SNC TEC

Terminal Effects of New Small Arms Ammunition

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ALWAYS ON target

New Cartridges for 5.56mm Weapons

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SNC TEC Facilities

- **SNC TEC is ISO 9001 –2000 certified:**
  - LAP operations, primers at Le Gardeur, near Montréal
  - Brass cases & metal parts at St-Augustin, near Québec
  - Extruded propellant at Valleyfield, near Montréal
  - GO/CO Proof & Test range at Nicolet, Québec
  - EU HQ in Brussels with SNC TEC-Lavalin offices

New Cartridges from SNC TEC

- 5.56mm SRTA: Short Range Training Ammunition
- 5.56mm CQT®: Close Quarters Target practice
- 5.56mm FX®: Marking Cartridge
- 5.56mm LRTA: Limited Range Training Ammunition
- 5.56mm IP™: Improved Performance operational
- 40mm DragonFly™: Low Velocity Training Grenade

5.56mm SRTA PROGRAM

OBJECTIVE

- Develop a 5.56mm Lead Free SRTA cartridge for training with the M4/M16/M249 family of weapons
- The SRTA cartridge will replace the 5.56mm M862 cartridge without requiring any weapon modifications

M862 works in M16A2 only

5.56mm SRTA Requirements

- **SRTA initial performance requirements:**
  - Dispersion: Sum of 2 sides of rectangle < 20cm at 25m
  - ±1mil Ballistic match with M855 round at 25m
  - No weapon modifications permitted
  - Functioning from –20° to +40° C
  - Similar noise & recoil to M855
  - Mark Silhouette targets
  - Lead-free components
  - Max range of 250m
- **Not an easy challenge!**

5.56mm SRTA Phase 1A Results

- **Phase 1A results:**
  - Monolithic finned projectile gave best results
  - Gyroscopically stable (factor > 1)
  - Good accuracy & match at 25m
  - Low impact obliquity on target
  - *But, Max range in excess of 250m* !
- **Additional performance requirement after Phase 1:**
  - Must be Frangible on hard targets
    - User-imposed requirement to limit range damage

5.56mm SRTA Phase 1B – Internally funded

Phase 1B approach:

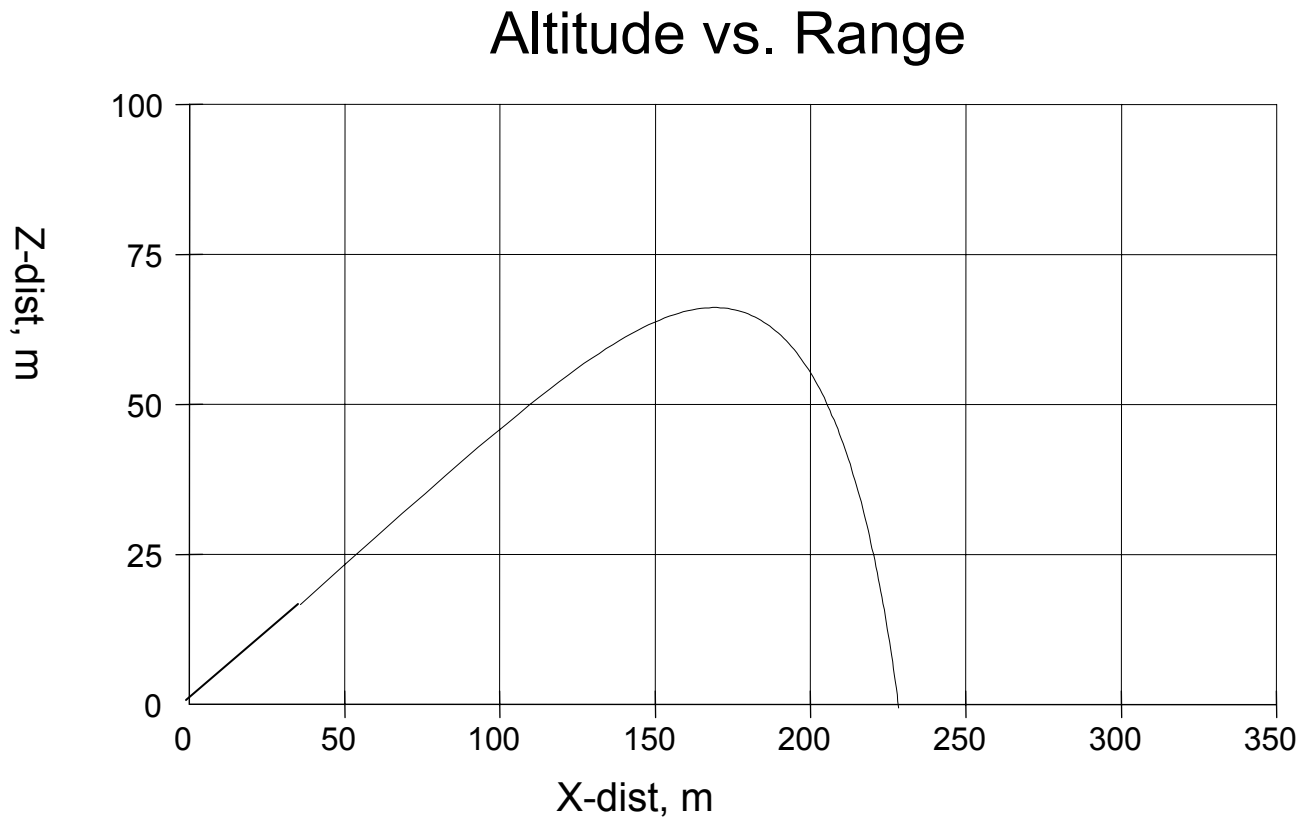
- Prioritize 250m max range requirement
- Focus on frangible concepts only
- Accept impact obliquity on target
- Perform more iterations on forward fins
- Reduce Gyroscopic factor; evaluate stability

5.56mm SRTA Phase 1B

- **SNC TEC most promising prototype in Phase 1B:**
  - Forward fins, frangible projectile
  - Same metal injection molded compound as SIMUNITION® GREENSHIELD® frangible training ammunition

5.56mm SRTA Max Range Test

- **RADAR Test data analysis**



PHASE 1B - SUMMARY OF RESULTS

1. FRANGIBILITY

- No penetration with one projectile hitting a hard target
  - (3/8" thick armor steel plate)

