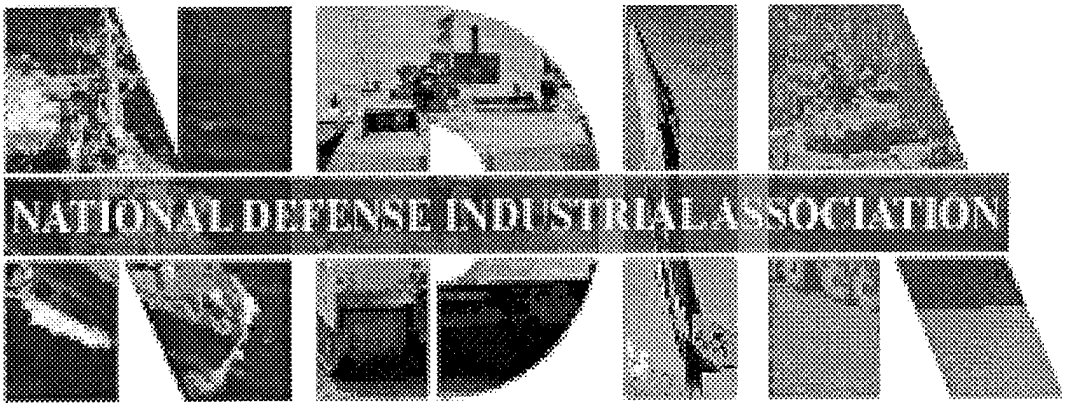


Small Arms Systems Section Annual Conference, Exhibition & Firing Demonstration

June 15-18, 1998

19980701 180

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Armament Division Overview

Small Arms Section

15-18 June 1998

Objective

Overview NDIA Armament Division

- Purpose
- Organization
- Charters
- Activity
- Plans

Armament Division Purpose

An Integrated Organization Structure
Focused to Armament Systems

Conventional Tactical Armament Systems

- Medium caliber
- Tank systems
- Artillery/mortars
- Small arms
- Rockets/missiles
- Others

- Needs/requirements
- Technology
- Concepts
- Integration
- Systems
- Platforms

- User
- Developer
- Acquisition
- Deployment
- Lessons Learned

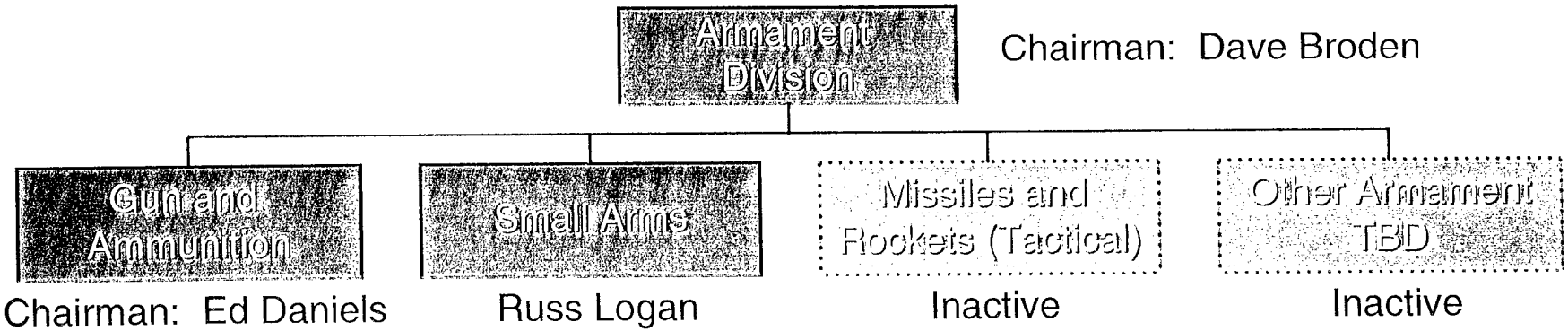
Armament Systems Division Objectives

- Strong active organization sections
- Organizational leadership for armament systems
- "Value added" symposiums and meetings
- Responsive to NDIA membership
- Intra-Divisional participation
- Activity beyond annual meetings – special studies, etc.

Facilitate Communications, Encourage Dialogue, Maintain and Grow Capability

Strength Through Industry and Technology

Armament Division Organization



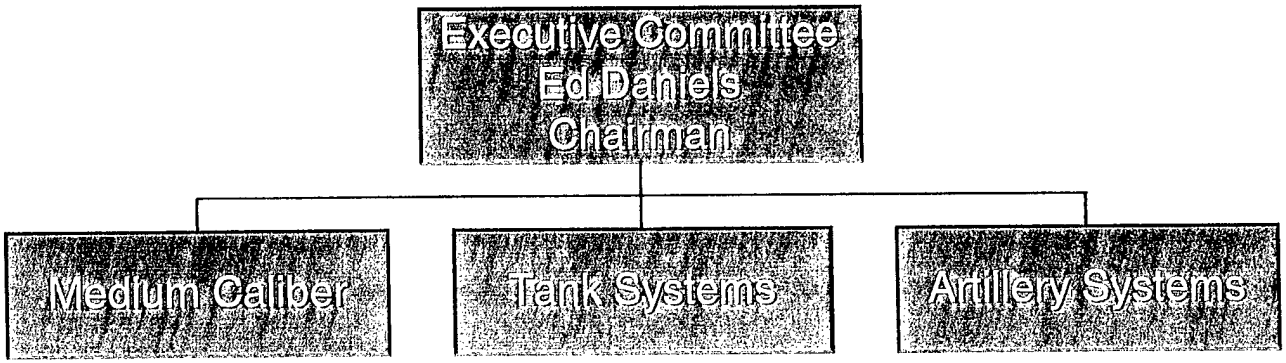
- Medium caliber automatic cannon systems
- Added larger caliber cannon systems (tank, artillery, etc.)
- Separate by caliber at later date

- Focused to individual and crew served system

- Goal to establish active unit in 1998

- Future growth

Armament Division
Gun and Ammunition Section



Requirements → Technology → Concept → Development → Deployment → Production

"Lessons Learned"

Technology → Subsystems → Systems → Platforms

Industry — Government Labs — Military

International

NDIA Integrated Benefits

Merger of ADPA and NSIA Provides

- Added capability to represent industry to DoD and Congress
- Large membership base → one voice
- Broadened network of technology, policy, warfare elements
- Increased opportunities for industry and government interaction
- Experienced leadership

"Value Added" for Individuals and Corporations

NDIA's 33 Committees, Divisions, and Groups

- Technology

  Space ... Missile Defense ... **Armaments** ... Science & Engineering ... Munitions ... Automatic Test ... Chemical Systems ... C4ISR ... Research, Engineering & Manufacturing ... Ballistics ... Information Technology ... Software Information Systems ... Tank & Automotive Systems ... Insensitive Munitions & Energetic Materials ... Systems Engineering ... Technical Information ... Test & Evaluation ... Security ... CALS

- Policy

  Environmental ... International ... Health Affairs ... Logistics ... Legislative Information ... Procurement ... Government Policy

- Warfare

  Expeditionary ... Undersea ... Strike, Land Attack & Air Defense ... Aviation, Air Targets, UAVs & System Ranges ... Combat Survivability ... Special Operations/Low Intensity Conflict ... Night Operations

NDIA Full-Service Association

- Organization
  - Local chapters
  - National
- National Defense Magazine
- 33 committees, divisions, and groups
  - Technology
  - Policy
  - Warfare

  - Symposia
  - Communications
  - Technical paper exposure
  - Resolve issues
- Affiliates
  - National Training System Association
  - Women in Defense

NDIA Membership: The Competitive Edge for You and Your Company

- 33 divisions and committees serving all sectors of industry and the Department of Defense
- Effective representation on Capitol Hill through a pro-active Government Policy Department
- Legal and ethical interchange between government and industry
- Focused industry support for critical defense issues
- Diverse conferences/symposia covering all aspects of the defense industry
- Gather critical and insightful analyses from *National Defense* Magazine
- Access to comprehensive resources for legislative, regulatory, contracting, and industry information affecting your business
- Association activities provide ideal forums to develop partnerships and teaming agreements

Charter Update

Objective: Provide a charter defining overall characteristics of Armament Division

- Relationship to overall NDIA
- Structure
- Responsibilities
- Organization
- Membership
- Activities

- Specific Annex for each Armament Division section

Charter to Provide the Framework — Membership Activity is the Focus

Charter Status

- Charter and Annexes for sections prepared
  - Review by section in process
- Executive Committee membership under review
  - Desire membership which is:
    - Multi disciplined
    - Life cycle
    - Industry, government, military

Executive Committee Structure

	Medium Caliber Systems	Tank Systems	Artillery Systems	Other
Ammunition				
Weapon				
Feed and Storage Systems				
Fire Control				
System/Platform				
DoD Labs				
Military User				
Other				

Membership for Total System Life Cycle

NDIA Technical Services Topics

- Committee/Division structure
  - Periodic reviews
  - Correct mix
  - Overlap
  - Life cycle interact ⇒ value added
- Mailing lists
- Membership
  - New
  - Continuing
- Inter-divisional activity
  - Joint meetings
  - Special meetings
  - Web site
- Meeting quality ⇒ "value added" objective
- Exhibits

Infantry



Today



Through 2010



And Beyond

Introduction

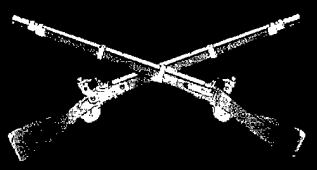
MG Carl F. Ernst

Chief of Infantry

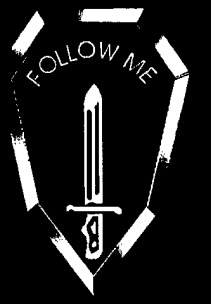


Commanding General of Fort Benning

Proponent for Small Arms and Ammunition

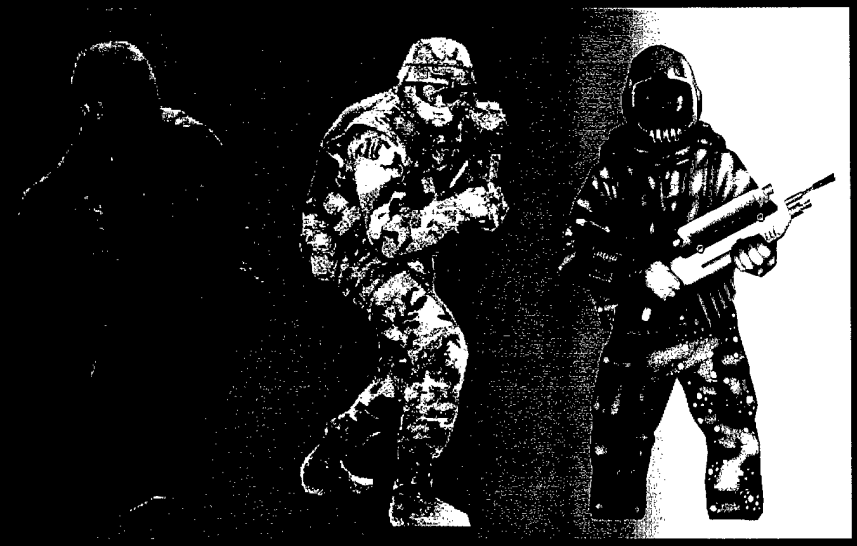


Agenda



- Who We Are
- Where We've Been
- Our Needs and Where We're Headed
- Conclusion

Today 2010 Beyond



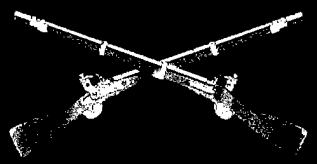
17

Purpose

Update the Small Arms Community on how the Infantry is preparing for the close fight , through and .



U.S. Army Infantry







Mechanized



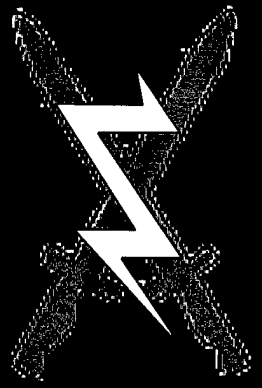


Airborne



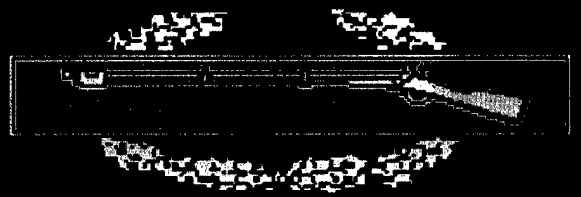
Ranger

Air Assault



Light

Five Types-One Mission



To close with the enemy by means of fire and maneuver in order to destroy or capture him or repel his assault by fire, close combat and counterattack



Revolutionary War

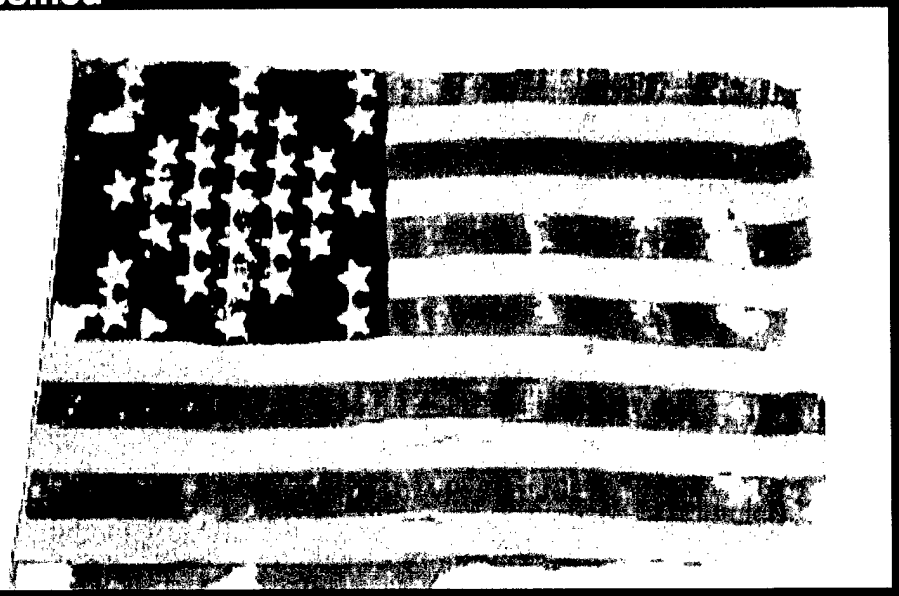


I Was There From the Beginning...



Civil War





From Bull Run to Appomattox, I fought









Where Brave Men Fight...There Fight I.







In Freedom's Cause... I Live, I Die.









Always ready…then, now, and forever.





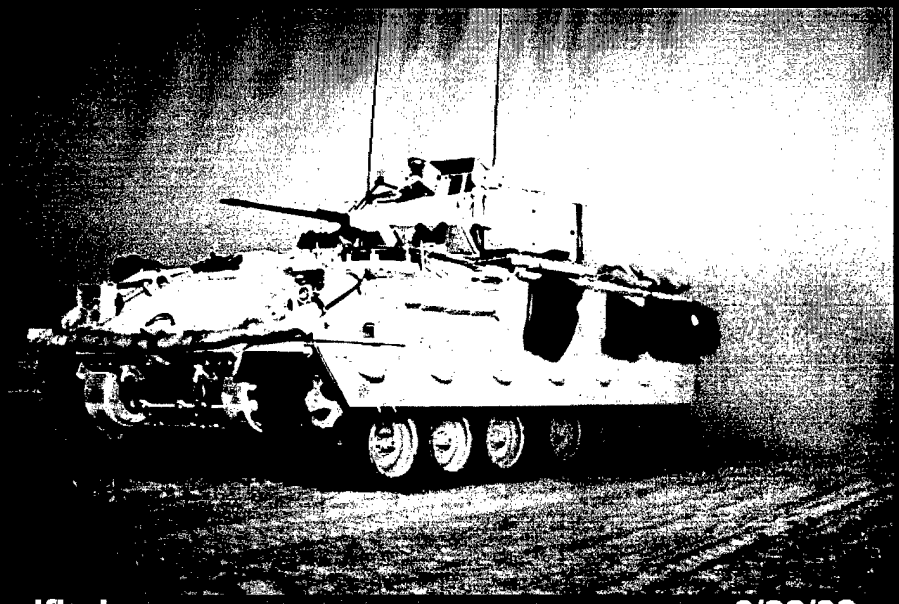


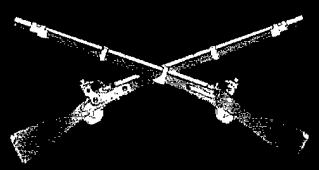


I am the Infantry!

FOLLOW ME!







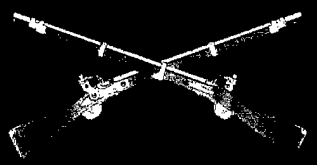
Fort Benning's Operational Deployments



Peace

Andrew
Bright Star
Restore Hope
JTF Bravo
Fuentos Defensas
Just Cause
Bosnia
Intrinsic Action
Croatia Provide Promise
Uphold Democracy
Desert Shield
Joint Endeavor
Desert Storm
Purple Dragon
Dynamic Guard
Vigilant Warrior
Vigilant Sentinel
Joint Guard
Ocean Venture
Sand Eagle
Fuentos Caminos
Eager Light
Somalia UNISOM II
Market Square
Eastern Castle
Ulchi Focus Lens
Internal Look
Roving Sands
Kuwait Southern Watch

29 Deployments In Last 7 Years Across the Conflict Spectrum



So What??



