

GENERAL DYNAMICS

Ordnance and Tactical Systems

20mm M940 MPT-SD vs. M246 HEI-TSD

Ground to Air Performance Comparison

41st Annual Gun & Missile Systems Conference

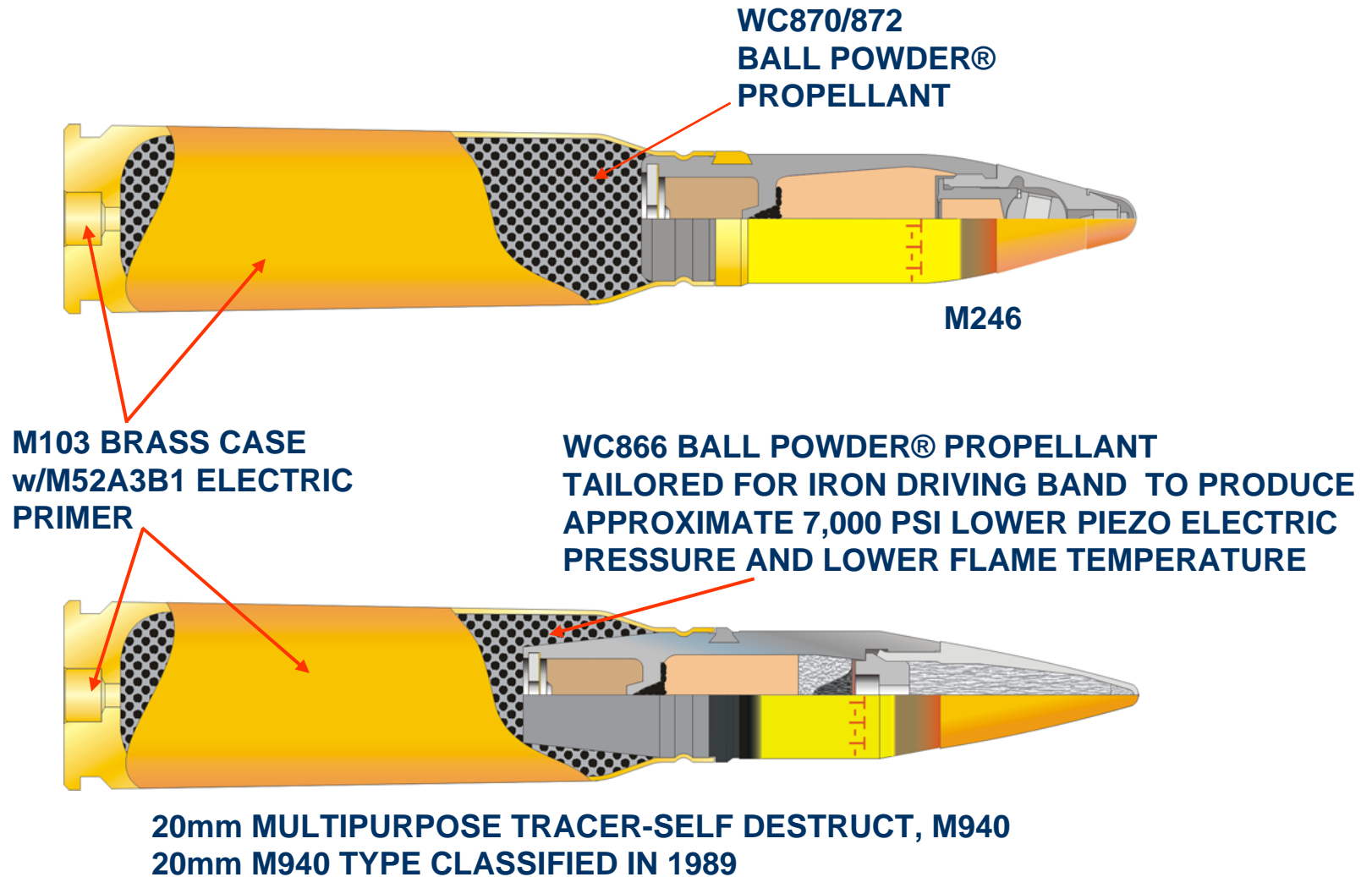
By D.E. Dillard, P.E.