REQUIREMENT IS MET

PHASE 1B - SUMMARY OF RESULTS

2. DISPERSION

BARREL	SERIES	HOR. (cm)	VERT. (cm)	H + V (cm)
#534	1	6.1	5.8	11.9
	2	5.9	6.7	12.6
	3	7.6	4.8	12.4
#539	4	5.2	5.6	10.8
	5	7.6	5.8	13.4
	6	4.0	4.2	8.2
AVG				11.6

Accuracy barrel

20cm REQUIREMENT IS MET

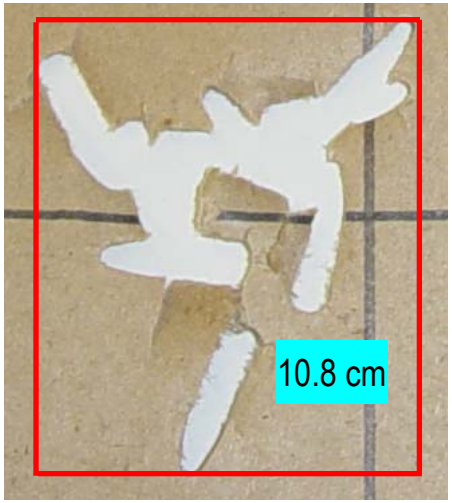
PHASE 1B - SUMMARY OF RESULTS

2. DISPERSION

- Dispersion was less than the required 20cm at 25m when fired from an accuracy barrel
  - Typical dispersion at 25m is 12cm
  - High obliquity at 25m !

SRTA

5.2 cm



5.6 cm

Accuracy barrel

GREENSHIELD®

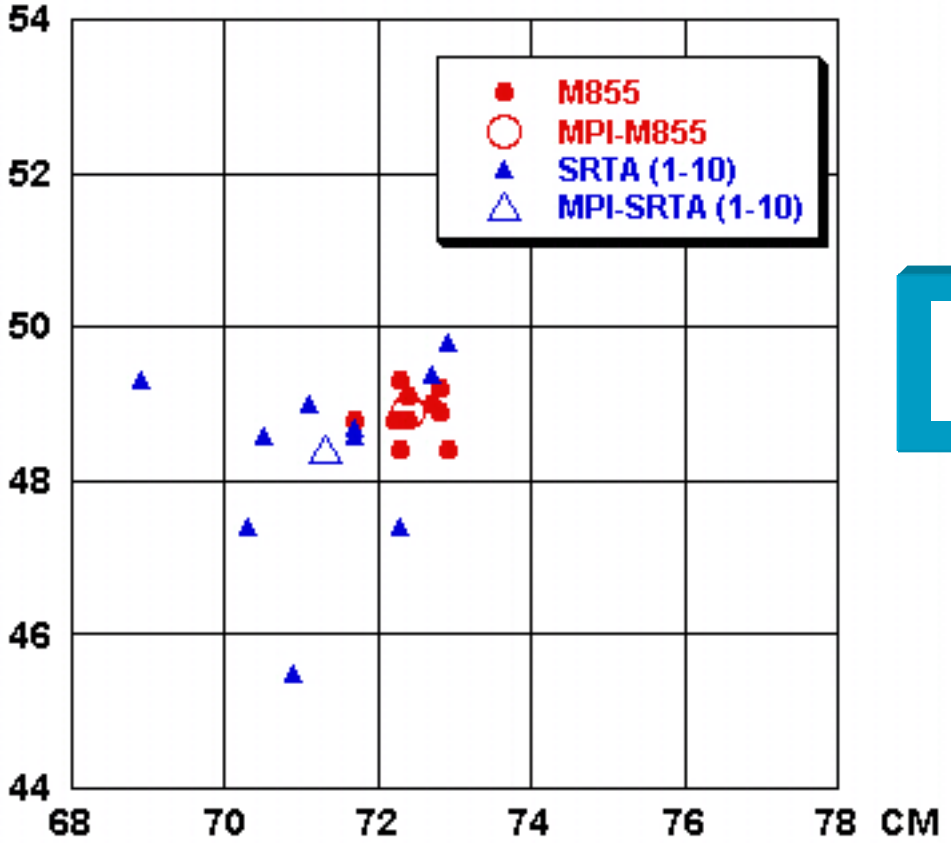
3.4 cm

2.0 cm

PHASE 1B - SUMMARY OF RESULTS

3. BALLISTIC MATCH WITH M855

- Match is better than 1 mil at 25m fired from accuracy barrel



Accuracy barrel

5.56mm SRTA Phase 1B Results

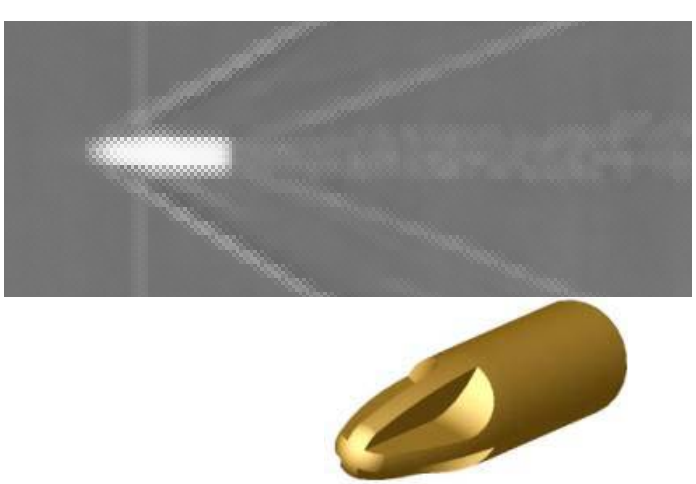
Phase 1B results:

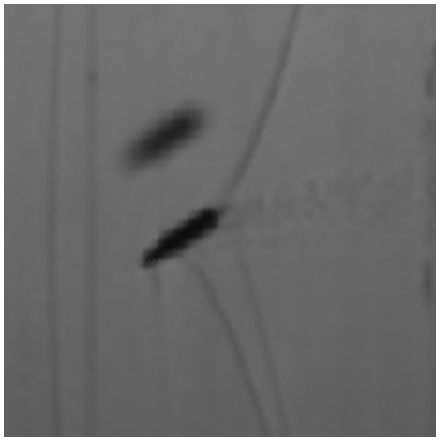
- Frangible projectile requirement met
- Accuracy requirement met: approx. 12cm at 25m
- Max range requirement met: approx. 225m
- Ballistic match requirement met at 25m
- High impact obliquity on target at 25m