- Over Time -- Weapons have changed --

- Army Infantry must maintain advantage over present and potential enemies -- How?
  - Land Warrior
  - Objective Family of Weapons
  - Night Vision Initiatives
  - Non-Lethal Technology Initiatives
  - Every Infantryman An Expert Rifleman

New Materiel Initiatives

Land Warrior



OICW

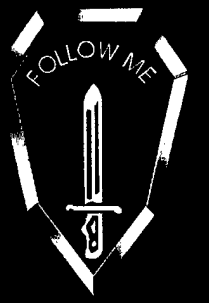


OCSW





Materiel



Today



Through 2010

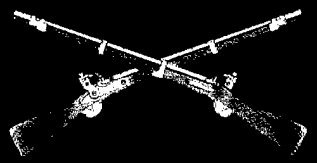


Beyond

Infantry Developmental Priorities:

1. Land Warrior
2. Infantry Fighting Vehicles
3. Anti-armor Family
4. Own The Night Family
5. Small Arms Family
6. Soldier Modernization Family
7. Mortar Systems
8. Mounted Systems, Other
9. Directed Energy Family
10. Robotics Family

Represents 582 programs



Land Warrior

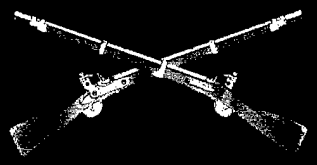


Integration of Improved Capabilities

- Modular Weapon System
- Thermal Weapon Sight
- Infra-red Aiming Light
- Close Combat Optic
- Combat Identification
- Advanced Combat Uniform
- Light Weight Chem Suit & Mask
- Laser Protective Eye Wear



First Fully Integrated Soldier Fighting System



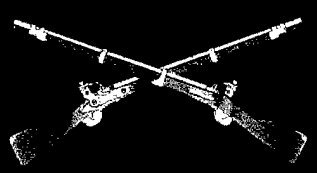
Land Warrior

With New Capabilities

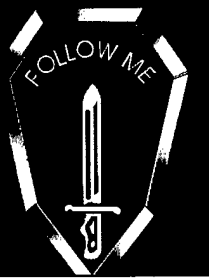


- Advanced Load - Carrying Equip
- Modular Body Armor
- Digital Image Capture
- Image Intensifier
- Laser Range Finder
- Improved, Integrated Helmet
- Soldier Computer
- Integrated SINCGARS Radio
- Squad Intercom
- Global Positioning System
- Heads up Display

- Future Upgrades
  - >OICW
  - >OCSW
  - >Fused Optics

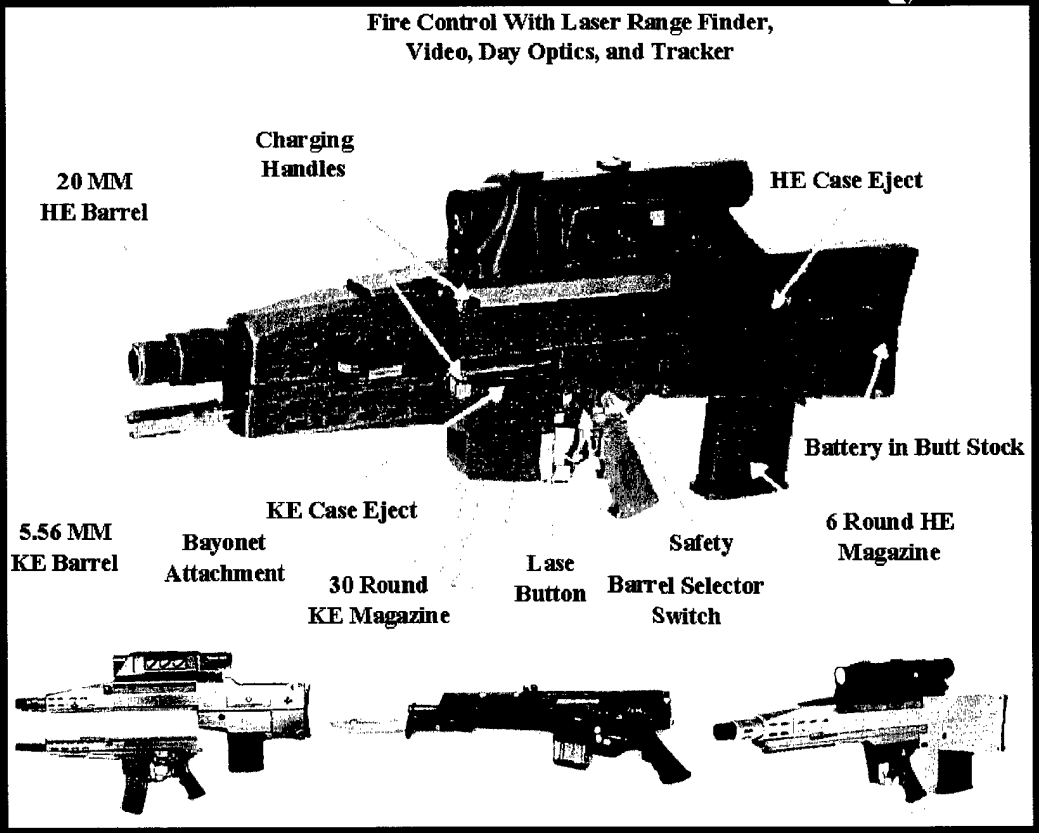


Objective Individual Combat Weapon (OICW) System

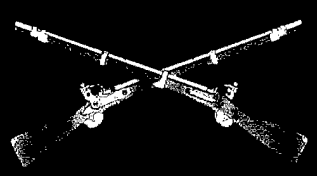


Modular, Compact Full Solution Fire Control:

- Direct View Optics
- Laser Range Finder
- Targeting Tracker
- Laser Steering
- Day/Video Sighting
- Thermal Viewing
- Electronic Compass
- Ballistic Computer
- Environmental Sensors
- Combat ID and Target Handoff



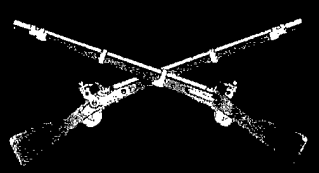
- Replacement For The M4/M16 Family Of Weapons In <u>Selected Units</u>



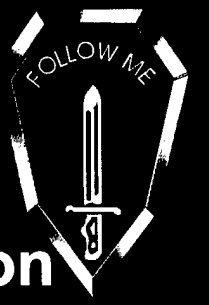
Objective Individual Combat Weapon (OICW) System



- Ergonomically Designed, Multi-functional Combat Weapon System
  - High Explosive, Air-bursting 20mm (1000m)
  - Kinetic Energy 5.56mm Projectile (550m)
- Modular System Flexibility
- FUE 2006

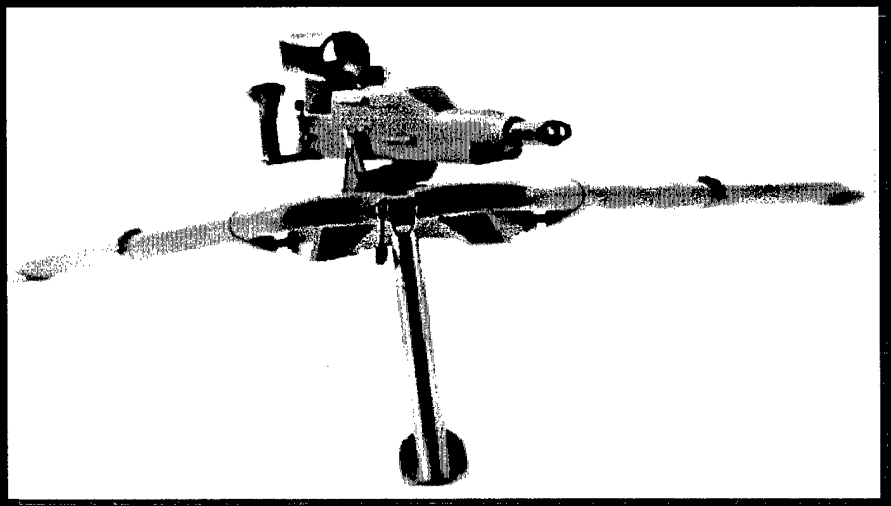


Objective Crew Served Weapon (OCSW) System

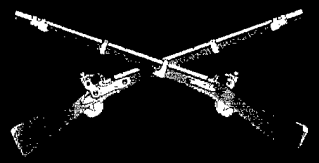


- 25mm Airbursting and Armor-Piercing Ammunition
- Modular, Compact Full Solution Fire Control
- Innovative Traverse and Elevation Mechanism

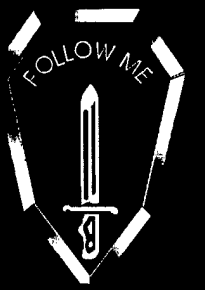
- System Weight:
  - Gun- 24 lbs
  - Tripod- 8 lbs
  - Fire Control- 4.6 lbs
  - Total- ~ 36 lbs



- Replacement for the M2 HMG, MK19 GMG, and selected M240B MMG at company level

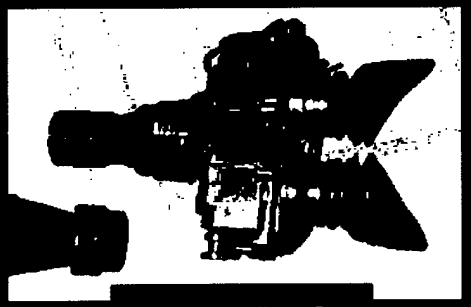


Own the Night



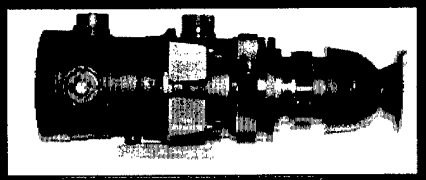
Present Systems

Night Vision Goggles AN/PVS-7D



Fielded

AN/PVS-4/AN/TVS-5

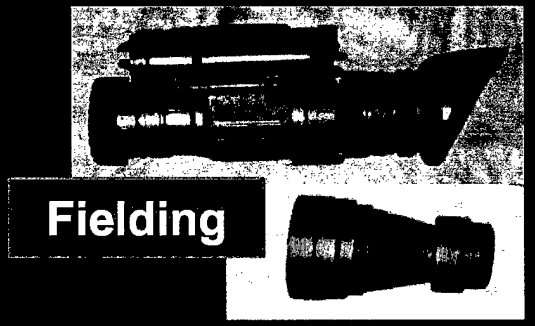




Fielded

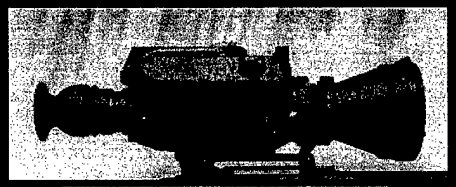
Emerging

Monocular NVD, AN/PVS-14 & 3X Extender



Fielding

TWS, AN/PAS-13

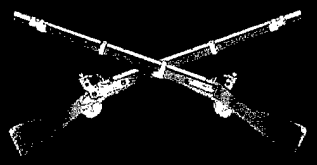


FUE 4QFY98

Future

Objective Individual Combat[illegible] Crew Served Weapon Sight

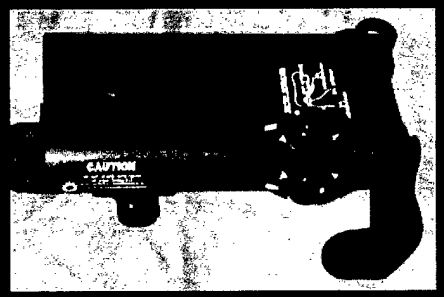
Fusion, Wide FOV



Own the Night

Present Systems

IR Aiming Light AN/PAQ-4C



Fielded

Leupold Sniper Day Sight



Fielded

Emerging

Target Pointer/ Illuminator/Aiming Light, AN/PEQ-2



FUE 4QFY98

AN/PVS-10 Sniper Day/Night Sight

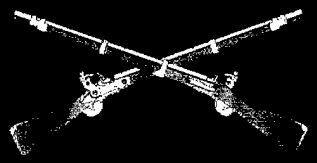


FUE 3QFY98

Future

Dismounted Soldier Combat Identification

Improved Night/Day Control/Observation Device (INOD)



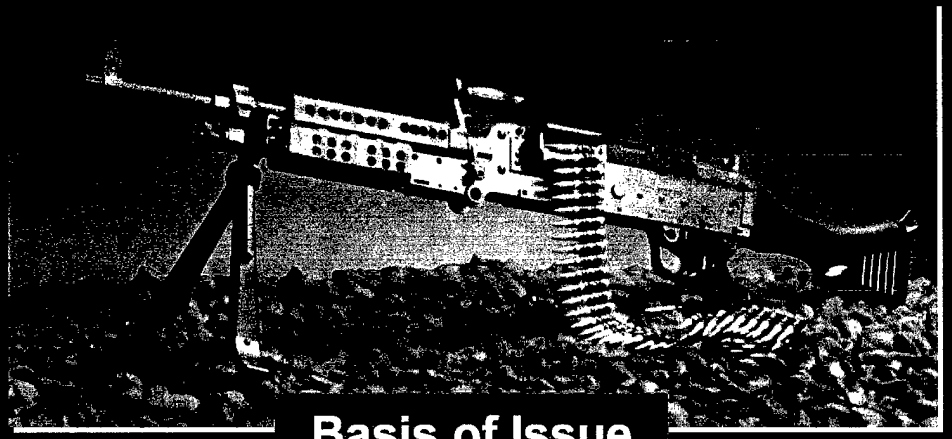
M240B MMG

Characteristics/Capabilities

- **Caliber:** 7.62mm
- **Weight:** 27.6 lbs
- **Max Range:** 3,725m
- **Max Effective Range:** 1,100m

Extremely Reliable

- 32,500 Rounds Between Operational Mission Failure (8Times > M60 MMG)
- 26,000 Rounds Between Stoppage (17 Times > M60 MMG)

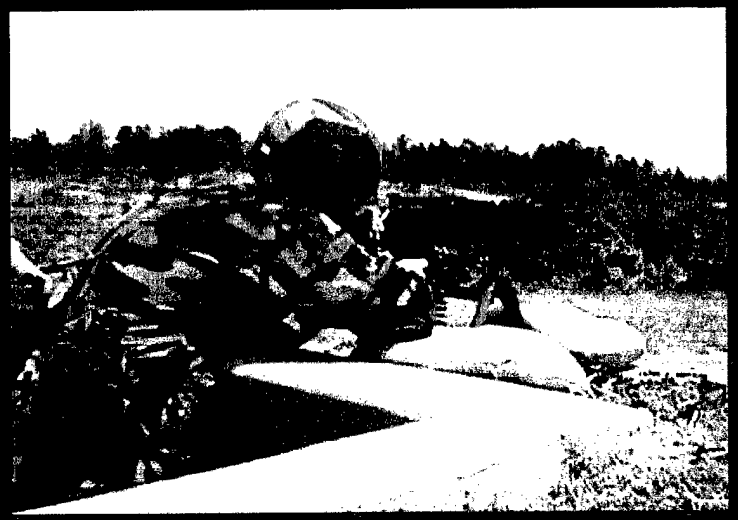


Basis of Issue

Replaces the Ground Mounted M60 MMG on a one-for-one Basis in Infantry, Armor, Special Forces and Select Combat Engineer Units. Ranger Battalions Will Replace Existing 240G MMG with 240B series Weapons

FUE August 1997

M240B MMG



Army currently fielding 11,785 weapons

Units Issued M240B

1-508 IN (SETAF)

Units Receiving M240B

Select

19TH, 20th SFG
6/22/98



Infantry Requirements



Today

- Increase lethality and survivability
- Reliable, non-complicated, and easy to use in combat



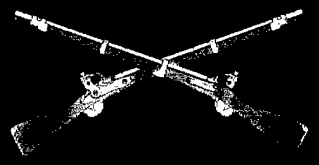
Through 2010

- Increase situational awareness
- Systems must be applicable across spectrum of use



Beyond

- Must leverage technology



Infantry Requirements



- Increase ability to operate under adverse conditions
- Lighten the Soldier's load
- Enhance flexibility of individual equipment to mission requirements

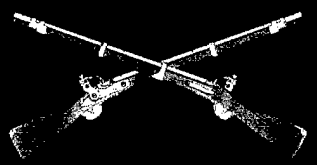


Why Infantry

"You may fly over a land forever, you may bomb it, atomize it, pulverize it and wipe it clean of life - but if you desire to defend, protect it, and keep it for civilization, you must do this on the ground, the way the Roman Legions did,

-- T.R. Fehrenbach



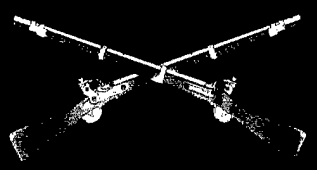


Summary

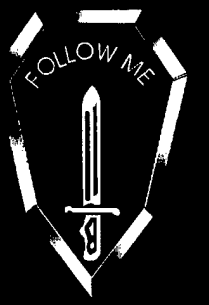


--Infantry necessary--Today, Tomorrow, and in the Future--

- Infantry need the best weapons and equipment



Challenge



- Look to the Future
  - Directed Energy ?
  - Acoustics ?
  - Electromagnetic Guns ?
  - Integrated Nonlethal Capability?



...Beyond 2010



TACOM

Mobility and Firepower for America's Army



TACOM-ACALA
Acquisition Reform Initiative Overview
NDIA Small Arms Conference
16 June 1998

Jimmy C. Morgan
Director, ACALA

Tank-automotive & Armamemts COMmand
Committed to Excellence

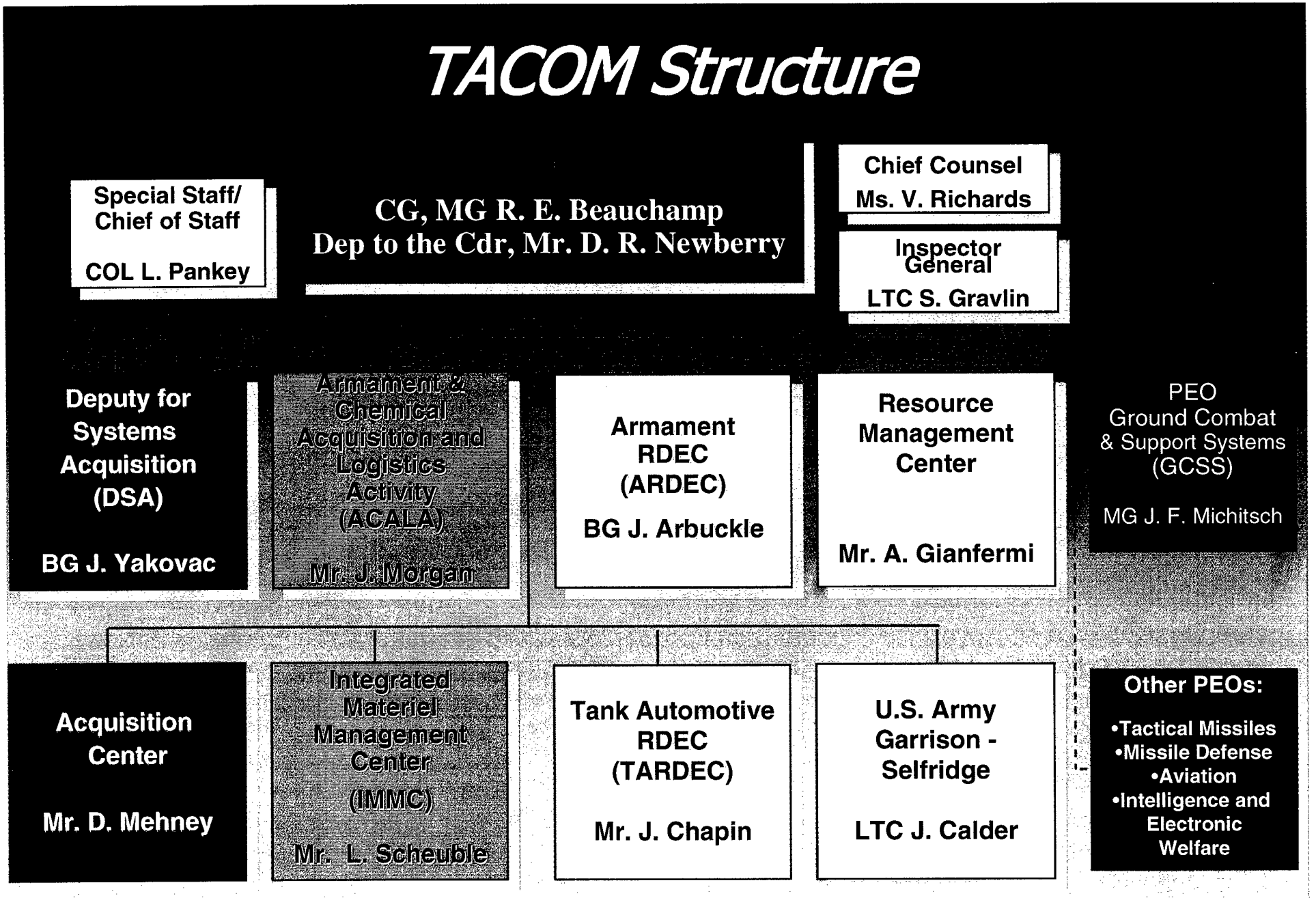

Tank-automotive & Armaments Command
Armament and Chemical Acquisition & Logistics Activity
TACOM-ACALA



ACALA Mission

Provide worldwide armament, Sets, Kits, and Outfits (SKO) and chemical defense equipment acquisition and integrated materiel, weapon system and security assistance management to field and sustain best value to our customer.

