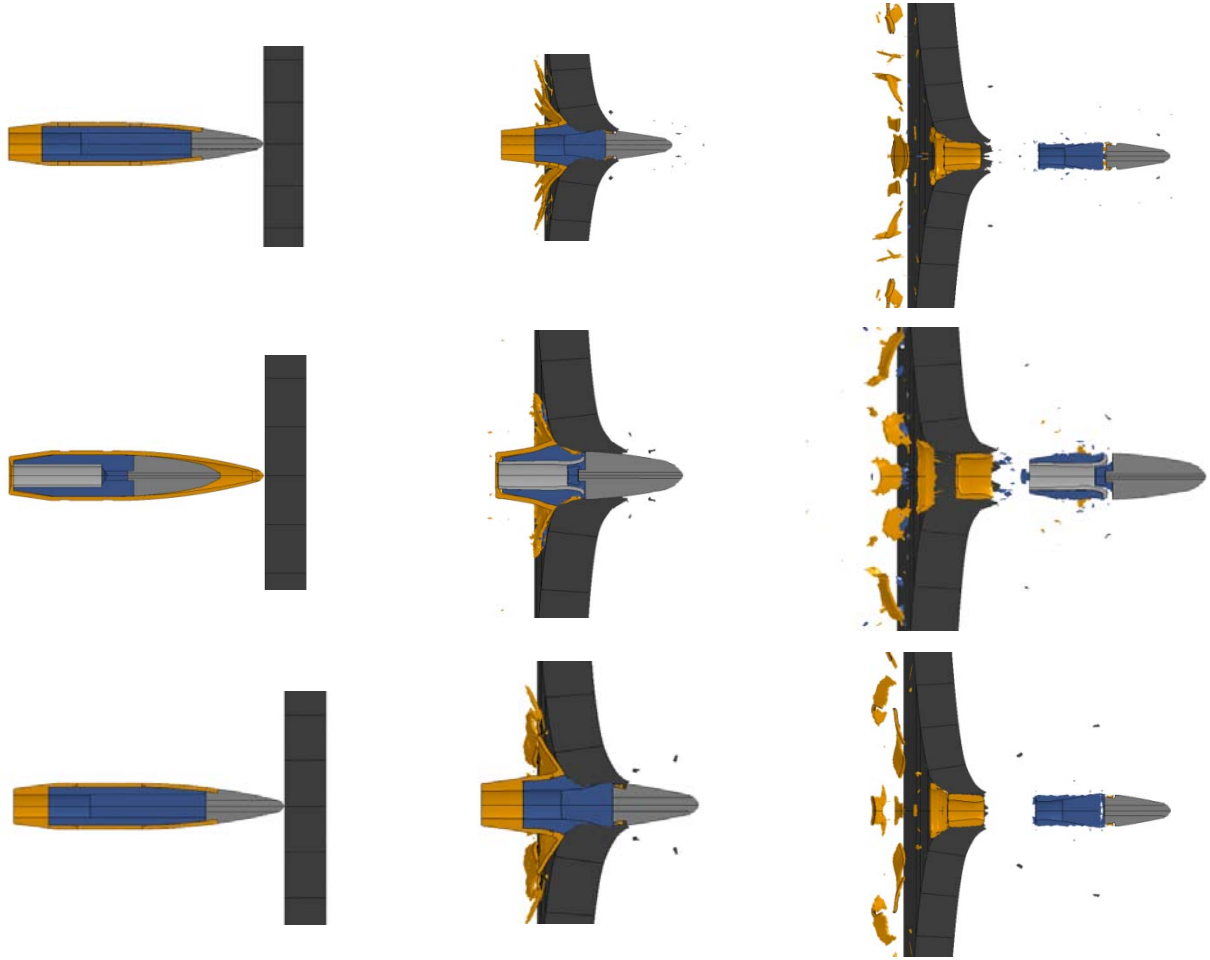
M&S Results, Terminal Ballistics

Penetration modeling against 3/8” RHA at 200m, Vs = 2500 ft/s

Concept 1
- Complete perforation
- Vr = 1667 ft/s

Concept 2
- Complete perforation
- Vr = 1592 ft/s

Concept 3
- Complete perforation
- Vr = 1708 ft/s



Limited Range Concepts have penetration capability comparable to M8