Spark Range Tests

Understanding the flight behavior of 5.56mm SRTA

- Spark range tests were conducted on 0.50 cal scaled-up model
  - at CDN Defence Research & Development Centre Valcartier
- " key holing" at 25m is due to a high Magnus dynamic instability
- Max range requirement met because the projectile experiences high Magnus dynamic instability at all Mach numbers, causing yaw to increase in flight

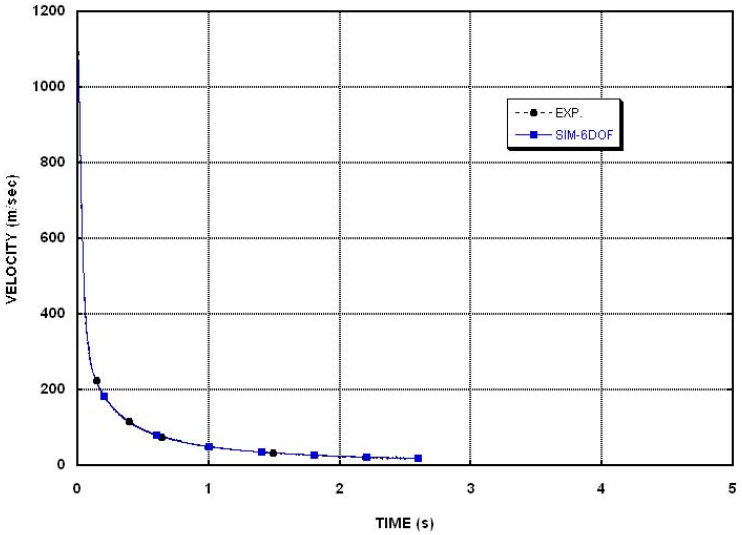




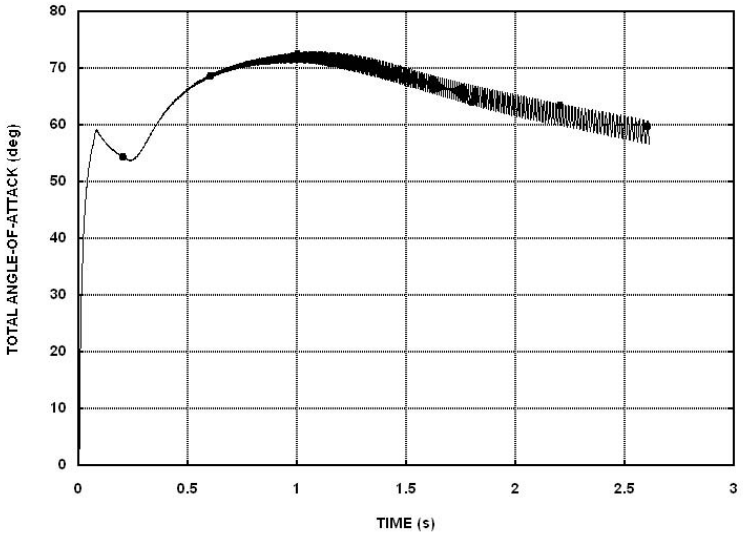
SRTA Flight Behavior

- 6DOF trajectory simulation

Velocity Vs Time



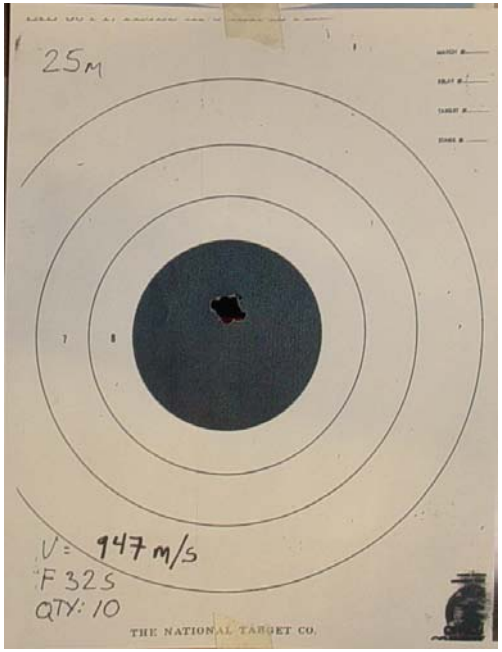
Angle-of-attack Vs Time



Alternate design – New Frangible (NF) concept

Evaluation of alternate design

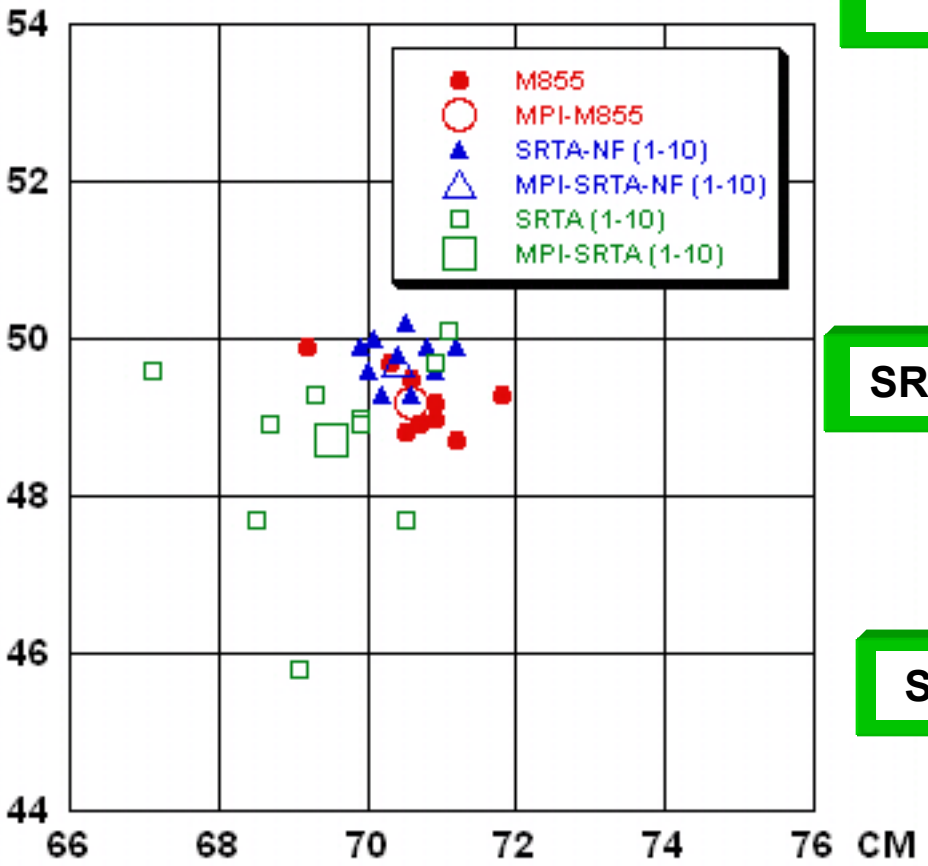
- Dispersion with New Frangible concept was lower at 25m when fired from an accuracy barrel at all temperatures
  - 10 rounds fired at 25m, less yaw than first SRTA concept
  - Better accuracy and ballistic match