TACOM Structure





Office of the Director

Small Business Office

Safety Office

Legal Group

Business Management

Security Assistance

Acquisition Center

Planning, Development & Programs

National Maintenance Point

Logistics Planning and Execution Center

Field Services Office

Field Artillery
Product Center

Armor
Product Center

Aircraft Arm & Small Arms
Product Center

Chemical,Tools/ Equipment & TMDE
Product Center

Product Center / Acquisition Center Functional Relationship

TACOM-ACALA PROCUCT CENTERS

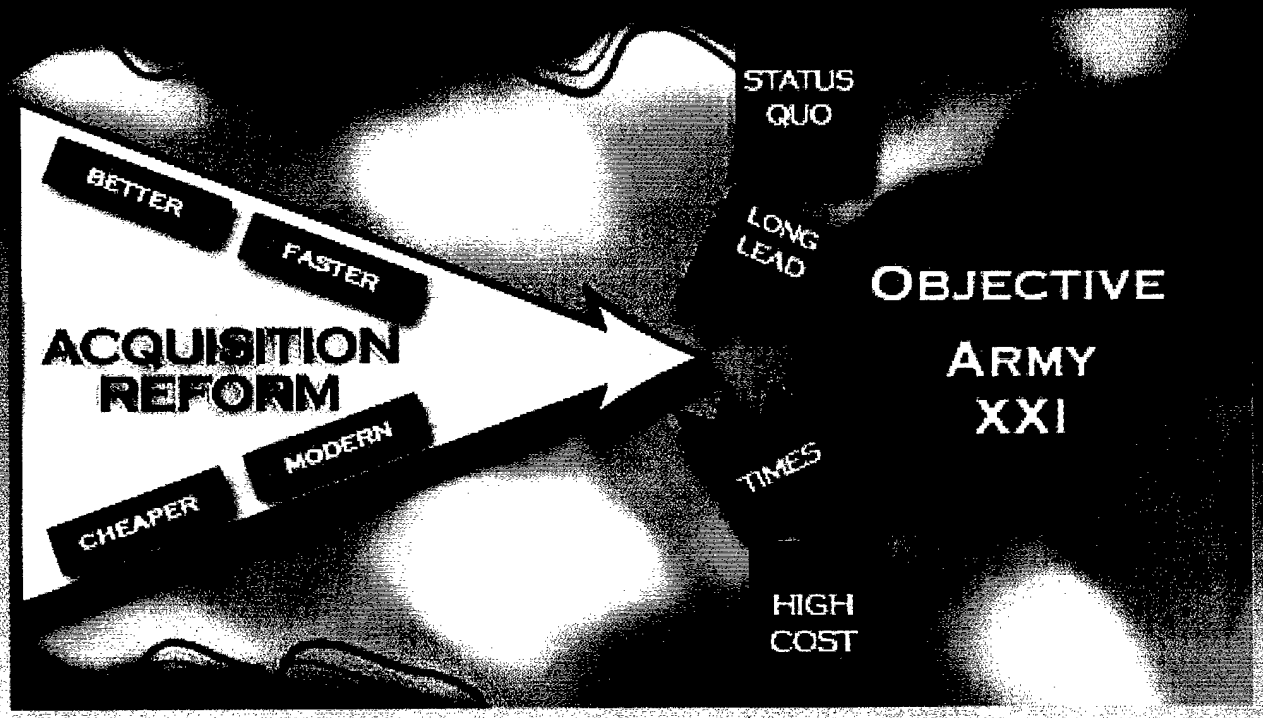


IPT IPT IPT

ARTILLERY & MORTAR GROUP	ARMOR & FIRE CONTROL GROUP	SMALL ARMS & AIRCRAFT ARMAMENT GROUP	CHEMICAL & FIELD SUPPORT GROUP

TACOM-ACALA ACQUISITION CENTER

ACQUISITION REFORM



The Journey

ACALA Acquisition Reform Policy





Support the Warfighter

BETTER

FASTER

CHEAPER

AMC Acquisition Reform Implementation Assessment Team (ARIAT)

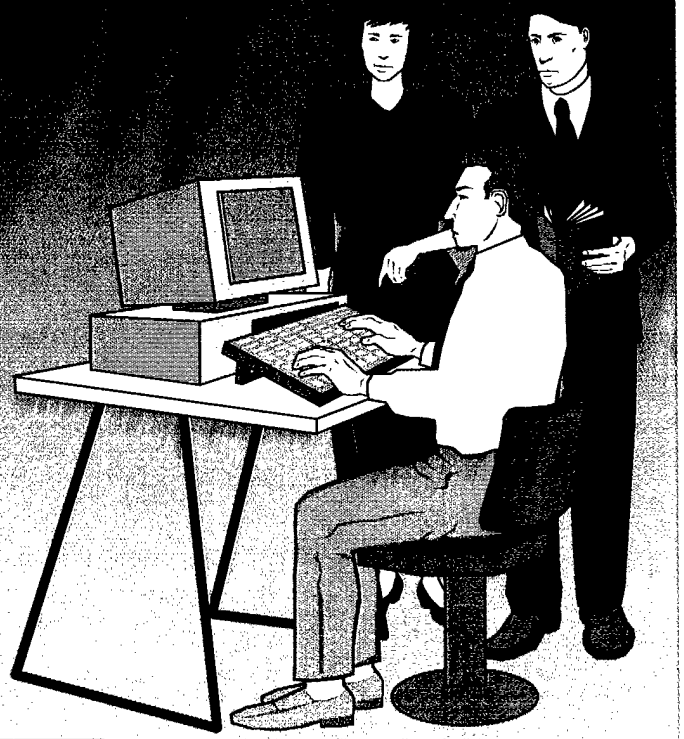
- **Audit team composed of members from HQ and major buying activities for unbiased assessment**
- **Evaluation Areas**
  - Management Processes
  - Tools & Techniques
  - Contract Review
  - Desired Outcomes
- Bottom Line: **95% improvement** from FY97 to FY98 ACALA composite score of 84

ELECTRONIC CONTRACTING

Solicitations on the Web

Technical Data

Central Contractor Registry

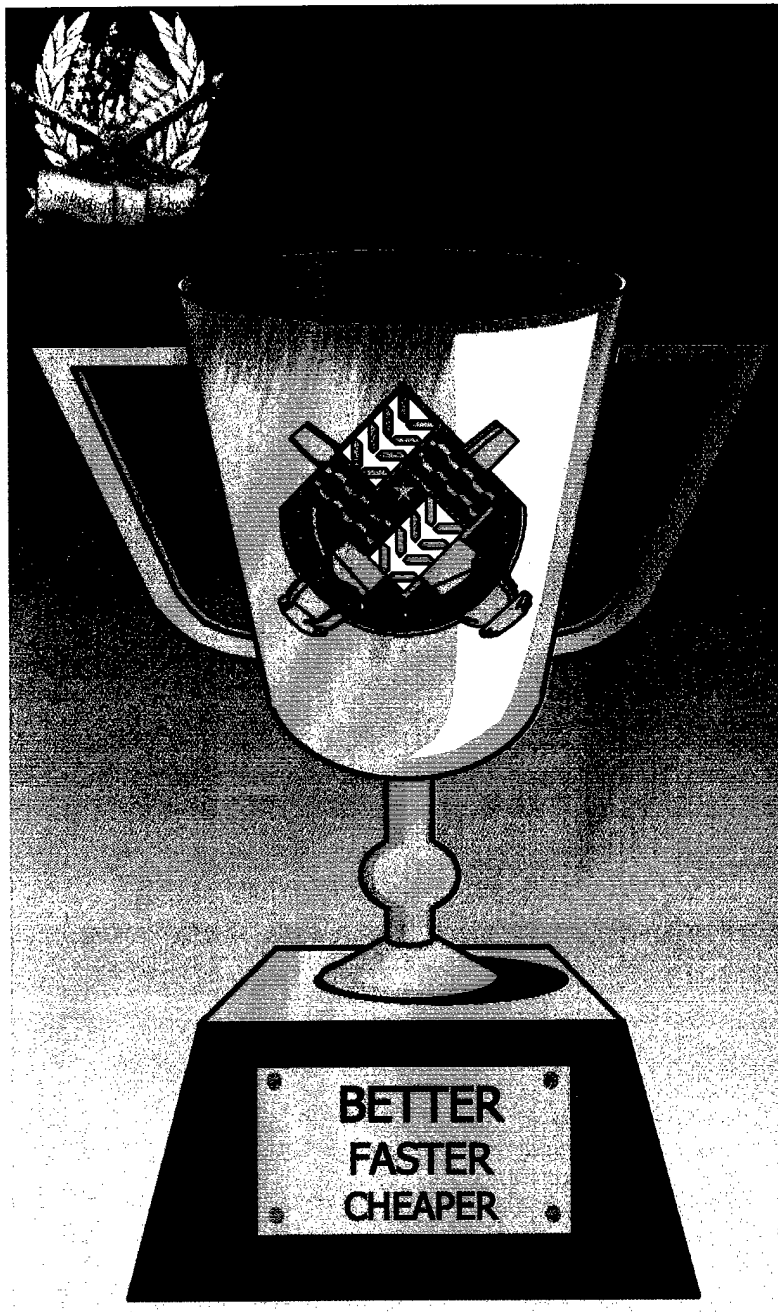




CONTRACT TYPES

- Long Term Contracts
- Combined Requirements
- IDIQ/ Requirement Type Contracts
- Commercial-type Contracts
- Credit Cards

CONTRACTING INNOVATION



ALPHA Contracting

Best Value Contracting

OTHER INITIATIVES

Partnering

Performance Specifications



ACQUISITION REFORM



A CHARTER FOR PROGRESS WHERE THE NEEDS OF THE WARFIGHTER ARE PARAMOUNT

UPDATE ON THE ACTIVITIES OF THE COMMITTEE OF SMALL ARMS PRODUCERS (CSAP) 1997-98

Jim Ritter
President & CEO
FN Manufacturing, Inc.

CHARTER
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
COMMITTEE OF SMALL ARMS PRODUCERS

OBJECTIVE: Organize a forum for interested National Defense Industrial Association (NDIA) members and Government representatives to review and discuss policies and procedures in the small arms arena. The committee called the Committee of Small Arms Producers (CSAP) will examine Industry and Government initiatives during the small arms lifecycle, from concept through disposal.

I. A committee called the CSAP will be formed from: NDIA Corporate membership consisting of 7 executives from industry defense producers of small arms and their components; the Vice President, Operations, NDIA; Commanding General (CG); U.S. Army Tank-automotive and Armaments Command (TACOM); Director, Armament and Chemical Acquisition and Logistics Activity (ACALA), TACOM); Director, Close Combat Armaments Center (CCAC); Product Manager (PM), Small Arms (SA); and Director, Operations, NDIA; and Chairman, Armaments Division, NDIA.

II. Corporate membership of the CSAP will be on a rotation basis. The term of membership is usually 2 years, with approximately 1/2 being rotated each year at the Small Arms Division's annual meeting.

III. The CG, TACOM; Director, ACALA (principal TACOM representative); Vice President, Operations, NDIA); Director, Operations, NDIA; PM, SA; Director, CCAC; and Chairman, Armaments Division, NDIA are permanent members.

IV. The Vice President, Operations, NDIA and Director, ACALA will appoint a Chairman. The term of the CSAP Chairman will normally be 2 years. To assure continuity, the Chairman will be appointed after serving at least 1 year as a regular member. The Chairman will be responsible for providing a Recorder/Secretary for his/her term.

V. The CSAP will meet at the call of the Director, ACALA and CSAP chairman at sites and times convenient to the membership.

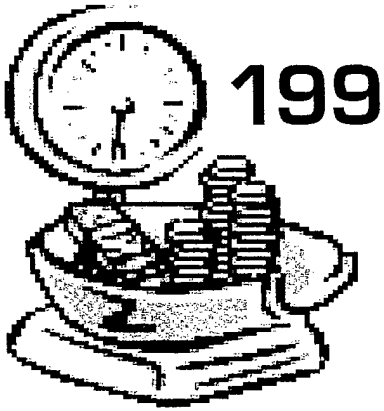
VI. Topics of interest for consideration by the committee will be solicited from CSAP members within the small arms community and from interested Government agencies.

VII. As necessary, subcommittees will be formed under the CSAP to research, review, study, and evaluate specific subjects from an industry viewpoint and prepare reports on such subjects which shall be available to members of NDIA and other interested parties.

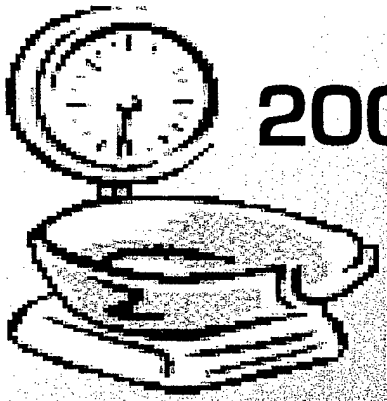
VIII. Minutes of the CSAP meetings will be made available to anyone interested through an open electronic bulletin board maintained by ACALA.

The data presented here today comes from the Phase II Industrial Base Study performed by TACOM-ACALA

COLD HARD REALITY: the small arms business is forecasted to be almost to the point of



1992:



2002:

Projected Small Arms Funding FY 1998-FY2003

FY 1998	FY1999	FY2000	FY2001	FY2002	FY2003
$38.7M	$35.4M	$68.7M	$59.7M	$24.6M	$34.6M

Projected Small Arms Buy FY1998 - FY2003
(FY 1999 Presidential Budget)

WEAPON SYSTEM	FY1998 QTY	FY1999 QTY	FY2000 QTY	FY2001 QTY	FY2002 QTY	FY2003 QTY
MK19 GMG	400	697	1026	649	727	1,255
M16A2 Rifle	11,297	16,067	22,848	0	0	0
M16A4 Rifle	6,497	11,328	16,068	6,672	0	0
M249 MG	406	1,525	0	0	0	0
M240B MG	1,500	673	2,154	1,746	0	0
M4 Carbine	7,484	6,310	8,687	8,309	0	0

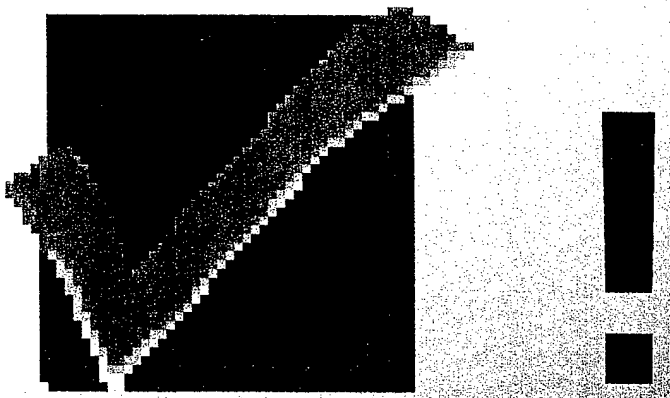
The focal point of the **CSAP** has been, and still is today, **preserving small arms industries, and the small arms industrial base!**

What does the future look like?

and

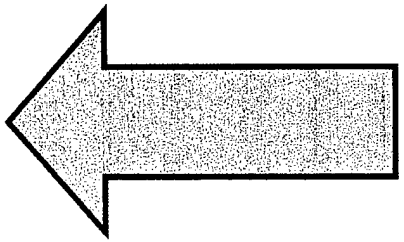
What can we do?

REALITY



"Industrial Base":

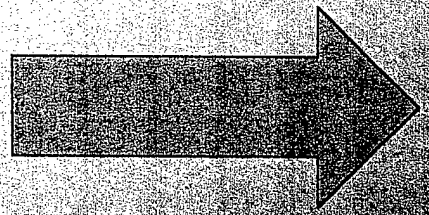
means different things to



Rock Island/TACOM,

different things to certain

CSAP members



CSAP members' opinions:

RANGE

Total free and open competition [unmanaged]



Managed with the market forces

DIFFICULT ISSUE

DIFFICULT TO DECIDE WHICH DIRECTION TO TAKE

Certain members of the CSAP:

"industrial base"=

systems integrators (SACO, Colt's and FNMI)

ONE OPINION:

you must have at least one systems integrator remaining, with the rest of the industrial base supporting this systems integrator.

FORECAST:

the business is contracting, through industry management, down to either a single systems integrator

or

DISASTER!

TOUGH ISSUE!

The government is not going to help. It is up to the industrial base to solve this problem through:

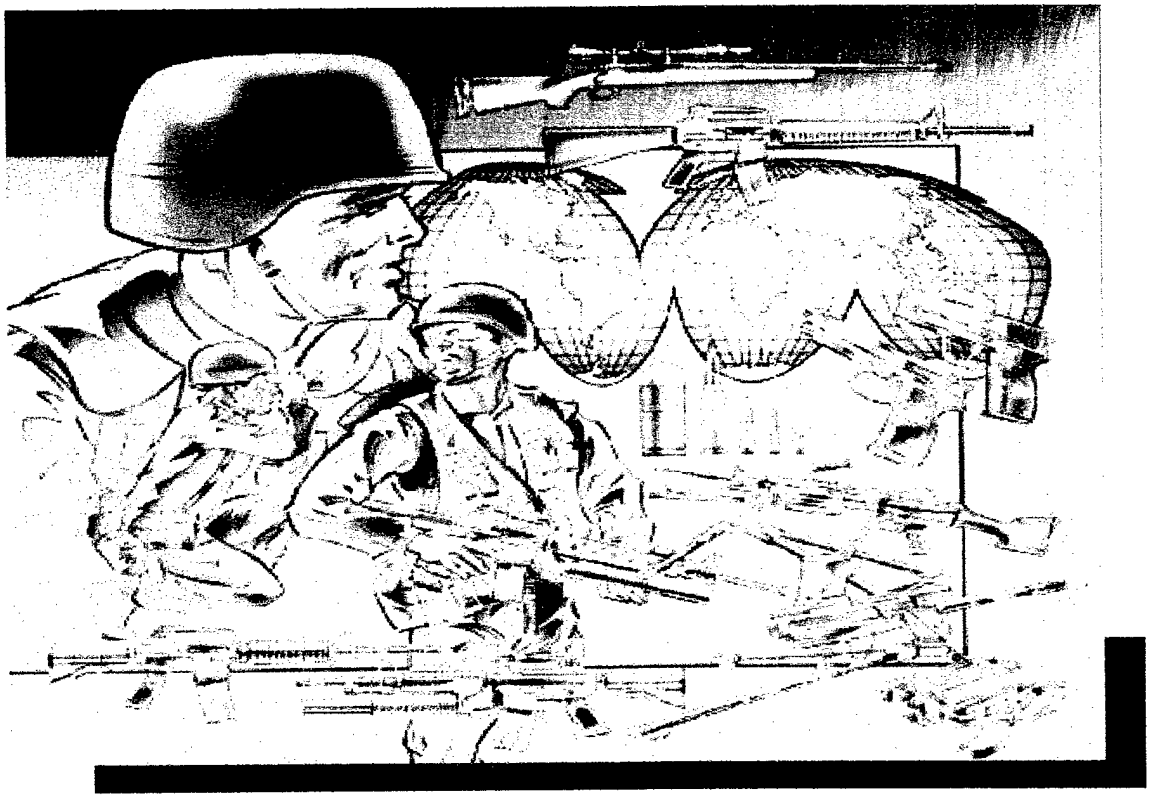
- joint ventures;
- partnerships;
- teaming;
- etc.