M940 vs M246

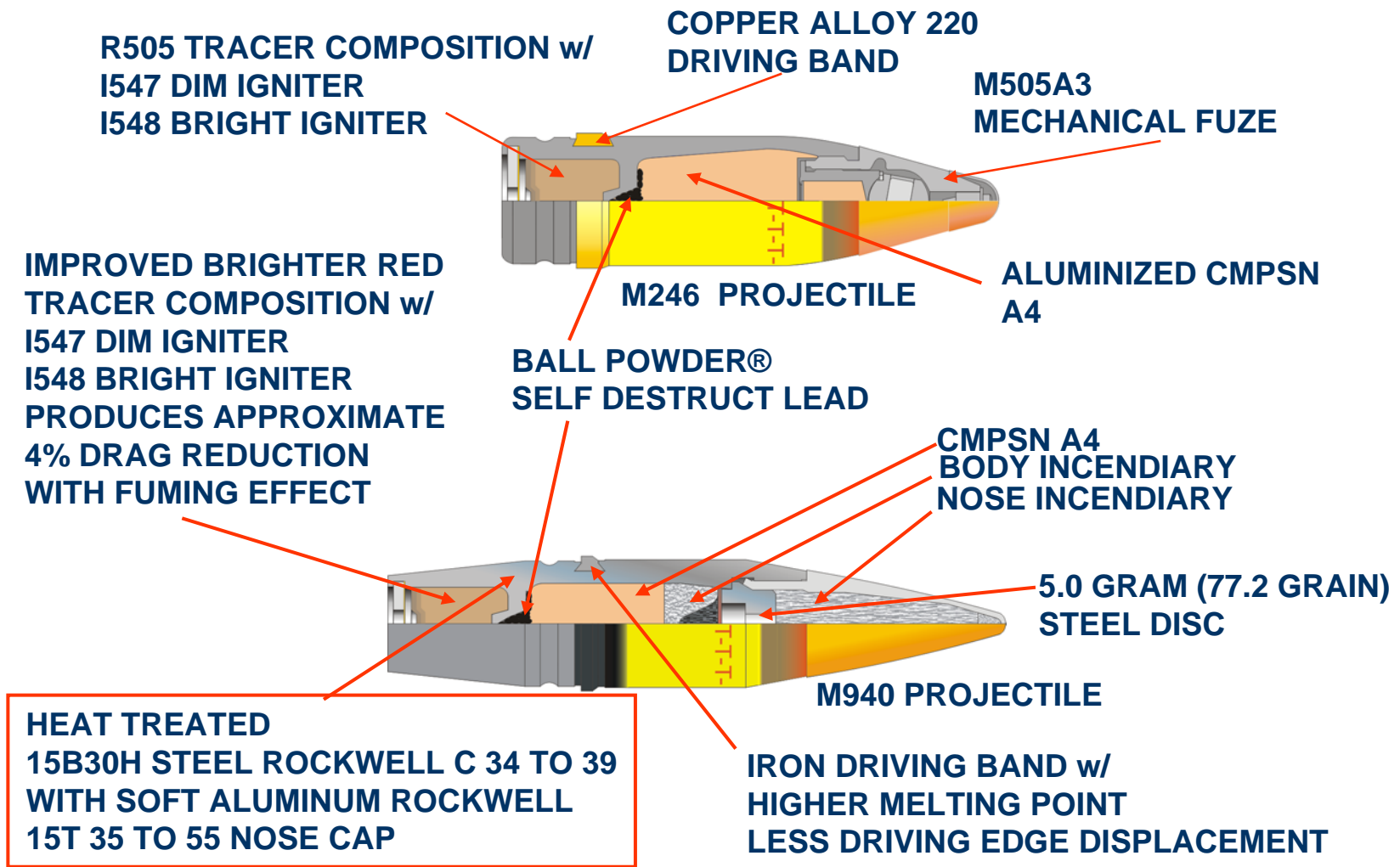
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20mm MPT-SD, M940 CARTRIDGE DESCRIPTION



20mm M940 PROJECTILE DESCRIPTION



20mm M940/M246 BALLISTIC PERFORMANCE COMPARISON

SPECIFICATION REQUIREMENT	M246 MIL-C-60678	M940 MIL-C-70793	COMMENT
Fragmentation Ten plate Array (.080 inch followed by 9each .040 inch 8.0 inch spacing	-	Minimum 8 perforations in tenth plate	Large M940 projectile body fragments carry effectiveness deep into threat
Armor Penetration 3/8 inch RHA @ 45° R ₅₀	-	547 Yards minimum (1640 ft)	M940 Armor Penetration performance exceeded requirement. Effective at 1094 yards (3,282 ft)