Accuracy barrel

Alternate design – New Frangible (NF) concept

DISPERSION and MATCH with M855 (SRTA & NF)



M855

SRTA-NF

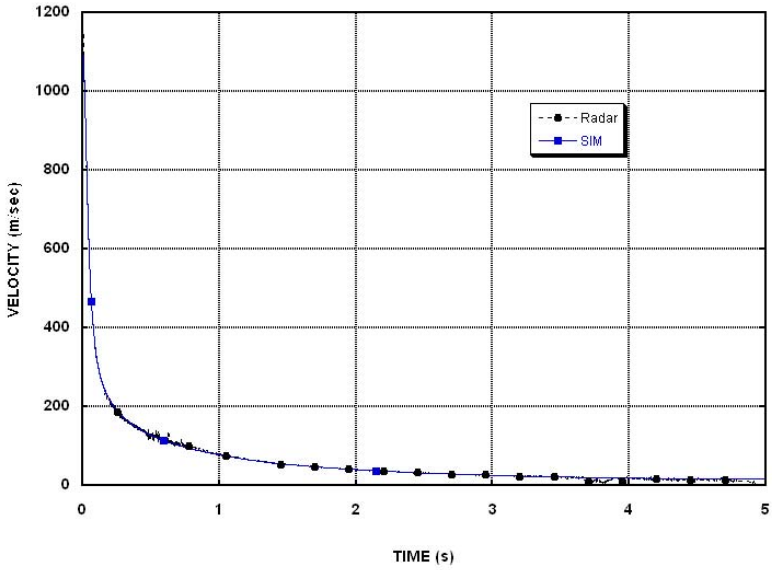
SRTA

Max Range of Alternate design – NF concept

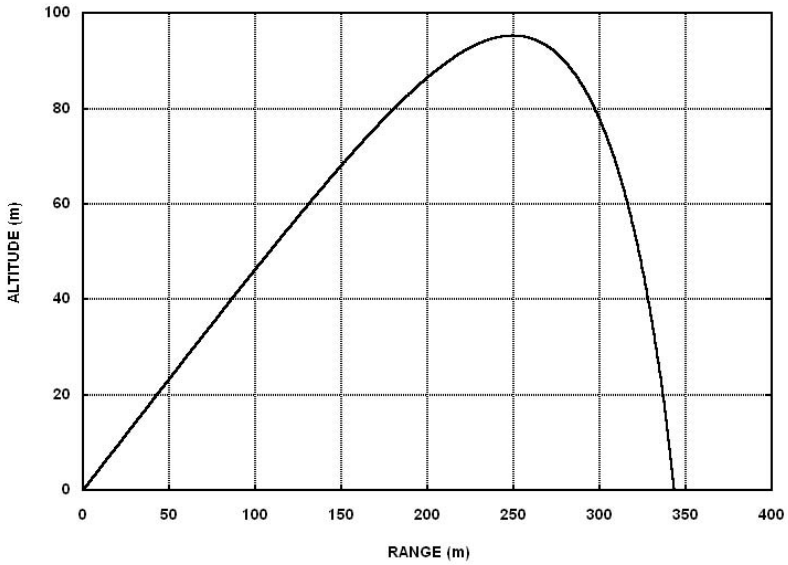
MAXIMUM RANGE (SRTA-NF)

- Maximum range of NF was less than 400m (5 rounds fired)
- Typical results were 350m when fired at 25° gun elevation

Velocity Vs Time



Altitude Vs Range



SIMUNITION® 5.56mm CQT®

SIMUNITION® 5.56mm CQT®

Advanced tactical shooting in non-ballistic facilities:

- Target practice in areas with reduced safety ranges
- Reduced lethality vs. ball or frangible rounds
- Training in environmentally sensitive areas
- 20 ± 5 Joules typical muzzle energy
- Ideal for training in Shoot-Houses
- Works with conversion bolt
- Non-toxic plastic projectile
- Ready for Qualification
- Functions in all M4A1, M249 and M16A2 weapons

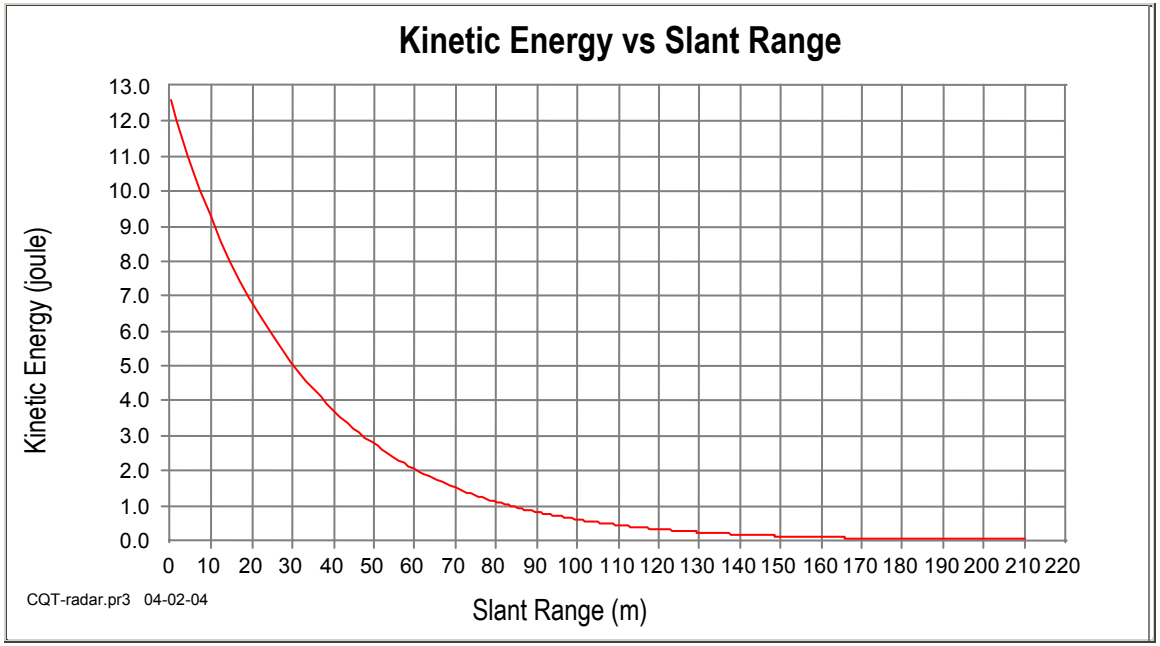
5.56mm CQT® Ballistics

Terminal ballistics:

- No penetration of 25mm plywood sheet at 10m
- No penetration of 12.7mm plywood sheet at 50m
- 300 meters max range
- Accuracy at 50m
  - Less than 30cm max spread
- Ballistic match at 50m
  - MPI of ± 20cm with 5.56mm ball rounds

SIMUNITION® 5.56mm CQT®

Kinetic Energy vs. Range, fired from M4 carbine



SIMUNITION® 5.56mm FX® Marking Cartridges

FX®

SIMUNITION® 5.56mm FX®

- **Force on Force MOUT training round:**
  - Non-lethal, deformable, sealed polymer projectile
  - Patented FX® projectile “mushrooms” open on impact
  - Impact energy spread over a larger area
  - Permits higher muzzle velocity, and
  - Reduced time of flight for:
- **Increased probability of hit on moving targets**

5.56mm FX® Design Criteria

- **Objective: No penetration into human tissue**
- **Means: Limit impact energy density of hits:**
  - Control muzzle velocity & projectile impact area
- **Tests by Sellier & Kneubuel show the energy bare human skin can absorb before breaking is approx. 0.1 J/mm^2**
- **Data generated by USAF Joint Non-Lethal Weapons, Human Effects Center of Excellence indicates that the maximum energy level the skin can absorb without penetration is 0.26 J/mm^2**
- **Energy Density = KE / Area = $\frac{1}{2}$ mV_i^2 / $\frac{1}{4}\pi d_i^2$**
  - Where M = projectile mass, V_i = impact velocity and d_i = projectile impact diameter

5.56mm FX® Energy Density

- **SIMUNITION® 5.56mm FX®:**
  - 0.25g projectile at 200 m/s; KE = 5.0 Joules
  - Impact projectile diameter = 9mm
  - Impact Energy Density = 0.08 J/mm^2
- **SIMUNITION® 9mm FX®:**
  - 0.45g projectile at 145 m/s; KE = 4.7 Joules
  - Impact projectile diameter = 11mm
  - Impact Energy Density = 0.05 J/mm^2
- **FX® impact energy is below skin rupture threshold**

5.56mm FX® Terminal Effects Tests Performed

- **Trade off between long range match & accuracy vs. short range safety**
  - Users demand greater effective range for training!
- **Terminal ballistic performance:**
  - No penetration of bare 20% ballistic gelatine at 0m
  - No penetration of 10% ballistic gelatine protected with a single layer of military uniform material at 5m
  - No penetration of 1.52mm thick Sand, Wind & Dust goggles at 0m
  - No penetration of military uniform on swine tissue blocks from 0 to 5m

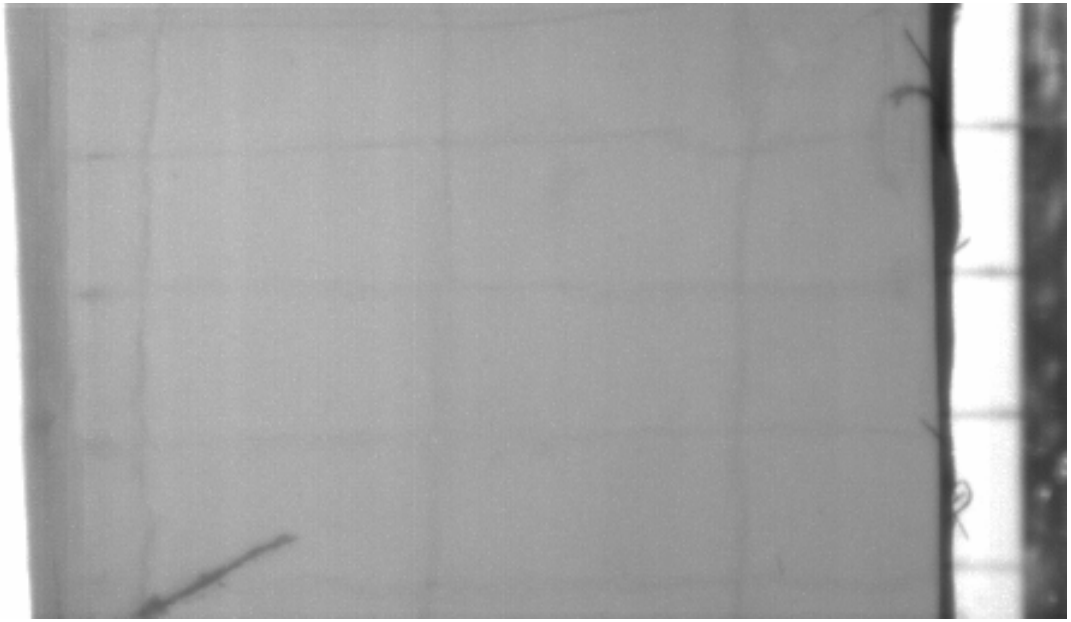
SIMUNITION® FX® Test Results – No Penetration

- 20% bare gelatine 1m, BDU & 10% gelatine 5m and SWD goggles at 30cm

SIMUNITION® FX® USE

- **FX® is a Non-lethal training round:**
  - Numerous field trials conducted over last year
  - Safe for use in force-on-force exercises at close range
  - Head, throat and groin protection recommended
  - Use with full BDU covering

SIMUNITION® FX® High Speed Video – No penetration



- **Video:**
  - 5.56mm FX® Marking Cartridge on BDU against 20% gelatin at 5m range