This is what we still have to work on!

We, the industry, must COLLECTIVELY MANAGE the contraction of this business.

TACOM

Mobility and Firepower for America's Army



NDIA
Small Arms Conference

Columbus, GA.

15-18 June 1998

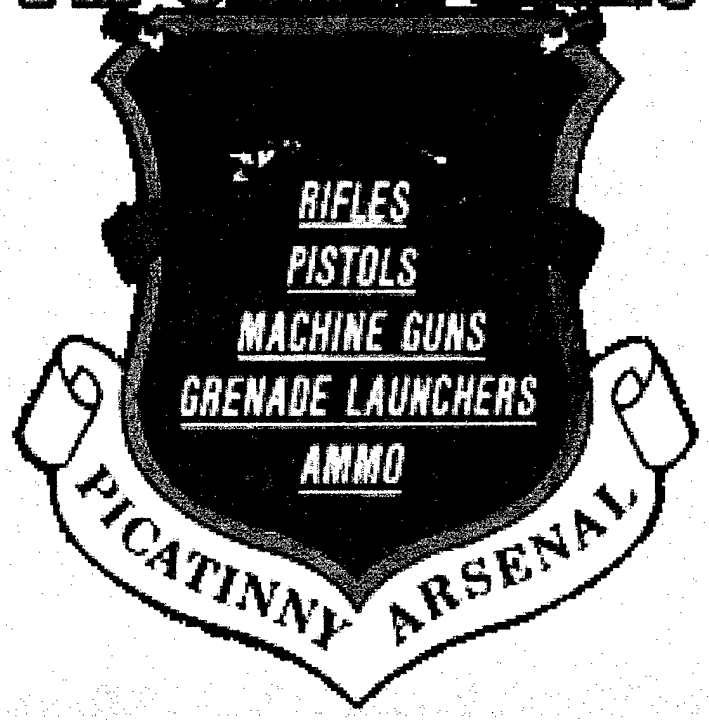
LTC W. Irish

PM Small Arms

Tank-automotive & Armaments COMmand

Committed to Excellence

PM SMALL ARMS



ACOM

Committed to Excellence

What Are We Doing For The Soldier?







4:00 am Raid at the JRTC

"Each platoon initiated the raid with their **90mm recoil-less rifle**, and then followed up with the **M-240 machine gun**. The weapon squad leader used a **laser aiming device** to direct the fires of the guns throughout the raid. While the machine guns were hammering away, a squad infiltrated to the first building and took it down by: blowing the lock with a **shotgun**, tossing a **flash-bang grenade** inside, entering with NVGs and shooting whatever looked hostile. They leap-frogged from one building to the next like this. Once a building was secured, the squad tossed an **IR grenade** at the next building for IR illumination, providing enough light to illuminate the target area (for the soldiers in NVGs). Once secured the buildings were marked with IR chem lights. **White-lights** were used to search secured buildings."



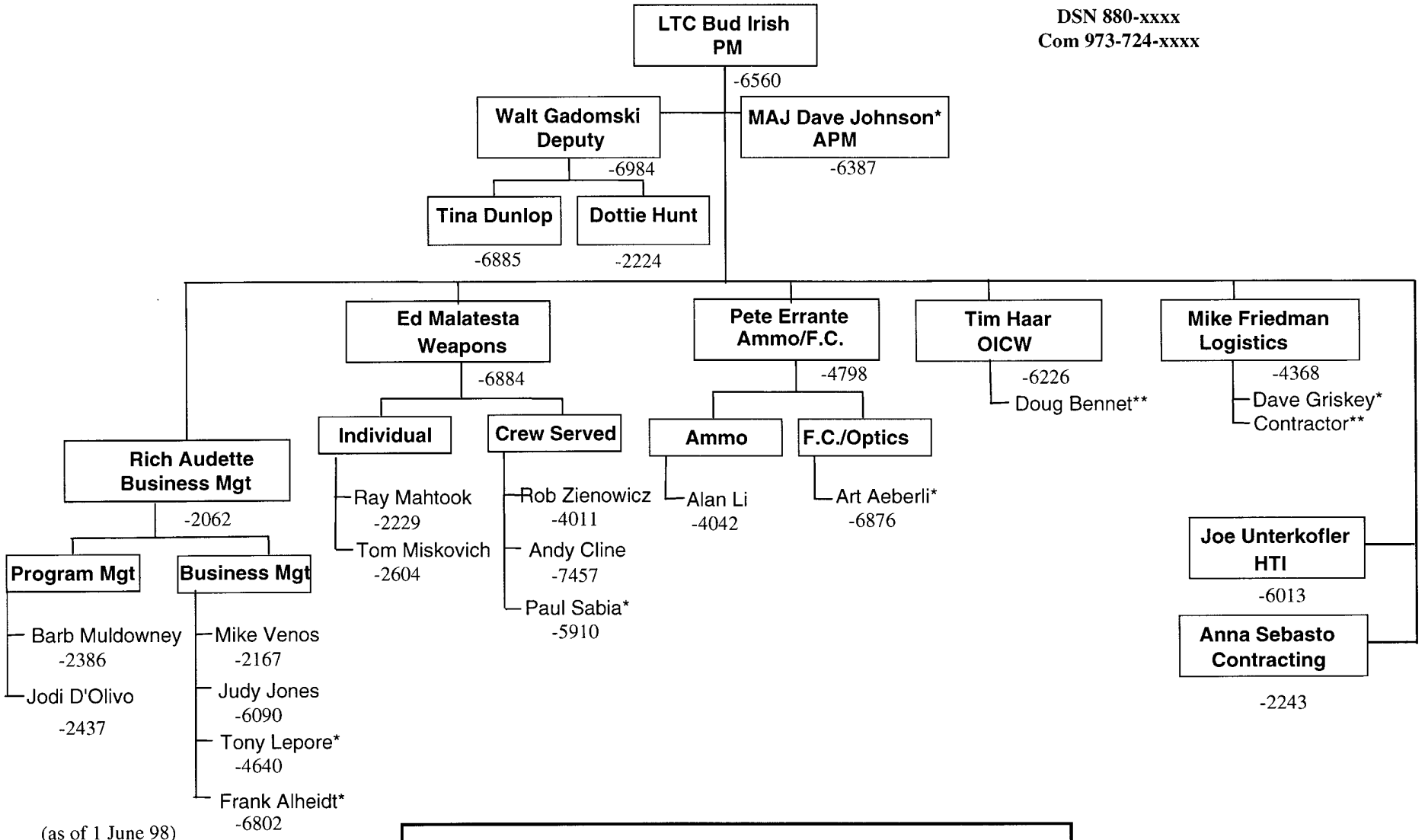




MISSION

- **Centralized life cycle program management of all assigned Army small arms weapon systems.**
  - **Individual and Crew Served Weapons**
  - **Grenades/Grenade Launchers**
  - **Mounts/Tripods**
  - **Ammunition**
  - **Fire Control/Optics**

Product Manager Small Arms



(as of 1 June 98)

Committed to Excellence

SMALL ARMS DIRECTION



EXISTING WEAPONS

M2 MG (1923)
M60 MG
M16 Rifle
M203 GL
M249 SAW
MK19 GMG
M24 Sniper Rifle
M4 Carbine
M9/M11 Pistols

25 SMALL ARMS IMPROVEMENT PROGRAMS

- Weapon Upgrades
- Modular Weapon System
- Optics/Fire Control
- Mounts/Tripods
- Suppressors, Adapters
- Buttstocks
- Equipment Packs/Magazines

16 NEW SYSTEM PROGRAMS

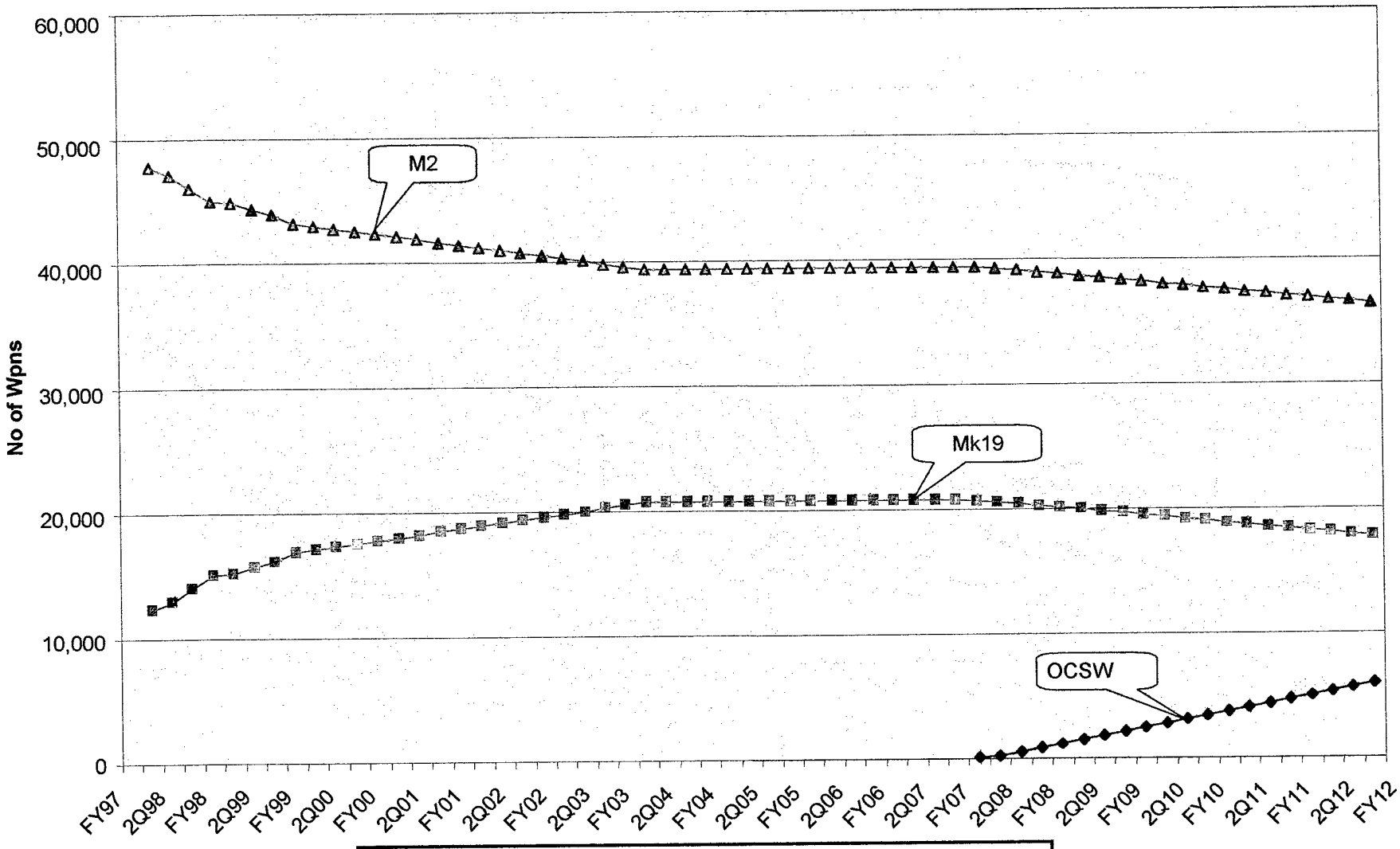
- Ammo (AP, Non-Lethal, Multipurpose,SLAP)
- Tracers, Grenades
- Mini/Stabilized Binoculars
- Sniper Rifle
- M240B