20mm M940 PROJECTILE TIME AT RANGE

RANGE METERS	M940 TIME TO RANGE SECONDS	M246 TIME TO RANGE SECONDS	M940 TIME AT RANGE DELTA SECONDS
1000	1.2651	1.4537	-0.1886
1500	2.2558	2.829	-0.5732
1800	3.065	3.8782	-0.8132
2000	3.69	-	-

M940 CAN EFFECTIVELY ENGAGE INCOMING THREAT AT GREATER DISTANCE
3.8 SECOND MINIMUM AVERAGE BURN TIME TO SELF DESTRUCT = GREATER RANGE FOR M940

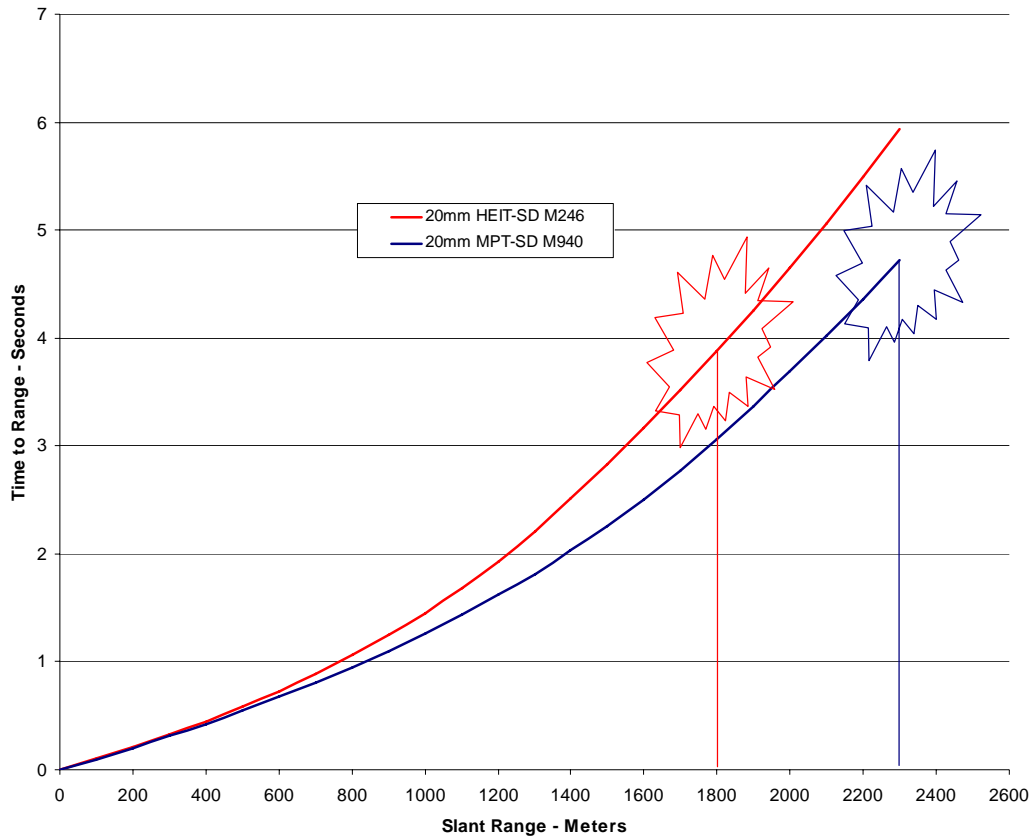
20mm M940 PROJECTILE VELOCITY AT RANGE

RANGE METERS	M940 VELOCITY METERS/SEC	M246 VELOCITY METERS/SEC	VELOCITY DELTA METERS/SEC
1000	600.7	460.8	139.9
1500	422.74	305.9	116.84
1800	332.7	269.5	63.2
2000	306.64	-	-

HIGHER M940 VELOCITY AT RANGE INCREASES RELIABILITY FOR FUNCTION AND INCREASED PENETRATION EFFECTIVENESS

20mm M940 PROJECTILE TIME AT RANGE

Time at Slant Range



20mm MPT-SD, M940		
TEMP ° C	TIME TO SELF DESTRUCT SECONDS	
	MINIMUM	MAXIMUM
-54	4.73	5.78
+21	4.52	5.05
+60	3.85	5.64

**M246 AVERAGE SELF DESTRUCT RANGE APPROXIMATELY 1800 METERS
 ACCEPTED M246 EFFECTIVE RANGE WITH PIVADS APPROXIMATELY 1200 METERS
 M940 DEMONSTRATED FUNCTION AT 2000 METERS AND SELF DESTRUCT AT 2300 METERS**