SIMUNITION® FX® High Speed Video – Projectile Deformation

- **Video:**
  - 5.56mm FX® Marking Cartridge Impact on a LEXAN plate

5.56mm LRTA Performance

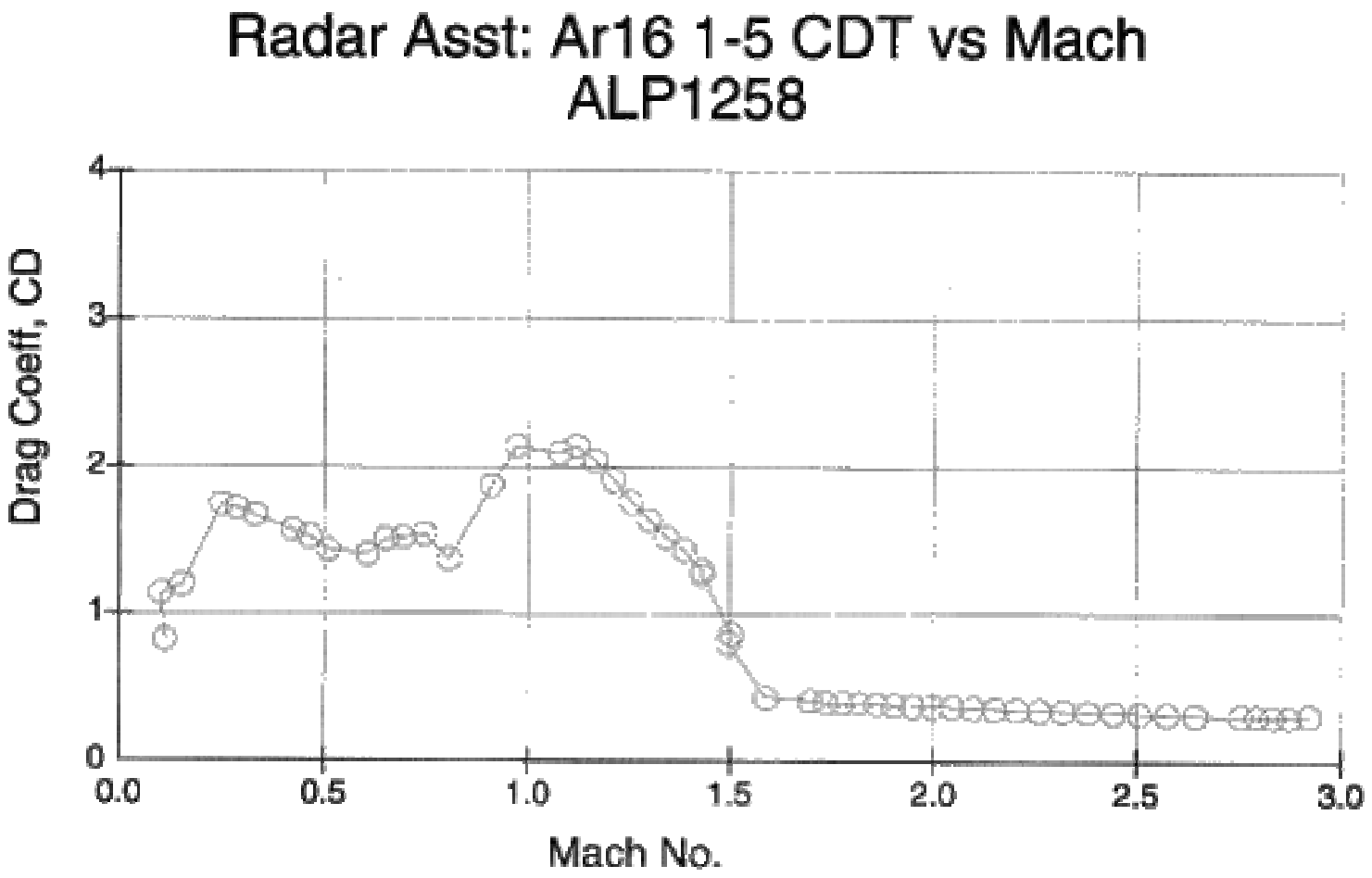
- **The 5.56mm LRTA Cartridge is:**
  - Limited Range Training Ammunition
  - Internal SNC TEC R&D program
  - Ready for qualification
- **LRTA performance objectives:**
  - ±1mil Ballistic match with Ball round at 100m
  - Dispersion: SDx, SDy < 5.5cm at 100m
  - No weapon modifications required
  - Functioning from –30° to +52° C
  - No fragmentation in ballistic gelatin
  - Non-toxic components
  - Max range of 1,000m

5.56mm LRTA Concept

- Monolithic finned projectile
- Typical dispersion (SD) of 3.5 cm at 100m
- Typical ballistic match of 2cm at 100m
- No impact obliquity on target at 100m
- Weapon function at all temperatures