HTI

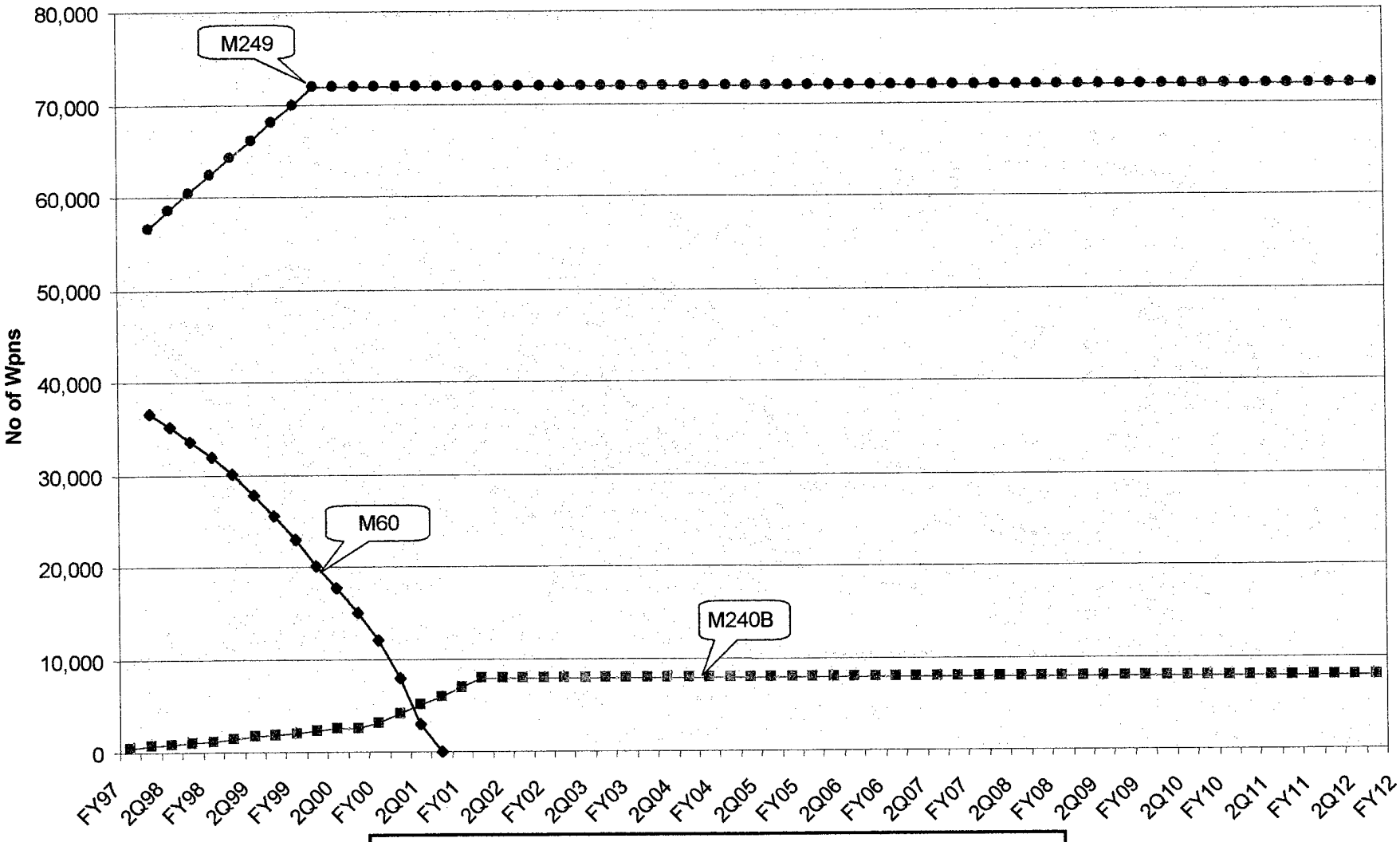
OBJ FAMILY OF WEAPONS

Individual Combat
Crew Served
Personal Defense

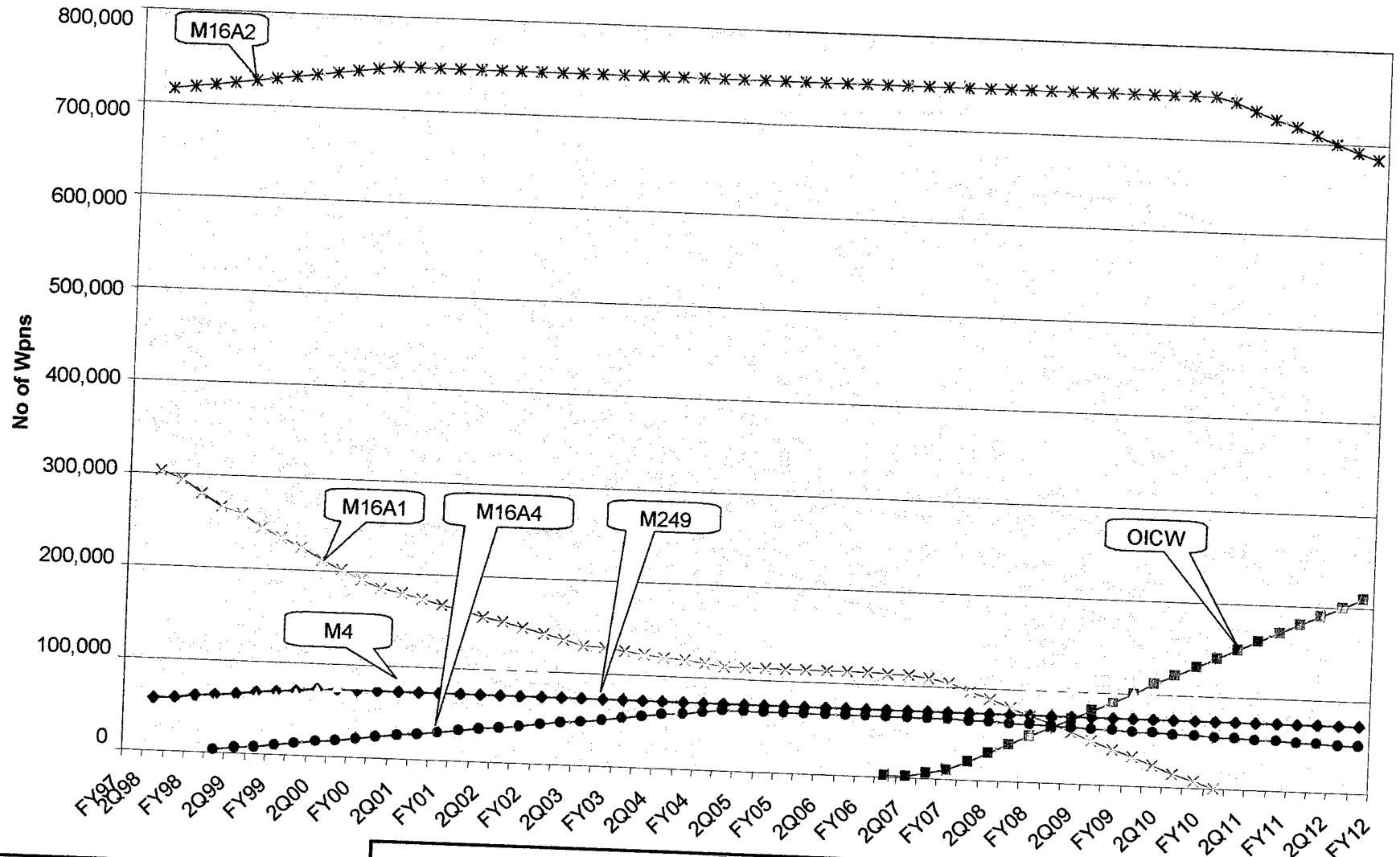
Heavy Weapons Fielding Status



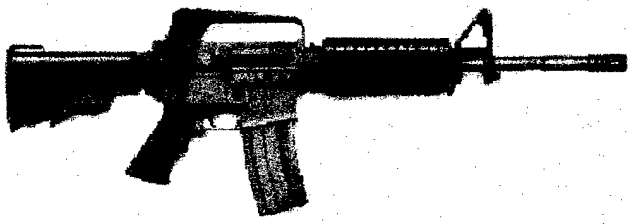
Med/Light MG Fielding Status



Individual Weapon's Fielding Status



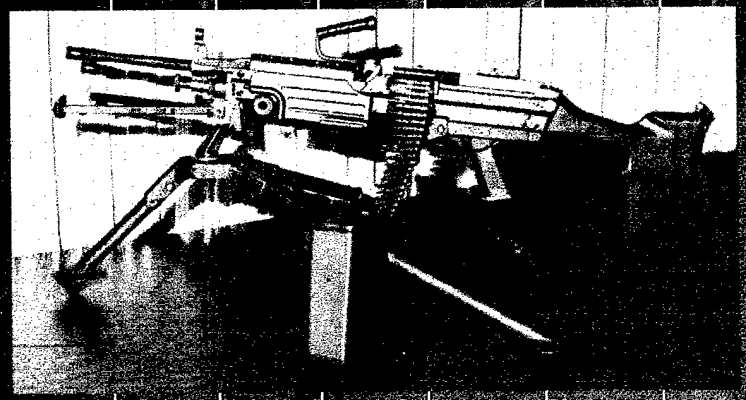
Army Procurement Objective (APO) Fill

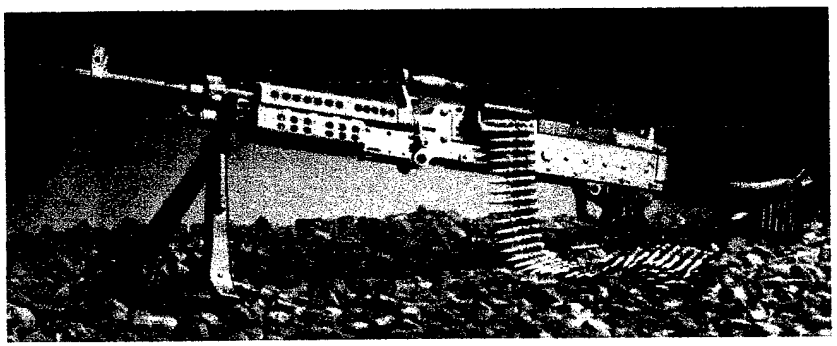




%

	98	99	00	01	02	03	04	05	06	07	08	09	10
M4 CARBINE	71	76	84	91									
M16A2/A4 RIFLE	81	82	84	85									
M249 SAW	93	95											
M240B MMG	44	50	70	86									
MK19-3 GMG	78	81	86	90	93	99							

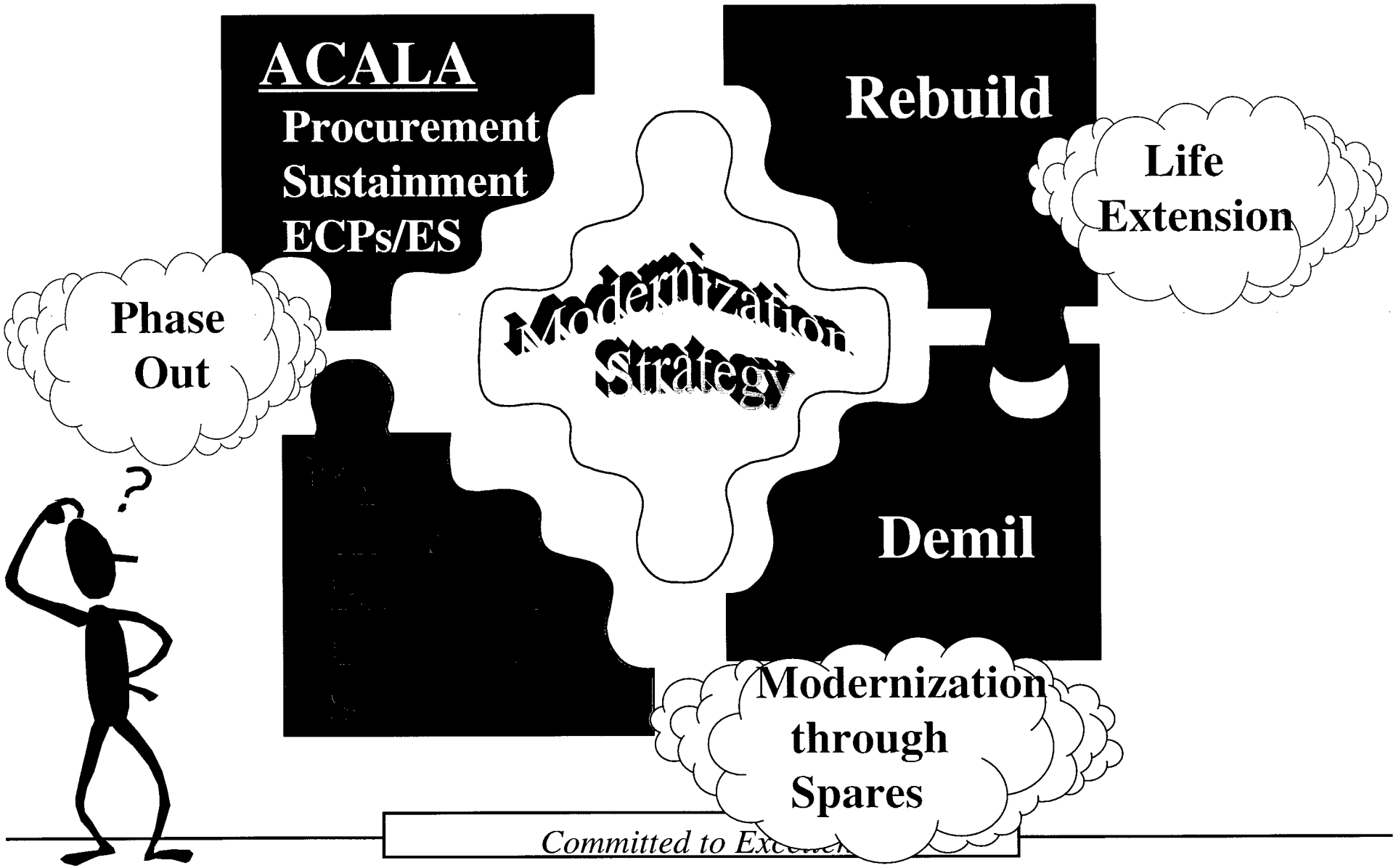






(as of 2 Dec 97)

SMALL ARMS STRATEGY



PM SMALL ARMS PROGRAMS

R&D PROGRAMS

WEAPONS AND ASSOCIATED HARDWARE

✓ 1. Long Range Sniper Rifle
2. M249 Feed Tray Cover
3. M249 Short Barrel
4. Backup Iron Sight for M16A4/M4
5. Sling, Close Quarters Battle for M4 Carbine
6. M240 Dismount Kit**
✓ 7. Medium Sniper Rifle System**
8. Adjustable Sight Bracket for MK19
✓ 9. .50 Cal QCB
10. Flashlight Mount
✓ 11. Modern HMG Mount
✓ 12. Remote MG Platform

AMMUNITION

✓ 13. IR Illumination Hand Grenade
✓ 14. 12 Gauge Non Lethal Point and Crowd Control
✓ 15. Non-Lethal 40mm Round
✓ 16. Rifle Launched Non-Lethal Munition
✓ 17. Stun Grenade, XM84
✓ 18. 40mm Infrared Illuminant, XM992
✓ 19. 40mm Canister Round
20. 7.62mm Short Range Training Ammunition (FCT)
✓ 21. 12 Gauge Breaching Round
✓ 22. Long Range Tactical Sniper Cartridge
✓ 23. Light Weight Fragmentation Grenade
✓ 24. M203 Improved Munition**
25. 40mm Low Cost Training Ammo(FCT)

FIRE CONTROL

✓ 26. Anti Reflection Device
✓ 27. Machinegun Optics Program
✓ 28. Stabilized Binoculars, XM25
29. Small Arms Fire Control System (SAFCS)
30. Common Remotely Operated Weapon System
✓ 31. M203 Enhanced Fire Control

PRODUCTION PROGRAMS

WEAPONS AND ASSOCIATED HARDWARE

✓ 32. MK19 GMG
33. MK19 Materiel Change
34. MK64 Materiel Change
✓ 35. M240B, Medium Machinegun
✓ 36. M16A4 Rifle
✓ 37. M4 Carbine
✓ 38. M249 Squad Automatic Weapon
✓ 39. Modular Weapon System(Rail Adapter System, M4/M5)
✓ 40. HMMWV Machinegun Mounts, M6 (M998) and M197
✓ 41. Dual Mount, MK93
42. Collapsible Buttstock, M5
43. Improved Buttstock for M4 Carbine
44. M203/M4 Compatibility

AMMUNITION

✓ 45. .50 Cal Multipurpose, MK211
✓ 46. .50 Cal SLAP, M903, M962
✓ 47. 5.56mm Armor Piercing, M995
✓ 48. 7.52mm Armor Piercing, M993
49. Assault Pack Soft for M249
50. Assault Pack Hard for M249

FIRE CONTROL

✓ 51. Close Combat Optics, XM68

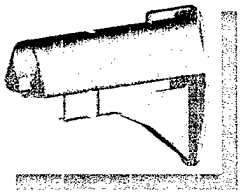
✓ M4 Mods (4,5,43,44)
✓ M16 Mods (4,10)
✓ M249 Mods (2,3,42)

✓NOTE: 36 ACAT III PROGRAMS
** 1999 NEW START PROGRAMS
X/XX

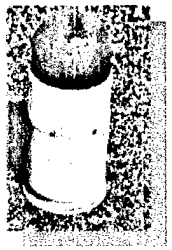
(As of 27 May 98)

Committed to Excellence

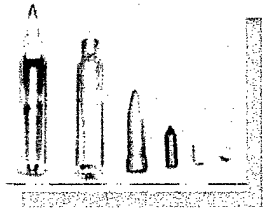
M16/M4/M203 INITIATIVES



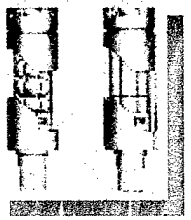
IMPROVED BUTTSTOCK FOR M4
FUE: 1QFY99



NON-LETHAL 40MM ROUND
IOC : 3QFY99*

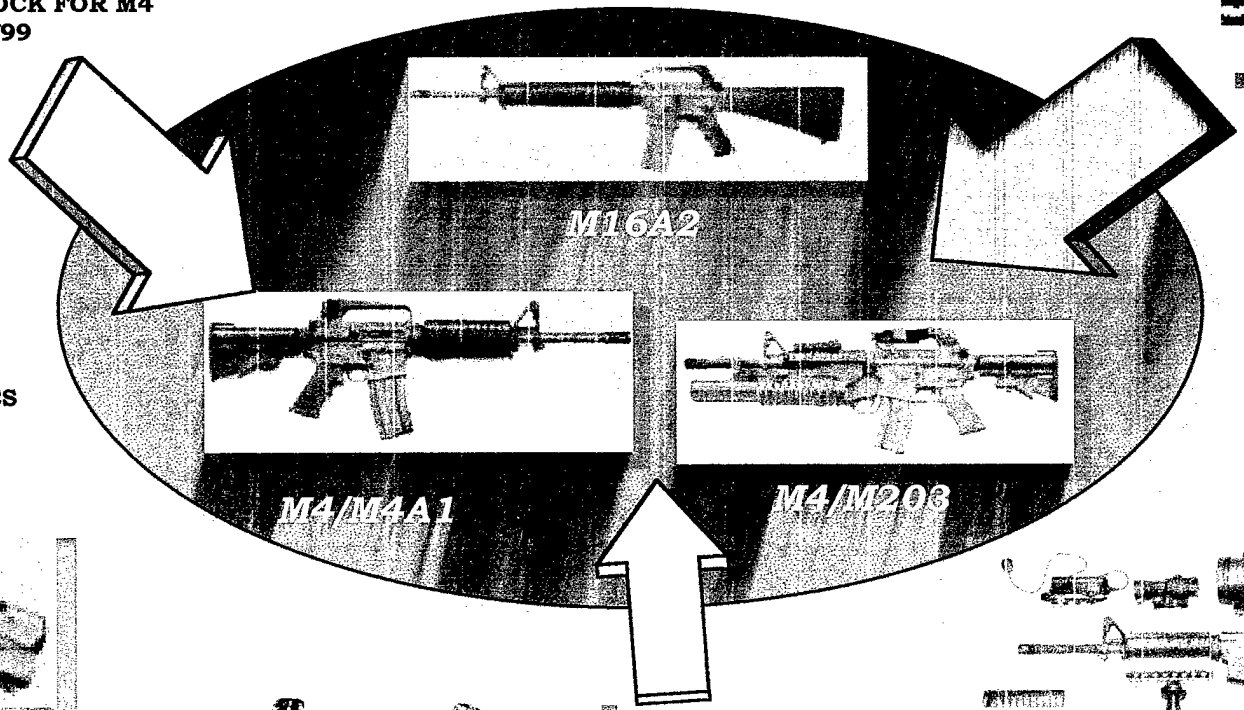


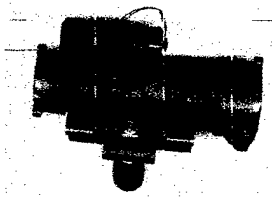
5.56 ARMOR PIERCING
IOC : 3QFY98



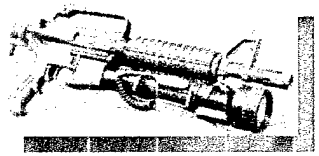
RIFLE LAUNCHED NON-LETHAL MUNITION
IOC : 3QFY99 *