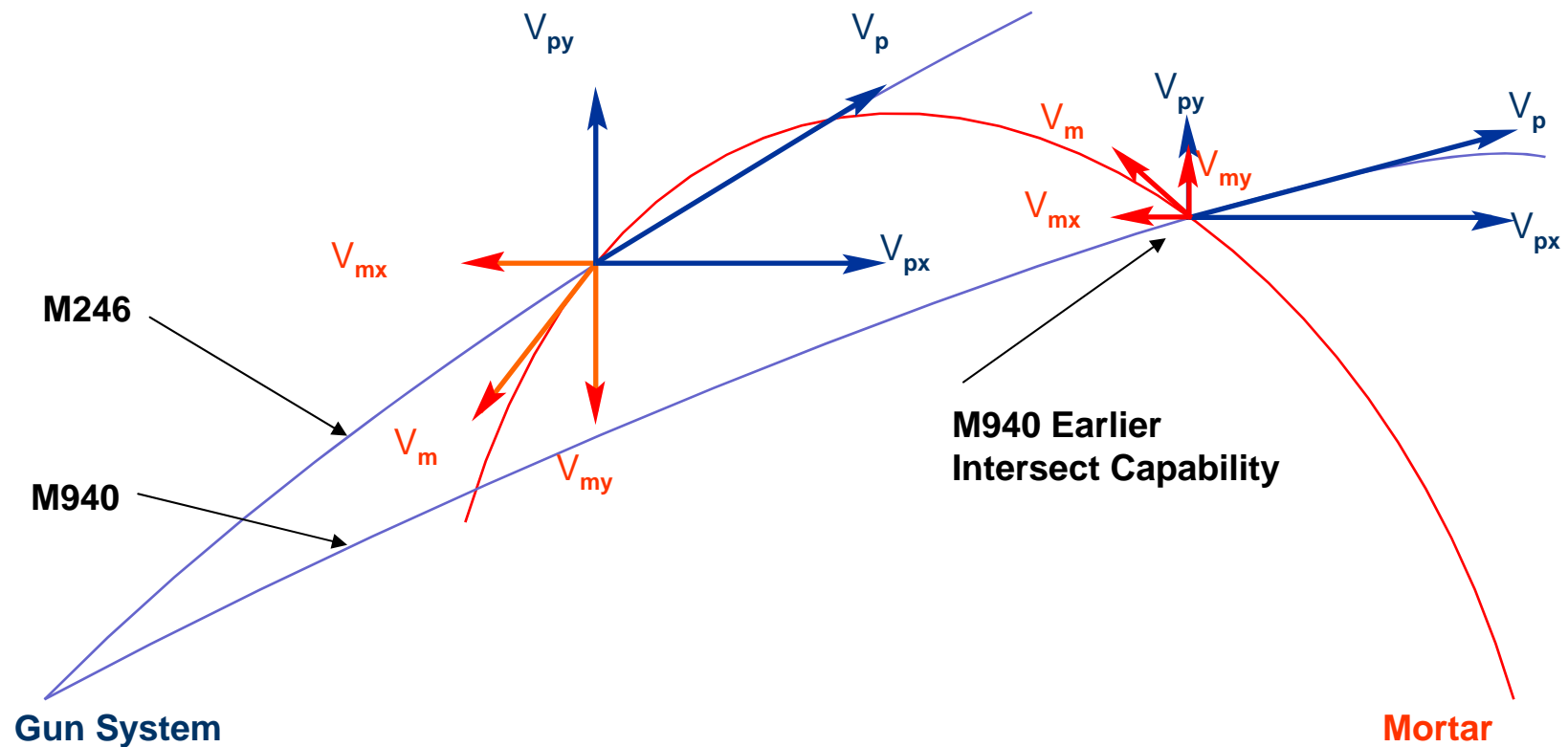
20mm M940 PROJECTILE DISPERSION

CARTRIDGE TEMP °C	NO. OF 10 SHOT TARGETS	AVERAGE MEAN RADIUS AT 500 M INCHES (MILS)
-54	3	5.4 (0.27)
+21	2	6.2 (0.32)
+60	3	6.8 (0.34)
COMPOSITE JUMP PREDICTION FOR M940 IS 19% LESS THAN PREDICTED FOR M246		