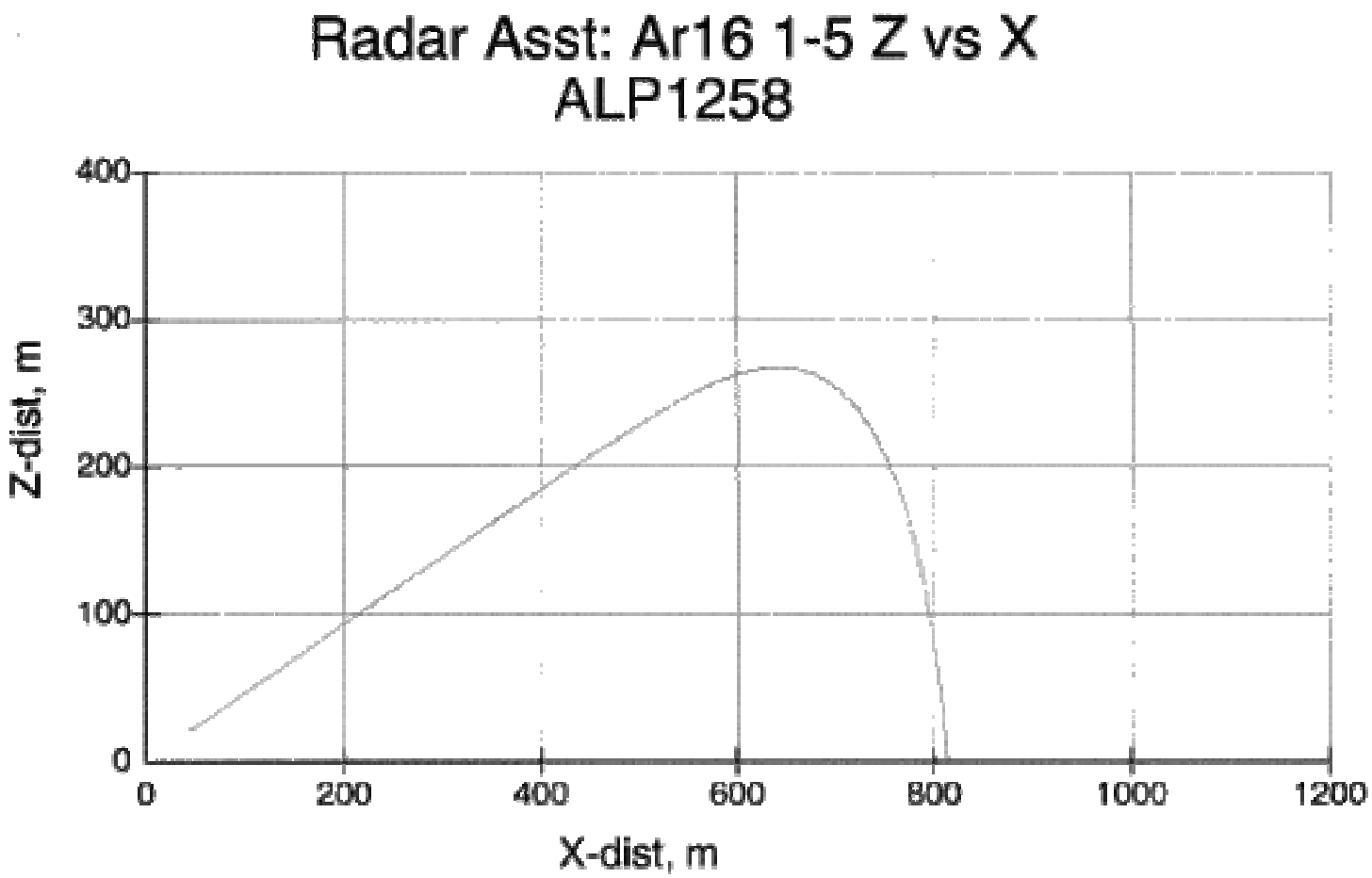
SNC TEC 5.56mm LRTA

- Drag vs. MACH number



SNC TEC 5.56mm LRTA

- Trajectory curve



SNC TEC 5.56mm IP™ (XC77A1)

The 5.56mm IP™ Cartridge:

- Improved Performance
- Operational Ammunition
- Hard steel core green bullet
- Non-toxic TOXFREE™ primer
- Improved penetration in hard targets
- Enhanced lethality over standard ball rounds
- Meets all NATO MOPI specifications
- Replacement for current 3-piece steel/lead core bullets

5.56mm IP™

Wound ballistics:

- Recent lethality study performed at the RMC of Canada
- 5.56mm IP equal to standard ball on unprotected targets
- 5.56mm IP greater than ball against protected targets
- 5.56mm IP starts to tumble faster than std ball projectile

Ballistic gelatine tests:

- 20% ordnance gelatin
- Simulate 550m range, modified twist barrel
- 2 High speed cameras, 10k frames/sec
- With and without Body Armor

5.56mm IP™

- **Probability of incapacitation:**
  - Given a hit: P(I/H)
  - Using Handbook of Human Vulnerability model (HHV)
  - Fragment mass and residual velocity key variables
  - Kinetic energy deposited, penetration depth
  - Test on unprotected and protected targets

- **Target types (Protected/Unprotected):**
  - Protection was CRISAT panel 5cm in front of block

5.56mm IP™

Striking velocity Results:

Striking Velocity in block	Protected Target		Unprotected Target	
	Mean	SD	Mean	SD
5.56mm IP	266 m/s	30 m/s	396 m/s	17 m/s
C77	246 m/s	20 m/s	402 m/s	27 m/s

5.56mm IP™ Protected Target

P(I/H) Results:

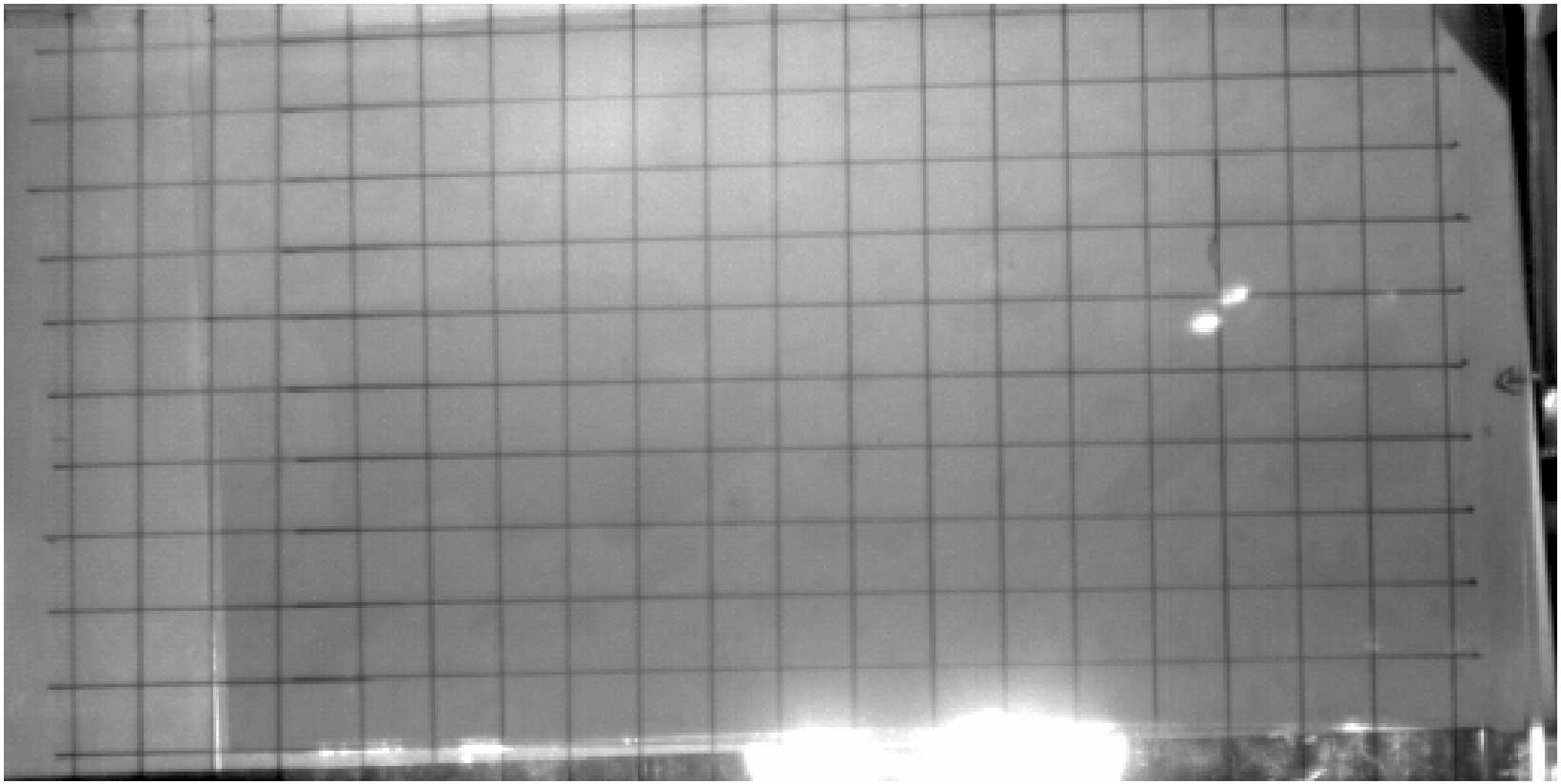
Protected Targets	P(I/H)	P(I/H)
550m range	**C77 ball round**	**IP round**
Defence < 30 seconds	.28	.33
Assault < 30 seconds	.38	.44
Assault < 5 minutes	.49	.54
Support/Supply < 12 hours	.51	.56