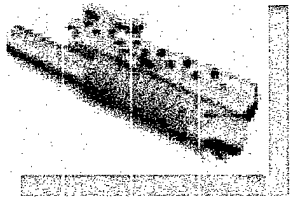




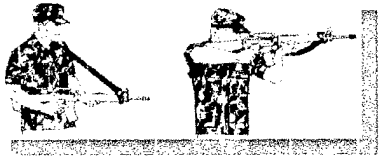
CLOSE COMBAT OPTICS
FUE : 2Q FY98



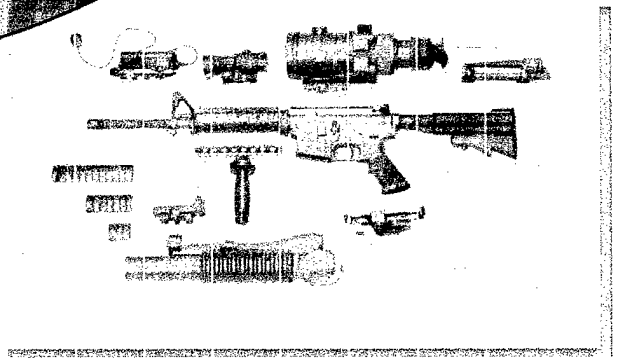
WEAPON FLASHLIGHT MOUNT
FUE: 4QFY99*



M203/M4 COMPATIBILITY
FUE : 3QFY98

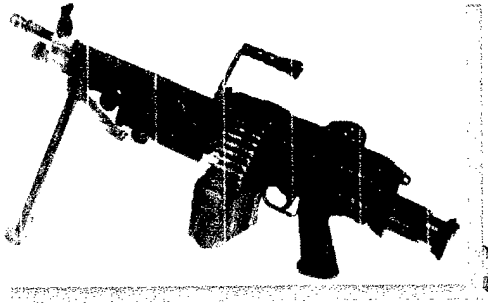


SLING, CLOSE QUARTERS BATTLE FOR M4
FUE: 3QFY99*

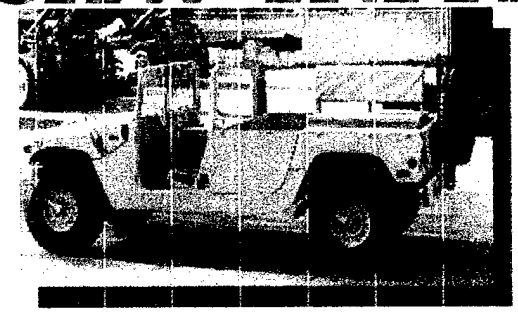


MODULAR WEAPON SYSTEM
FUE : 4QFY98

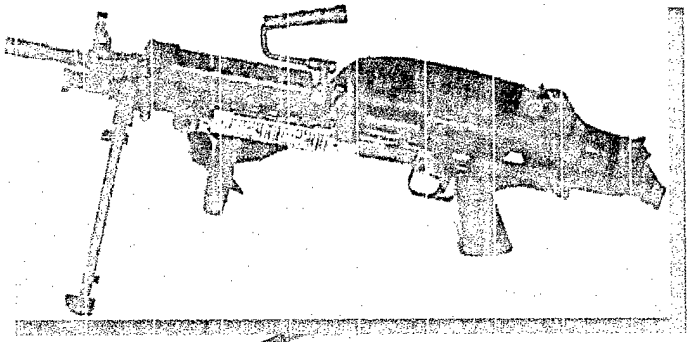
M249 SAW INITIATIVES

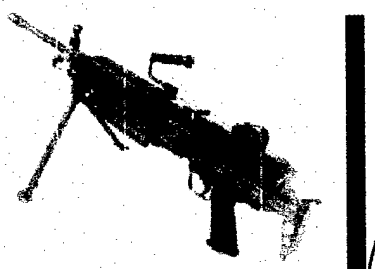


SHORT BARREL FUE: 2QFY00

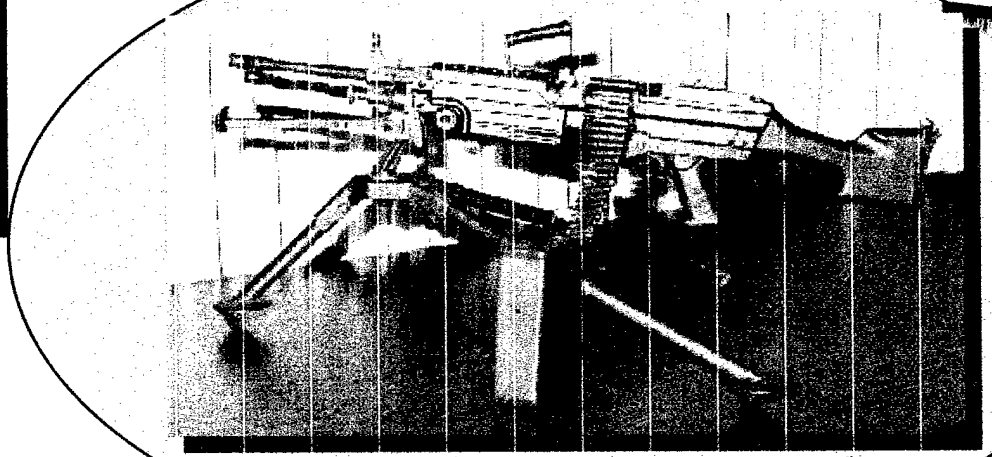


HMMWV MOUNT
FUE : 3Q FY98

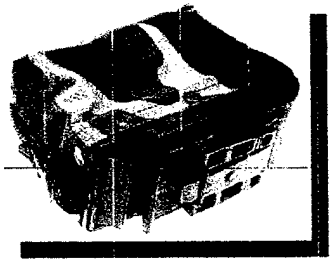




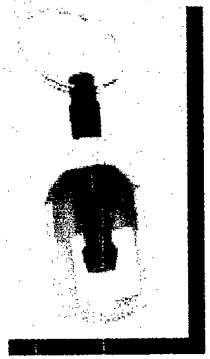
COLLAPSIBLE BUTTSTOCK
FUE : 4QFY97



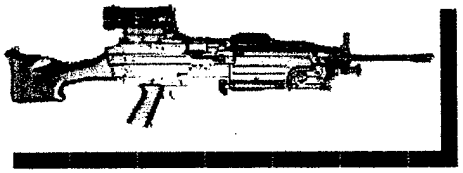
Alt Mounting Surfaces
FUE : 1Q FY02*



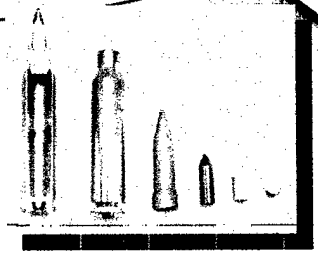
ASSAULT PACK
FUE : 3Q FY98



BLANK FIRING ADAPTOR
FUE : MAY 95



MACHINEGUN OPTICS
FUE : 3Q FY99

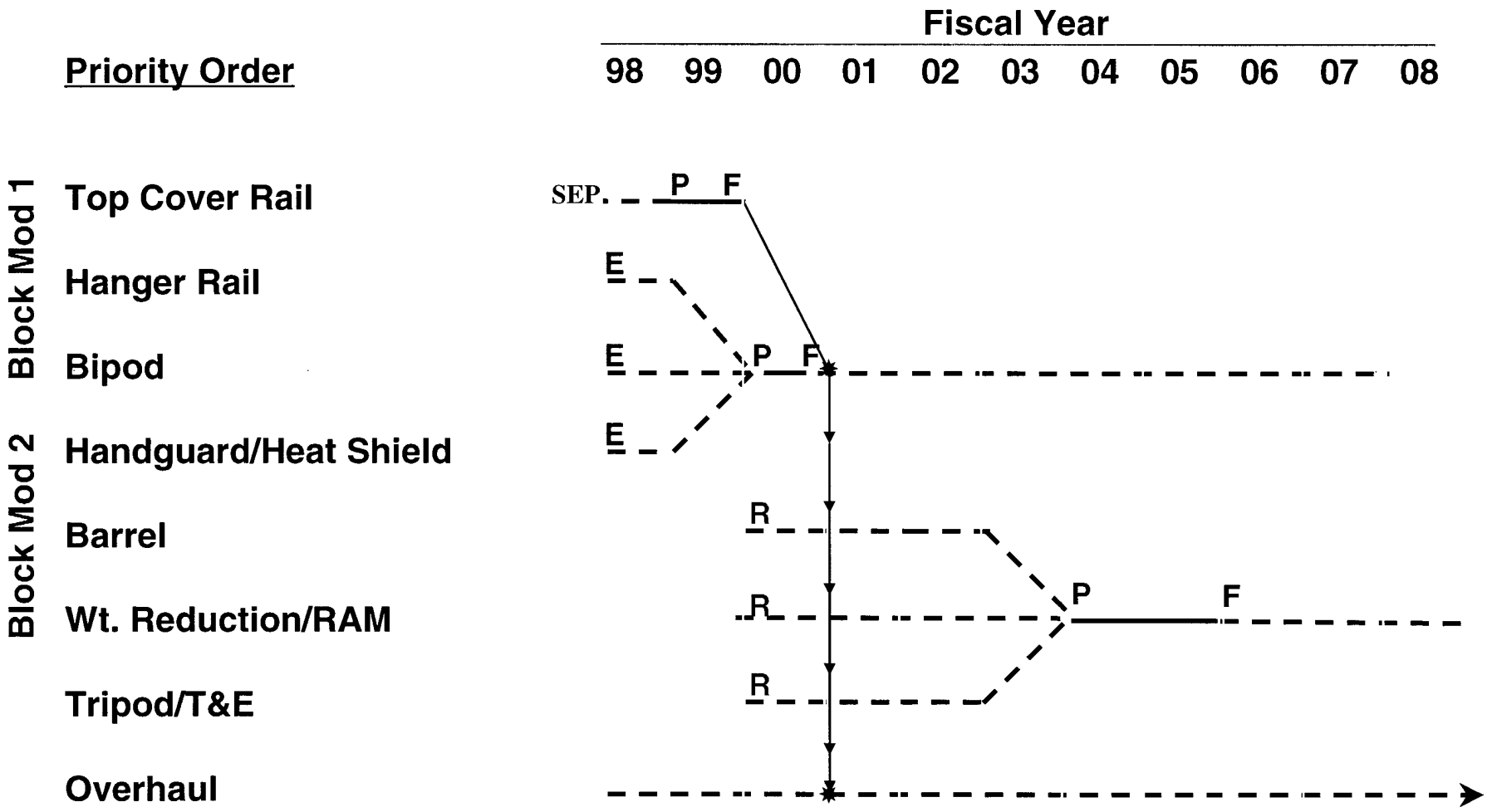


5.56 ARMOR PIERCING
IOC : 4QFY98



FEED TRAY COVER
FUE : 1Q FY99*

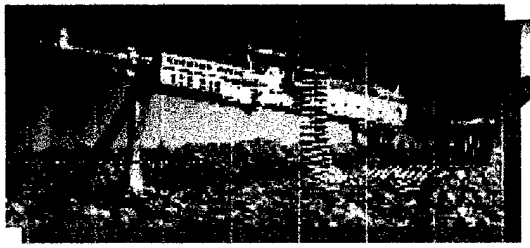
M249 SAW Weapon Block Modification



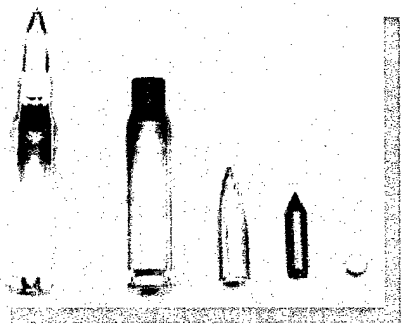
E = Production $ for Engineering Studies
P = Production
R = Development $ (A Requirements Document is Needed.)
F = Fielding

(as of 8 Apr 98)

7.62 MACHINEGUN INITIATIVES

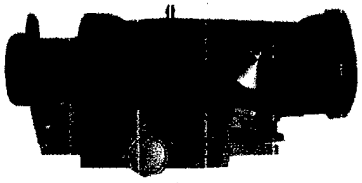


MEDIUM MACHINEGUN UPGRADE
FUE : 4QFY97

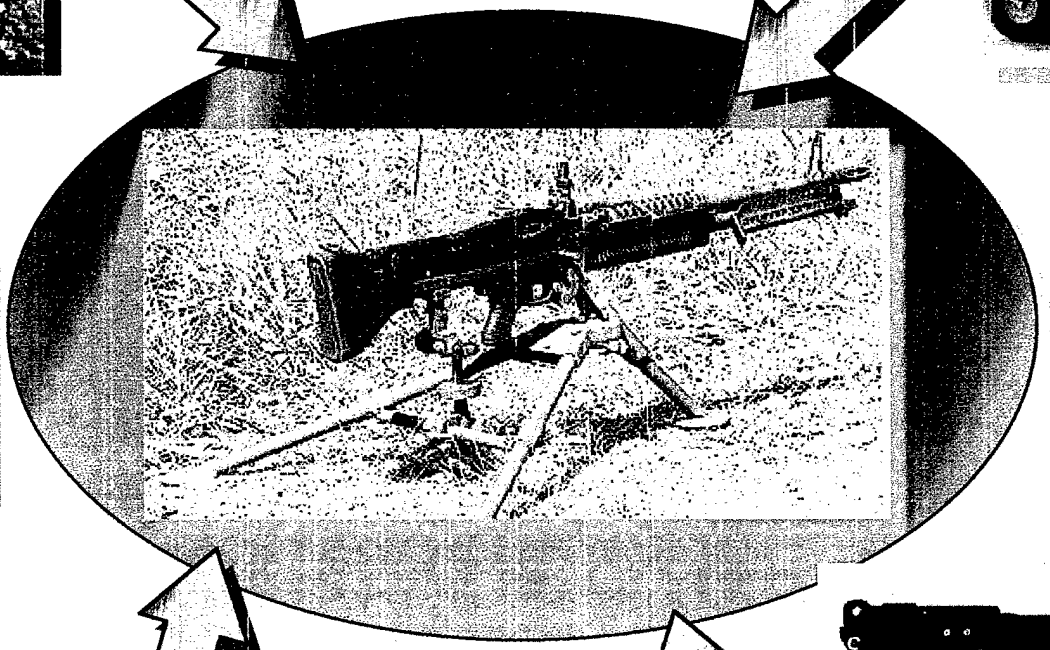


7.62 ARMOR PIERCING
IOC :4QFY98

XM 145 Telescope

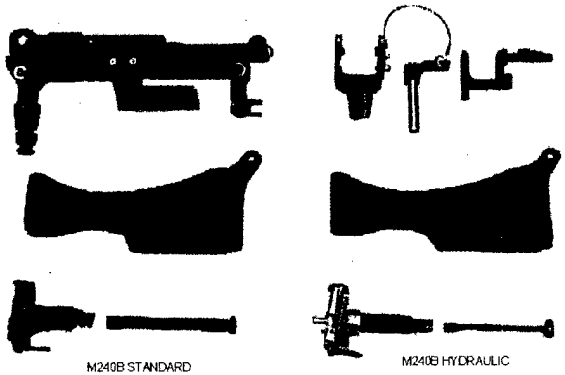


MACHINEGUN OPTICS
FUE : 3Q FY99





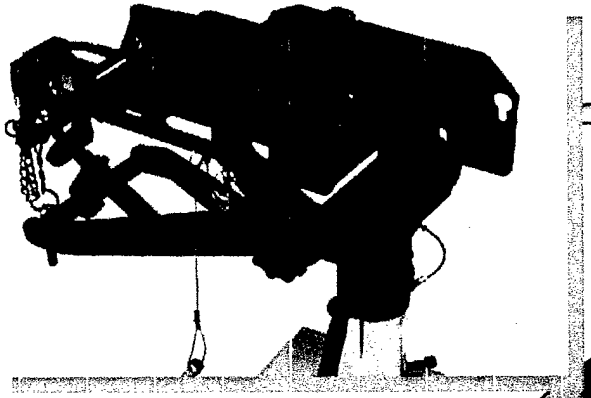
HMMWV MOUNT
FUE : 3Q FY98



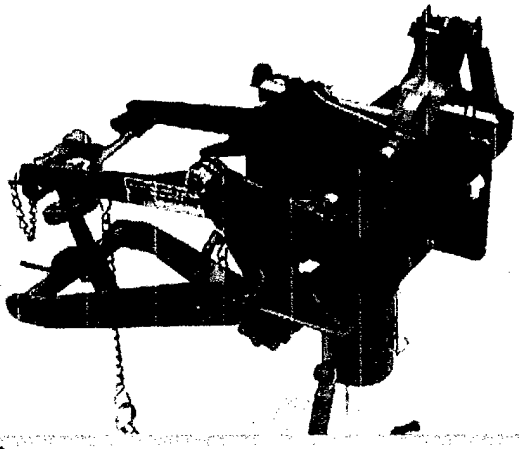
Improved Buffer
FUE: 4Q99

MK 19 GMG INITIATIVES

MODERN HEAVY MG MOUNT
FUE: 1QFY05



MK93 MOD 1, DUAL MOUNT
FUE : 3QFY98



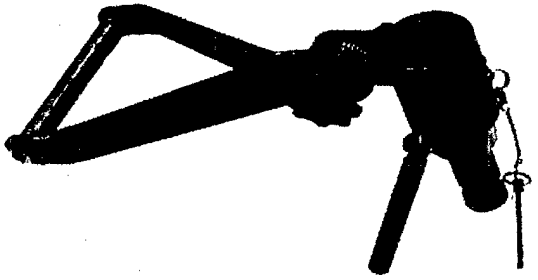
MK64 MOD 9
FUE: 3QFY98





ADJUSTABLE SIGHT BRACKET
FUE: 2QFY01

REMOTE MG PLATFORM
FUE: 1QFY05



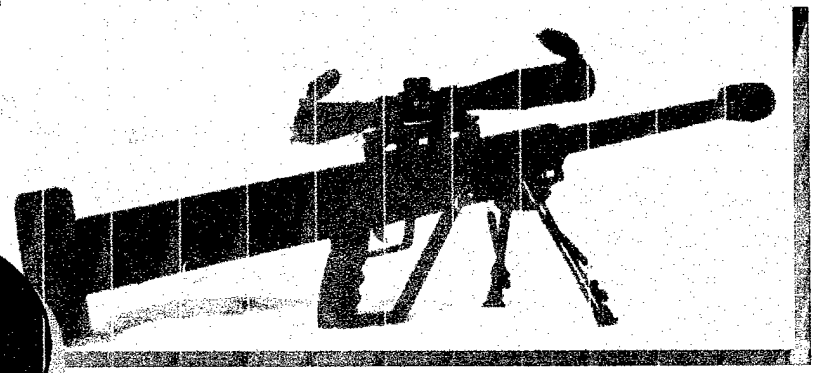
MK64 MATERIEL CHANGE
FUE: 3QFY98

SNIPER WEAPON SYSTEM INITIATIVES

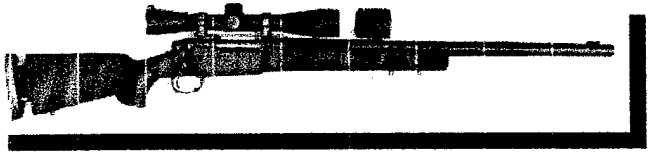
Future Programs



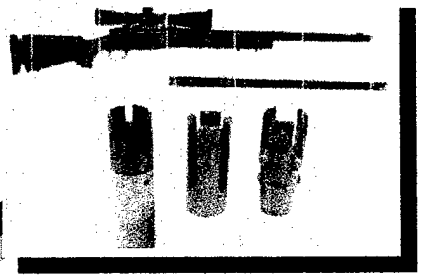
M24 SNIPER WEAPON SYSTEM (SWS)