**LOWER M940 DISPERSION IS RESULT OF BETTER BALANCE OF PROJECTILE
CENTER OF GRAVITY AND TRANSVERSE MOMENT OF INERTIA.**

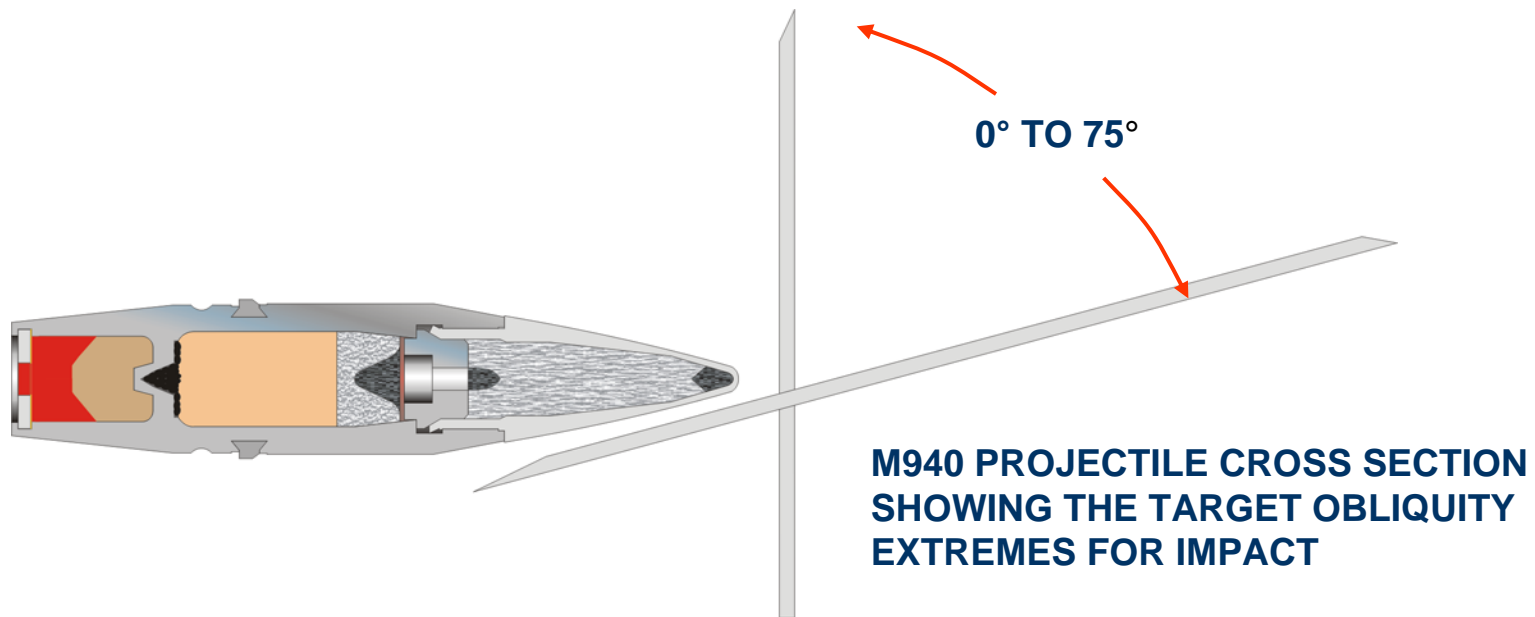
**(THESE CHARACTERISTICS ARE DRIVEN IN THE WRONG DIRECTION FOR THE
M246 WITH THE STEEL BODY M505 PD FUZE.)**

PROJECTILE MORTAR CLOSING VELOCITY



HIGHER M940 KINETIC ENERGY ON TARGET TAKES REACTION DELAY EFFECTIVENESS INSIDE THE THREAT AT EXTENDED RANGE!

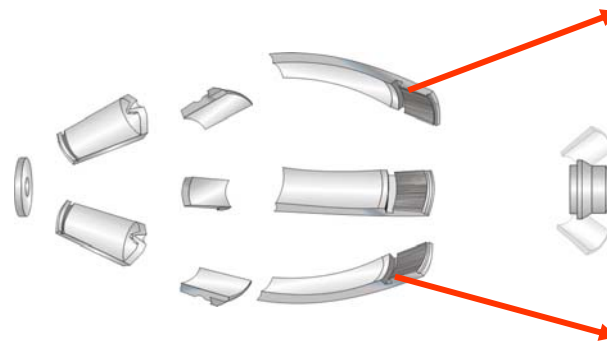
20mm M940 PROJECTILE REACTION DELAY EFFECTIVENESS



THE MPC NOSE IS EFFECTIVE AT VERY HIGH OBLIQUE IMPACTS UNLIKE THE M505 WHICH SUFFERS RICOCHET AND DUDING AT HIGH OBLIQUITIES.