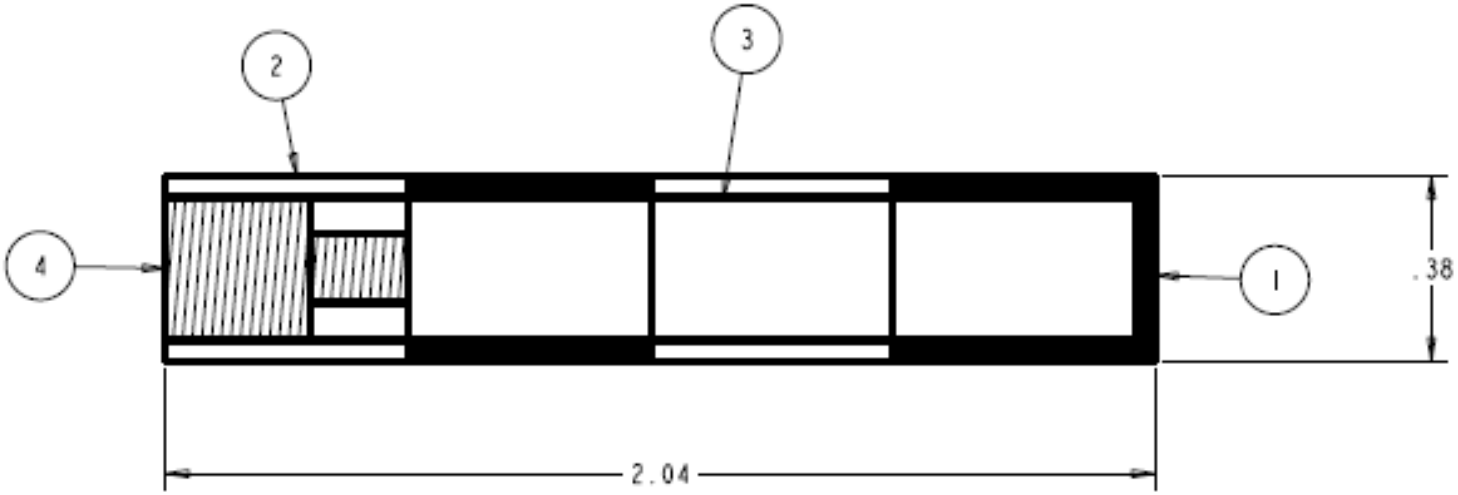
Proof of Concept Testing

Points of Observations

- Energetic (Structural Reactive Material) used
- Burn rate achieved
- Temperatures Generated (observed, not measured)
- Pressures Generated (observed, not measured)
- Initiator used, and its effectiveness at initiating the SRM
  - Tracer mix
  - RM Powder
  - Thermite mix