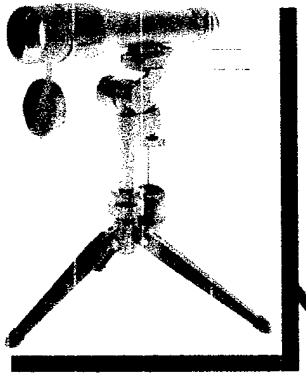
LONG RANGE SNIPER RIFLE



OPTICAL LASER HARDENING
FUE : JUL 94

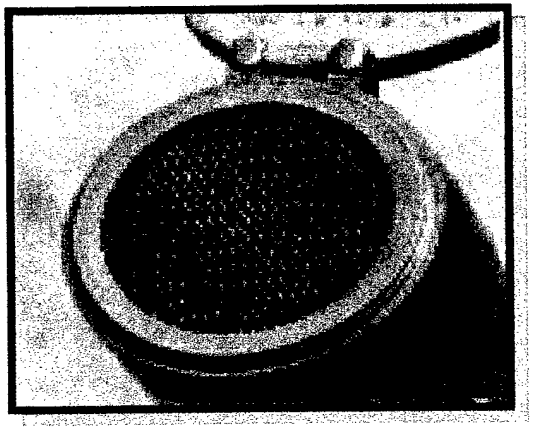


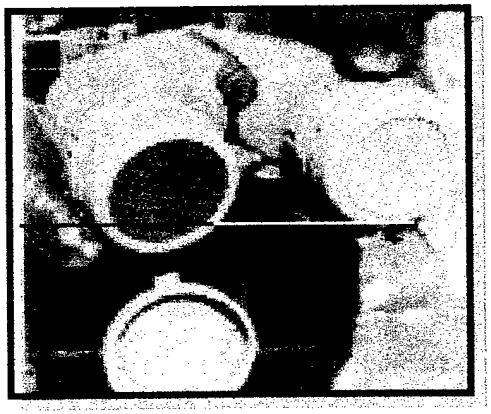
FLASH/BLAST ATTENUATOR
FUE : 4Q FY97



XM144 STRAIGHT TELESCOPE
FUE : JUL 96

FIRE CONTROL

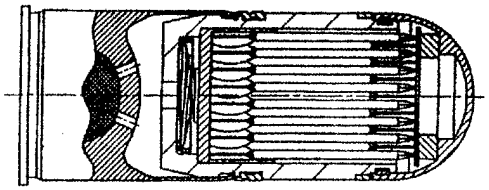




Anti Reflection Device
FUE: 1QFY99



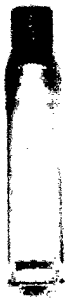
XM25, Stabilized Binoculars
FUE: 2QFY99



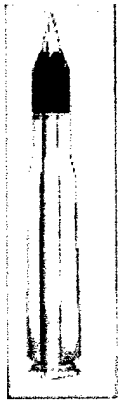
40mm Canister Ctg.
TC: 2QFY00







7.62mm AP
MR: 4QFY98

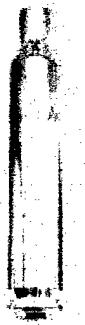


.50 Cal SLAP
MR: 4QFY96

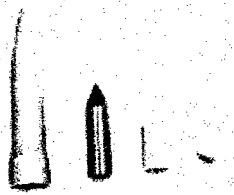


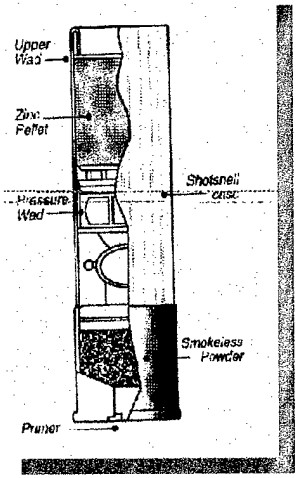
LETHAL MUNITIONS





5.56mm AP
MR: 3QFY98



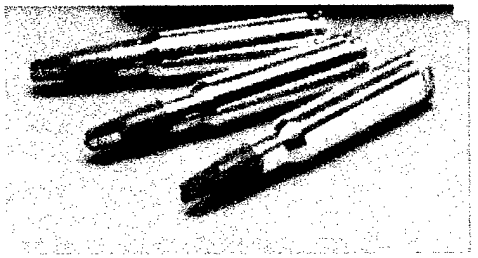


12 Ga Breaching Rd
MS III: 3QFY00

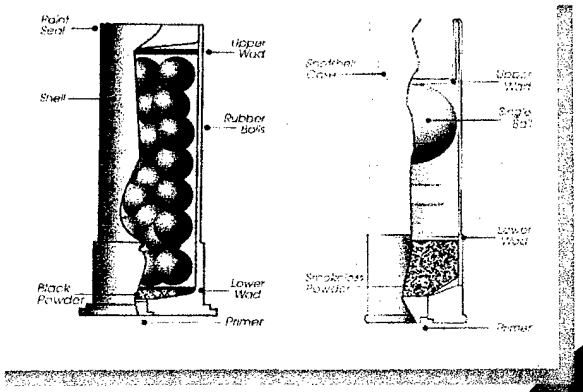




Lt Wt Frag Hand Grenade
TC: 1QFY01



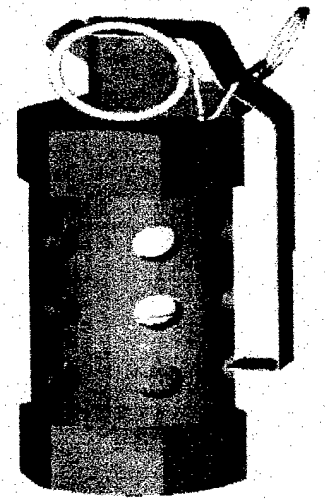
7.62mm Short Range Trng Ammo
TC: 1QFY99

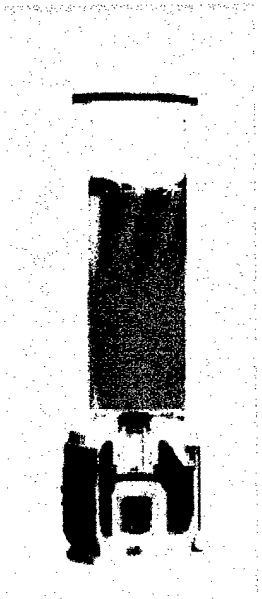


12 Ga NL Point & Crowd
TC: 4QFY99

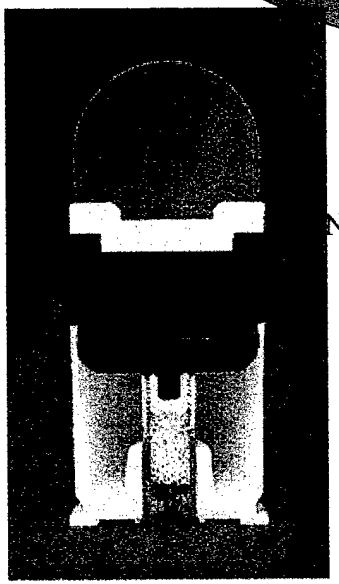
NON-LETHAL MUNITIONS

IR Illum
Hand Grenade
MS III: 1QFY00

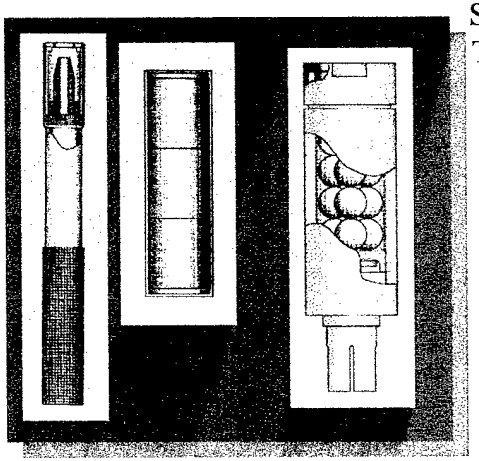




40MM IR ILLUM
MS III IPR: 2QFY97



NL 40mm Round,
XM1006
TC: 3QFY98



Rifle Launched NL Munition
TC: 3QFY98

Stun Grenade
TC: 3QFY98

Product Manager Small Arms







http://www.pica.army.mil/orgs/pmsa/top.html

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SMALL ARMS ACCOMPLISHMENTS

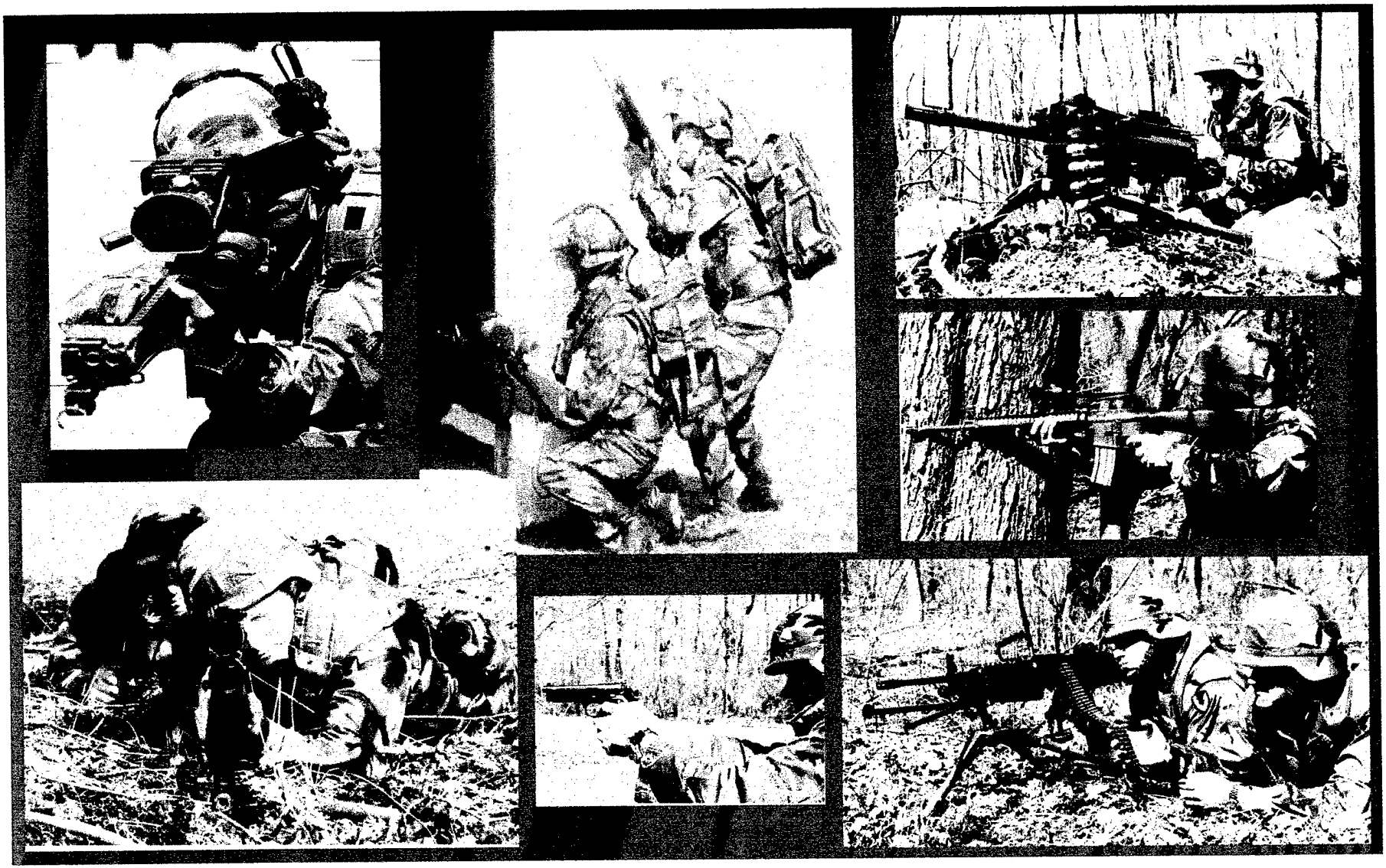
- PALADIN/FAASV
  - Universal Pintle Adapter
- PM-LTV/ CRUSADER/ GRIZZLY
  - Remote Firing Weapon
- ACALA
  - MOA
- ARDEC
  - OICW Transition
- PM-COMBAT ID
  - CIDDS Interface
- PM SOLDIER
  - SEP/CO-MDA
  - Land Warrior
- PM-NV
  - SAFCS/TWS P3I
  - Adj Sight Bracket
- CECOM
  - PVS4
  - PAQ4/PEQ2

SMALL ARMS ACCOMPLISHMENTS Cont'd

- SOCOM
  - Sniper Rifle
  - Modular Weapon System
- U.S. NAVY
  - CCO
- USMC
  - Universal Pintle Adapter
  - MK93 Dual Mount
  - Modular Weapon
  - Mini Binoculars
- U.S. AIR FORCE
  - Non-Lethal Ammo
- COAST GUARD
  - Remote Firing Weapon
- FIELDING CONFERENCES
  - All MSCs
  - Small Arms/Night Vision
- COMMUNITY DAYS
  - Integration
  - Commonality



GIVING THE SOLDIER



THE FIREPOWER THEY NEED

Committed to Excellence

Joint Service Small Arms Program
(JSSAP)

Deploying
for
Force XXI and Army After Next

16 June 1998

Joel M. Goldman
Chief, JSSAP Office
Phone: DSN:880-7913/Com'l: 973-724-7913
Email: jgoldman@pica.army.mil

Deploying for Force XXI and Army After Next

Agenda

- Customer
- JSSAMP
- General Objectives
- OICW
- OCSW
- OSW
- OFSA Tech Advancements
- Funding
- Opportunities
- Summary

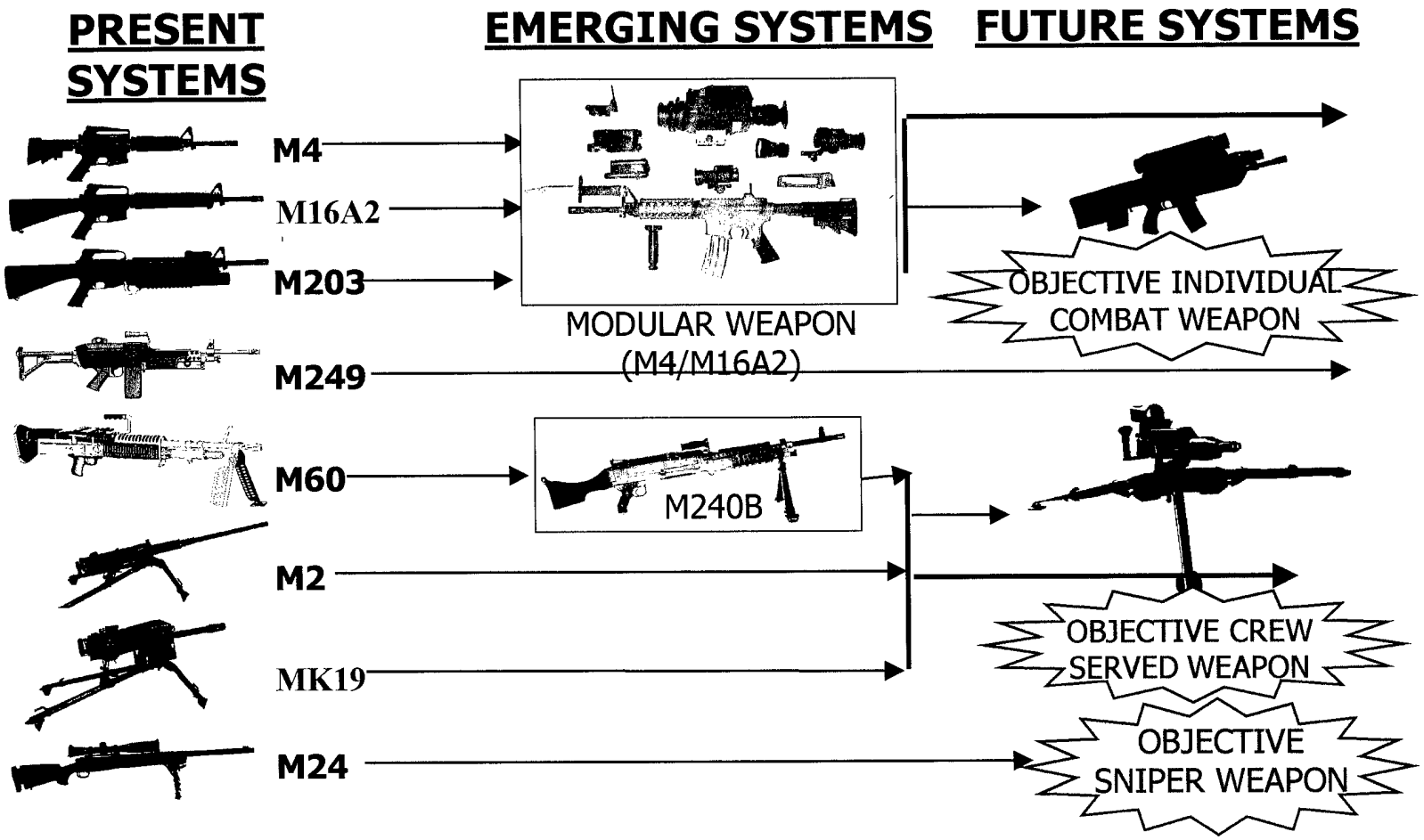
JSSAP Management Committee

Chairman: COL W. Ehly (Commander, CCAC)*

Army:	COL R. Hobbs (USAIS)*
Marines:	COL R. Owen (MCSC)*
Air Force:	COL R. Eldard (HQ AFSF)
Navy:	CDR R. Huss (PM SPECWAR)
Coast Guard:	CAPT L. Hail (HQ USCG)*
SOCOM:	COL D. Voorhees (HQ SOCOM)*
Army PMSA:	LTC W. Irish (TACOM/ARDEC)

*Departing Members

SMALL ARMS EVOLUTION
(Master Plan)



Deploying for Force XXI and Army After Next

General Objectives

- Gain Full Funding for OICW and OCSW
- Strengthen Support for Remainder of OFSA
- Establish Foundations for 21st Century
- Broaden Small Arms Role

!! Make JSSAP a $20 Million Program !!

J.S.S.A.P. JOINT SERVICE SMALL ARMS PROGRAM

Deploying for Force XXI and Army After Next

COMBAT WEAPON (OICW)





- Additional $3.0M Received from Congress
  - TRADOC Approves Conditional ORD
    - Full EMD Funding Secured ($125M)
- Prototype Demo Conducted Successfully
  - Follow-on Contract Awarded to Alliant Team
    - Transition Funding Gains Congress' Interest ($2.0M)

Deploying for Force XXI and Army After Next

OBJECTIVE CREW SERVED WEAPON (OCSW)

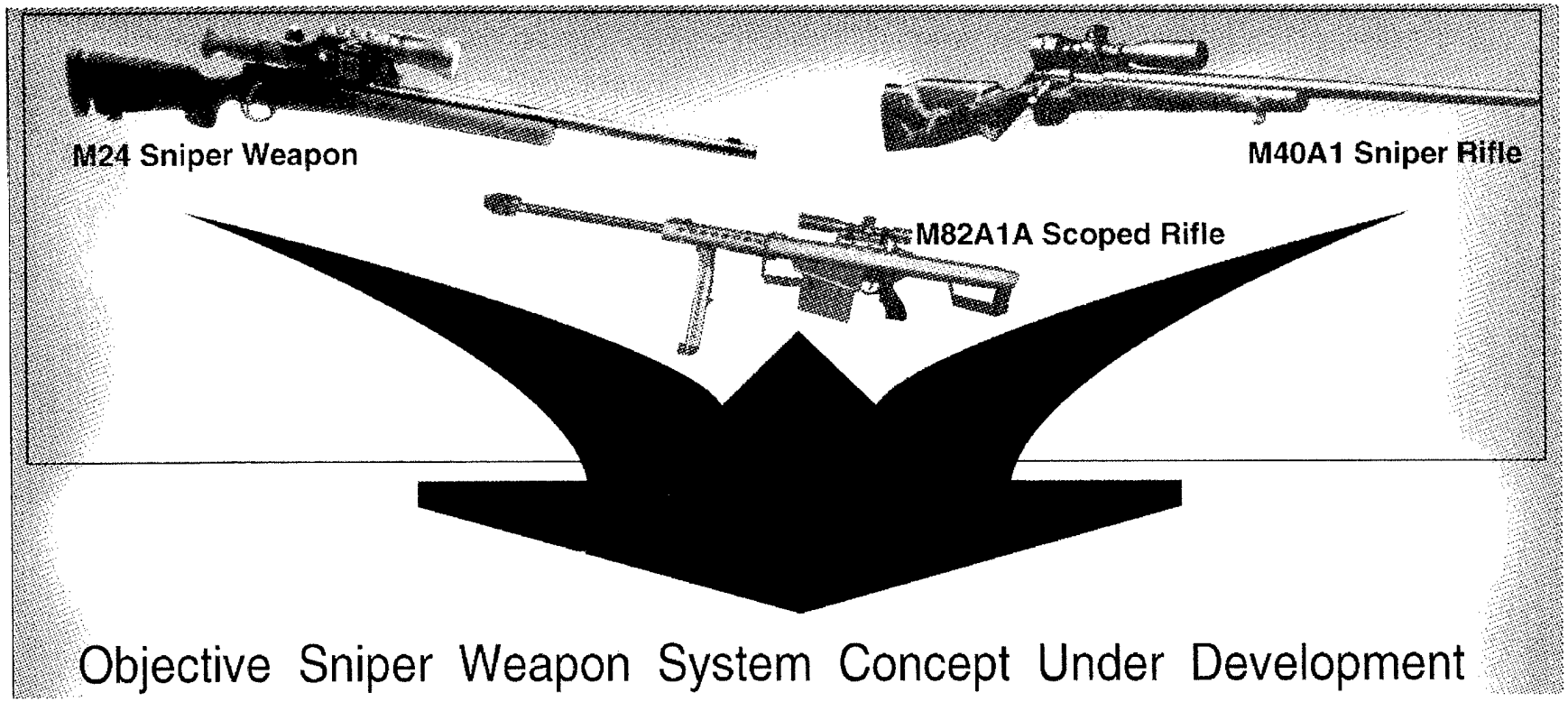




- Received Additional $6.0M from Congress
  - Demonstrated Long Range Air Bursting HE Munition Feasibility
    - Attained Milestone 0 Decision on OCSW
- Awarded Phase III Contract Mod
  - Gained SARD/Congress Support for FY99 Plus-Up ($3.5M)
    - Proposed OCSW as ATD