20mm M940 PROJECTILE REACTION DELAY EFFECTIVENESS

**BODY SIDE WALL FRAGMENTS
EXPELLED AT IMPACT VELOCITY
PLUS APPROXIMATELY
1,000 TO 1,500 FT/SEC**



**5.2 GRAM DISC
EXPELLED AT IMPACT
VELOCITY PLUS
APPROXIMATELY
1,600 FT/SEC**

20mm M940 PROJECTILE REACTION DELAY EFFECTIVENESS



**TYPICAL VALID
PERFORATION OF 3/8" RHA**



**SPALL AND FRAGMENT
SIGNATURE ON WITNESS PANEL**

20mm M940 PROJECTILE REACTION DELAY EFFECTIVENESS



2.0 mm ALUMINUM FOLLOWED BY 9 EACH 1.0 mm SPACED 20 cm APART

20mm M940 PROJECTILE REACTION DELAY EFFECTIVENESS



M940 PROJECTILE AT
T= 0 SECOND IMPACT
WITH 2mm ALUMINUM
SHEET

T= APPROX 300
MICROSECONDS

5.2 GRAM STEEL DISC
IMPACT VELOCITY
PLUS 1,600 FT/SEC

PROJECTILE BODY FRAGMENTS
MOVING AWAY FROM CENTER OF
REACTION IN AN APPROXIMATE
30° INCLUDED CONE ANGLE WITH
IMPACT VELOCITY PLUS 1,000 TO
1,500 FT/SEC

**RELIABLE TERMINAL BALLISTIC FUNCTION
DEMONSTRATED ON 2mm ALUMINUM**

0° OBLIQUITY – 183 M



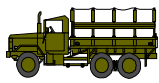


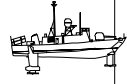

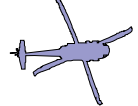
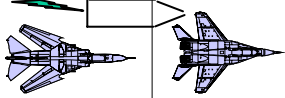
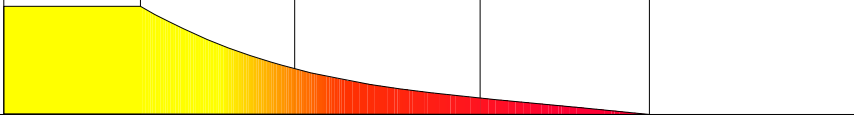
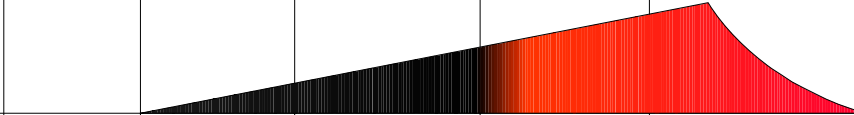
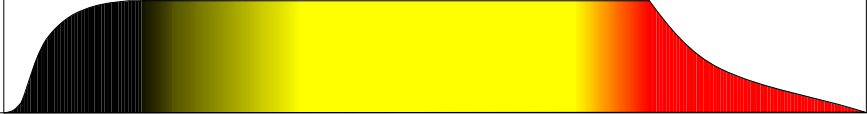
0° OBLIQUITY – 2000 M

75° OBLIQUITY NATO – 800 M

20mm M940 SUMMARY

- **LOWER TIME OF FLIGHT TO TARGET**
- **HIGHER VELOCITY/KINETIC ENERGY ON TARGET**
- **LOWER DISPERSION RESULTING IN HIGHER PROBABILITY OF HIT**
- **ARMOR PENETRATION CAPABILITY RESULTING IN HIGHER PROBABILITY OF KILL**
- **COMPETITIVE COST**
- **RECENT TESTING HAS DEMONSTRATED M940 SUPERIOR CAPABILITY OVER THE M246**
- **APPROX. 800,000 PRODUCED BY GENERAL DYNAMICS**

MEDIUM CALIBER CARTRIDGE EFFECTIVENESS COMPARISON

LAND					
SEA					
AIR					
HEI					
API					
MPC					

The 20mm MPT-SD, M940 LOW DRAG SHAPE AND DELAYED REACTION OF EXPLOSIVE DEFEATS HARDER TARGETS AT EXTENDED RANGES AS COMPARED WITH M246 HEIT-SD.