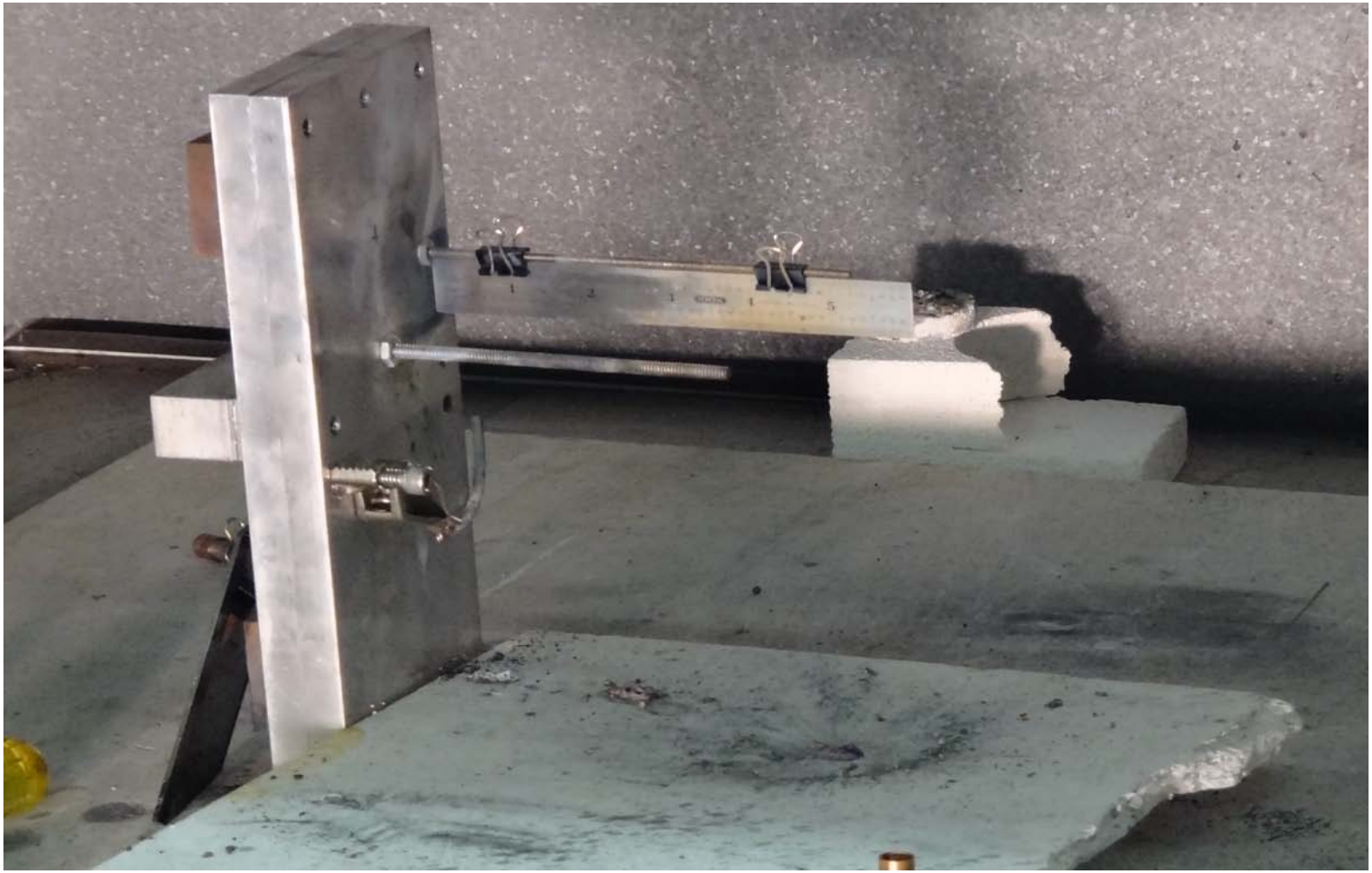
SRM Bar Initiated in Open Air

Proof of Concept Test Part



ITEM OR FIND NO.	QTY. REQ.	CAGE CODE	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	REMARKS
4	1	19200		Trace Mix	
3	1	19200		RM Core	
2	3	19200		Copper Sleeve	
1	1	19200		Closed Copper Sleeve	

Proof of Concept Test Apparatus



Proof of Concept Test

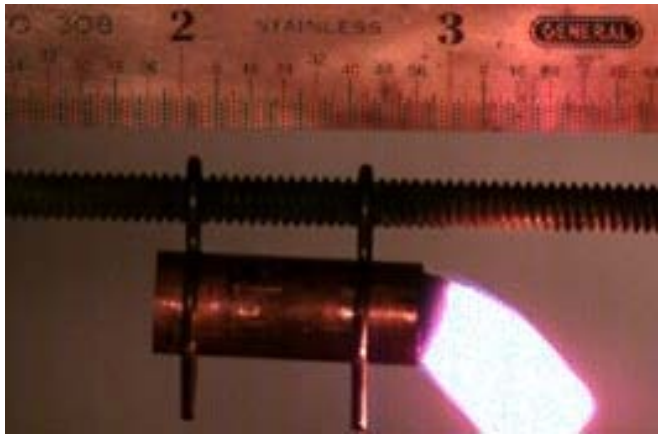
- Igniter initiated using Multi Application (MAPP) torch
- Given igniter failure, SRM initiated using MAPP torch

Proof of Concept Test

Result of Structural RM reacting inside a closed end one piece copper tube

Lessons Learned

- The product of a SRM reaction is structural yet brittle
- Heat loss from the igniter into the copper[1] tube must be minimized
- SRM heat loss via conduction into the copper[1] tube must be minimized
- Tracer mix has a low probability of initiating the SRM



1. Cu alloy 145 is 99.5% Cu, 0.0 – 0.7% Te, 0.0 – 0.012 P

Phase 1 Summary

- Developed projectile design concepts
- Performed M&S to predict projectile capabilities
  - All projectiles concepts will survive launch
  - All projectile concepts are gyroscopically stable
  - All projectile concepts exceed the penetration capability of the M33
- Performed proof of concept test
  - SRM is difficult to ignite
  - When ignited SRM is able to melt copper alloy 145
  - May need to insulate igniter mix and SRM to reduce heat loss, via conduction, into surrounding materials
  - SRM reactant is structural yet brittle
- Program at TRL 3

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