5.56mm IP™ Unprotected Target

P(I/H) Results:

Unprotected Targets	P(I/H)	P(I/H)
550m range	**C77 ball round**	**IP round**
Defence < 30 seconds	.36	.37
Assault < 30 seconds	.48	.50
Assault < 5 minutes	.58	.59
Support/Supply < 12 hours	.60	.61

5.56mm IP™ - 20% Gelatine Penetration Video



5.56mm IP™ Unprotected Target: 40m range

Penetration Results:

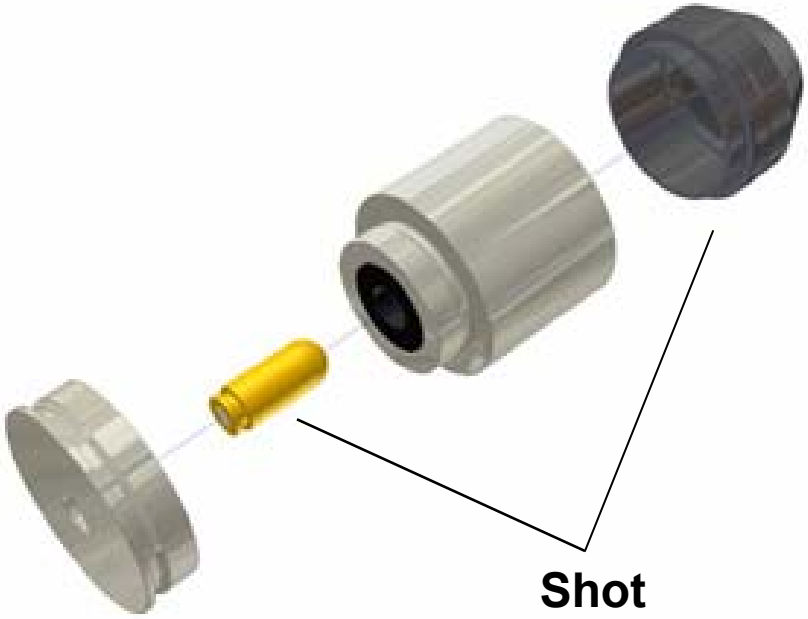
			Temporary cavity		
Rounds	Projectile	Length of narrow channel (in)	Max. diameter (in)	Maximum volume (in^3)	Maximum area (in^2)
1	XC77A1	2.25	3.46	80	25
1	C77	4	2.54	58	19

Target distance: 40 meters, C7 rifle, Full charge. Gelatin 20% conditioned at +5°C.

New 40mm LV Training Concept: DragonFly™

- **Cost-effective target practice system**
- **Re-usable steel cartridge case KIT:**
  - Simple, but effective 2-piece design
  - High/Low pressure chambers
  - Patent pending
- **Affordable SHOTS:**
  - Comprises Projectile & Propulsion system
  - Powered by specially modified blank round
  - 1.4S explosive class

40mm DragonFly™ Assembly



Shot

Assembly

40mm DragonFly™ Components

Re-usable Conversion Kit

Propulsion System

40mm DragonFly™ Shots

Light

Medium

Heavy

40mm DragonFly™ Designs

- **3 different designs of SHOT available:**
- **25m training = Light SHOT, 15g projectile**
- **50m training = Medium SHOT, 50g projectile**
- **100m training = Heavy SHOT, 120g projectile**
- **SHOT propulsion via modified blank round:**
  - 1 SHOT = 1 projectile & 1 blank

40mm DragonFly™ Performance

- **40mm performance:**
  - Light SHOT: 35cm max spread at 25m
  - Medium SHOT: 35cm max spread at 50m
  - Heavy SHOT: 50cm max spread at 100m
  - Function in:
    - M203, H&K 69 and other 40 x 46mm launchers
  - No weapon modifications required
  - Functioning temperatures from –8° to +40° C

40mm DragonFly™ Status

- Newest SIMUNITION® training product
- Effective training for MOUT ranges
- Non-toxic projectiles
- Ready for qualification
- Available for demos

Summary of New Rounds from SNC TEC

CONCLUSION

- Comparison Table: Terminal Effects of New Ammunition

5.56mm Product	Application	Optimal Range	Match with Ball	Typical Accuracy	Max Range	Lethality	Status
FX®	Interactive Training	30m	± 30cm	20cm max spread	200m	Non-lethal	In Production
CQT®	Target Training	50m	± 30cm	20cm max spread	300m	Reduced lethality	In Qualification
SRTA	Target Training	25m	± 2.5cm	< 20cm rectangle	250m	Lethal at short range	
LRTA	Target Training	100m	± 2cm	3.5cm SD	1,000m	Lethal at limited range	Ready for Qualification
IP™	Operational	0-550m	Equivalent	12cm SD	4,400m	Lethal	In Production
40mm DragonFly™	Target Training	25–100m	Not Applicable	35-50cm max spread	150 to 400m	Lethal	In Production