Deploying for Force XXI and Army After Next

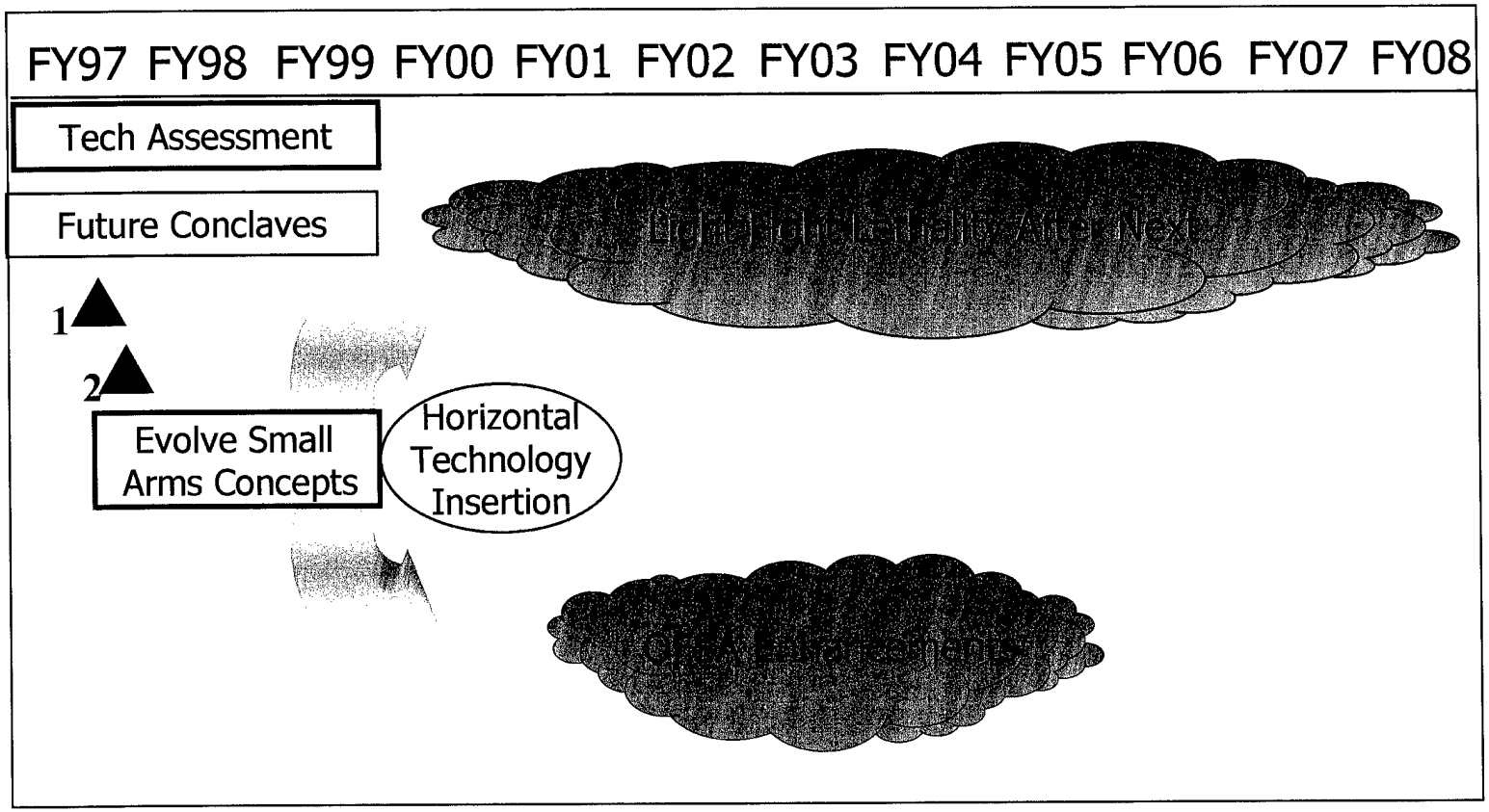
OBJECTIVE SNIPER WEAPON (OSW)



Objective Sniper Weapon System Concept Under Development

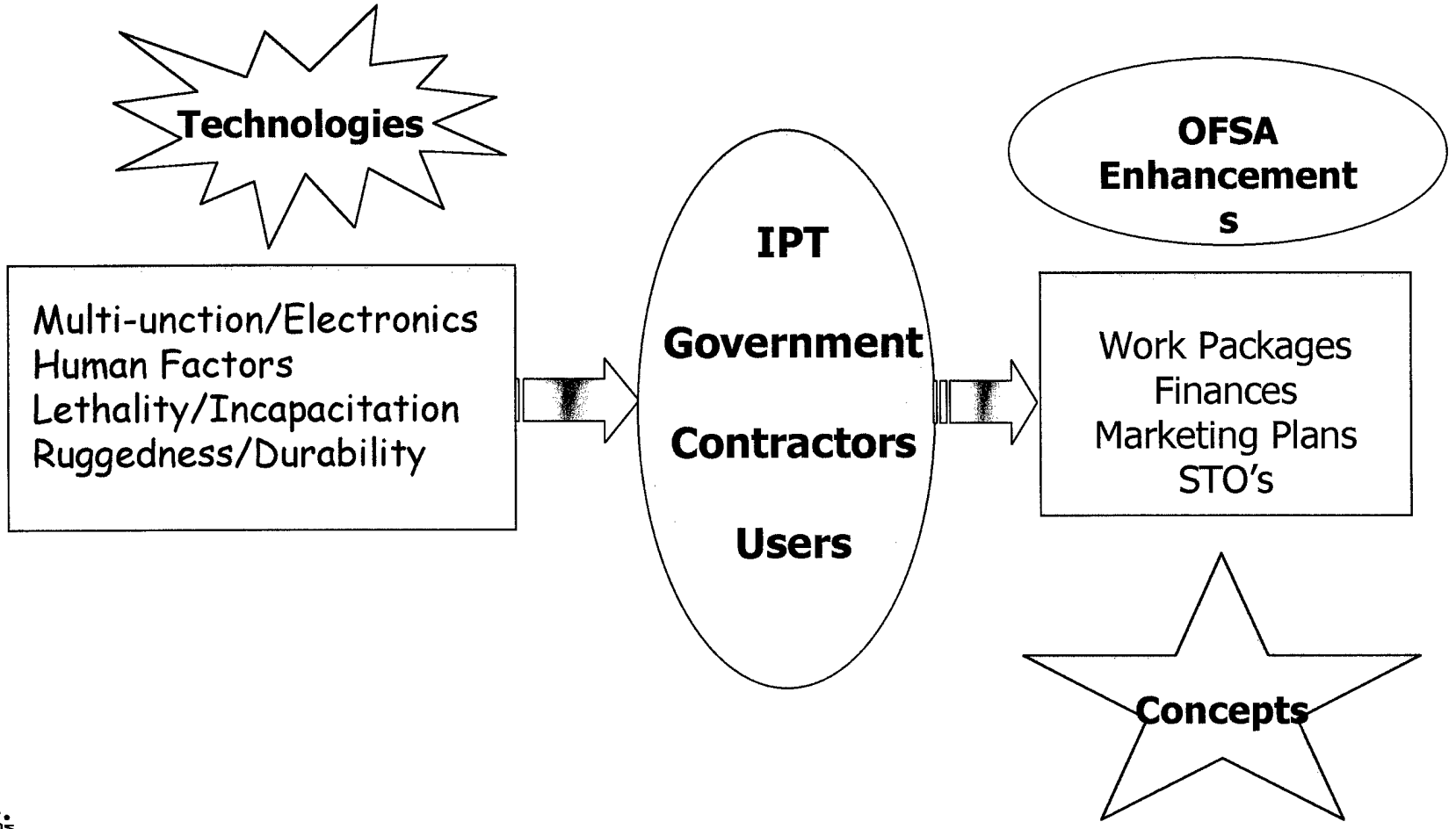
Deploying for Force XXI and Army After Next

Objective Family of Small Arms Enhancements



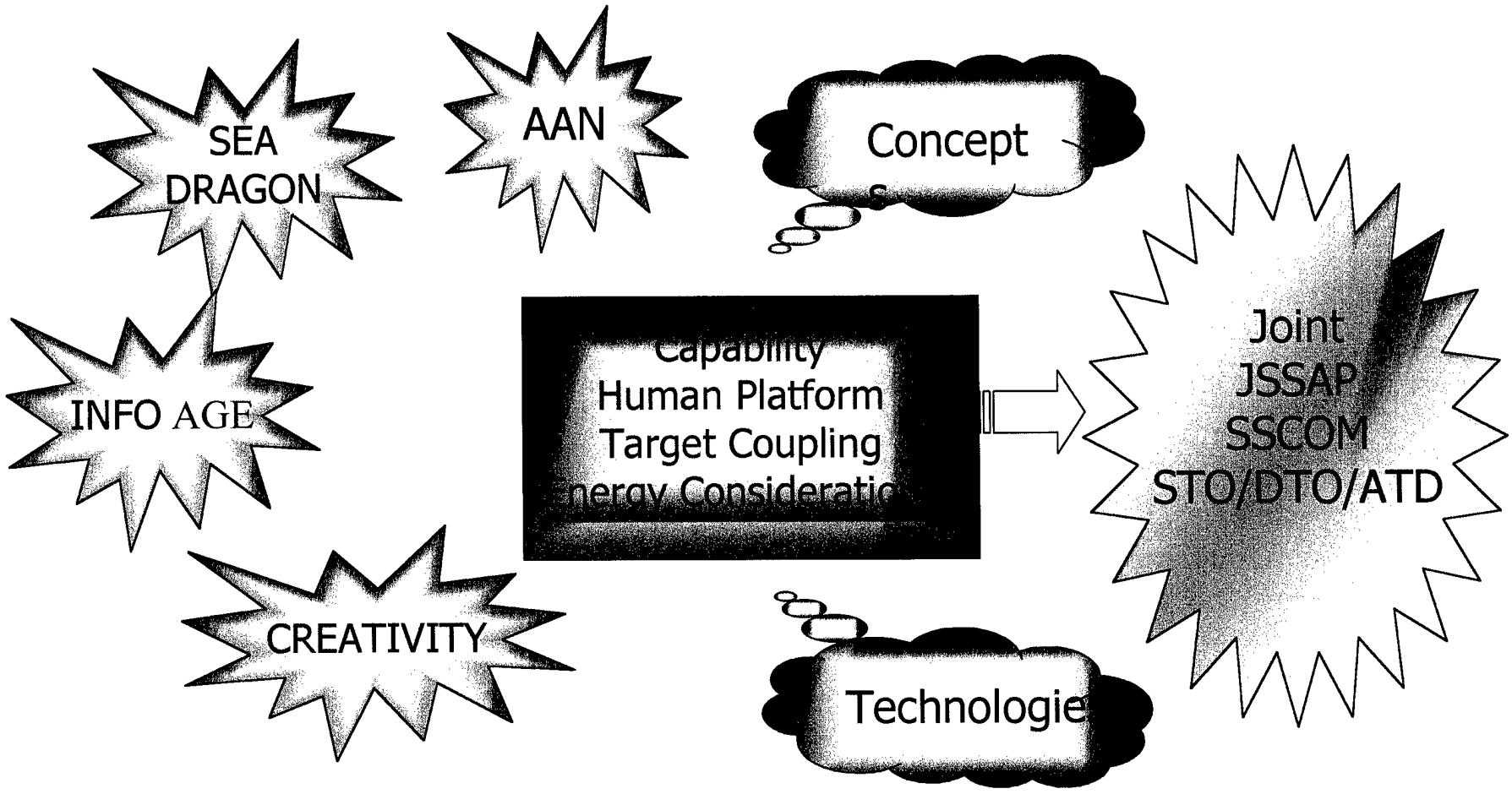
Deploying for Force XXI and Army After Next

Objective Family of Small Arms Enhancements



Deploying for Force XXI and Army After Next

Light Fighter Lethality After Next (LFLAN)



Deploying for Force XXI and Army After Next

Funding

FY	97	98	99	00	01	02	03
Total Funding	14.0*	18.7*	19.4*	13.1*	13.0*	13.5*	13.0*

*Plus-ups Included
**Potential Increases Included

OPPORTUNITIES

- Objective Sniper Weapon
- Objective Family Enhancements
- Light Fighter Lethality After Net
- Advanced Medium Machine Gun

Summary

- Overall Program Customer-Focused
- Program Priorities Clearly Stated
- Aggressive Plan for Program Growth in Place
- Significant FY98 Financial Growth Achieved
- Foundation for FY99 Financial Growth Established
- Challenging Technical Obstacles Being Overcome
- Significant New Opportunities Begin in FY00-FY05

Objective Individual Combat Weapon (OICW)

Advanced Technology Demonstration (ATD)



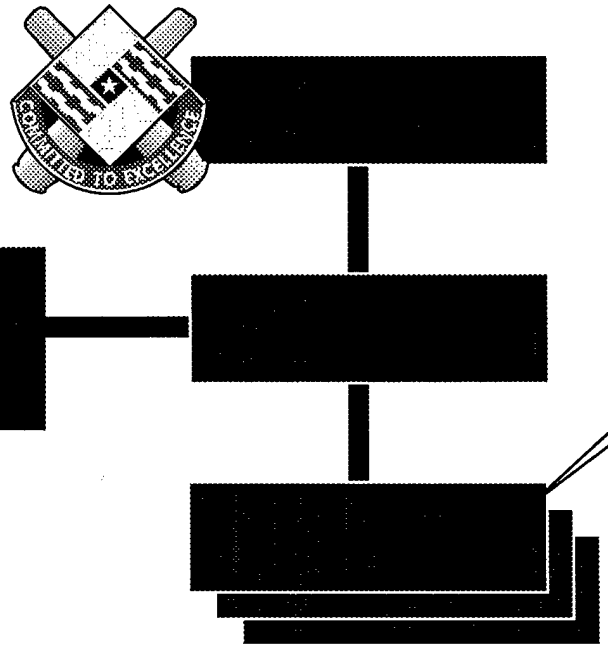
"NO PLACE TO HIDE"

Matthew T. Zimmerman
OICW ATD Program Manager
Joint Service Small Arms Program (JSSAP)
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zimmerman@pica.army.mil

Michael Moore
OICW Program Manager
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mike_moore@atk.com

Program Definition

- Harmonize and Execute Joint RDTE Projects
- Identify and Apply Technology Base
- Establish Joint Service Requirements
- Transition to PMs for Full Development and Production
- Continue Developmental and Production Oversight
- Serve as Focal Point for All Alliance Needs/Developments



OBJECTIVES

Determine Operational Utility and Technological Maturity

Demonstrate

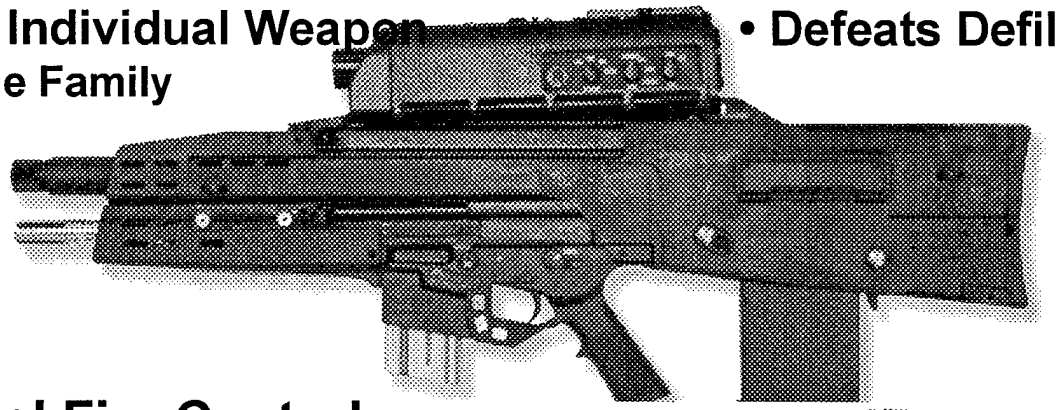
- Target Effects
- Affordability
- Versatility
- Lethality
- Dual-Munition Synergy

Establish Basis for EMD

What Is the OICW?

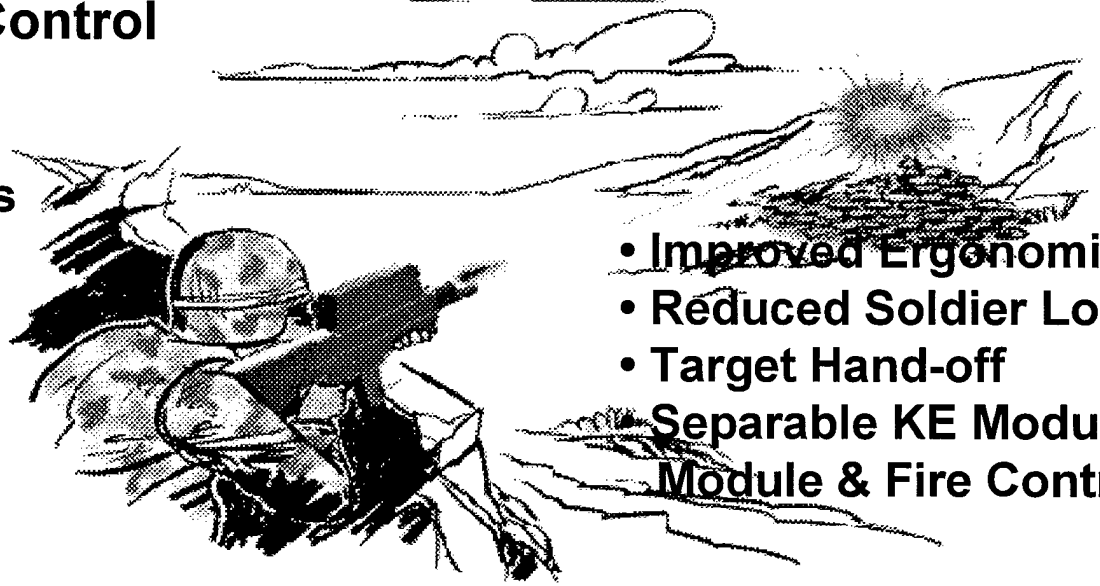
- Dual-Munition System
  - 5.56mm NATO Cartridge
  - 20mm Air Bursting Munition
- 1,000 Meter Range
- Next Generation Individual Weapon
  - Replaces M16 Rifle Family

- Land Warrior's Future Weapon
- Increased Lethality
- Devastating Target Effects
- Defeats Defilade Targets



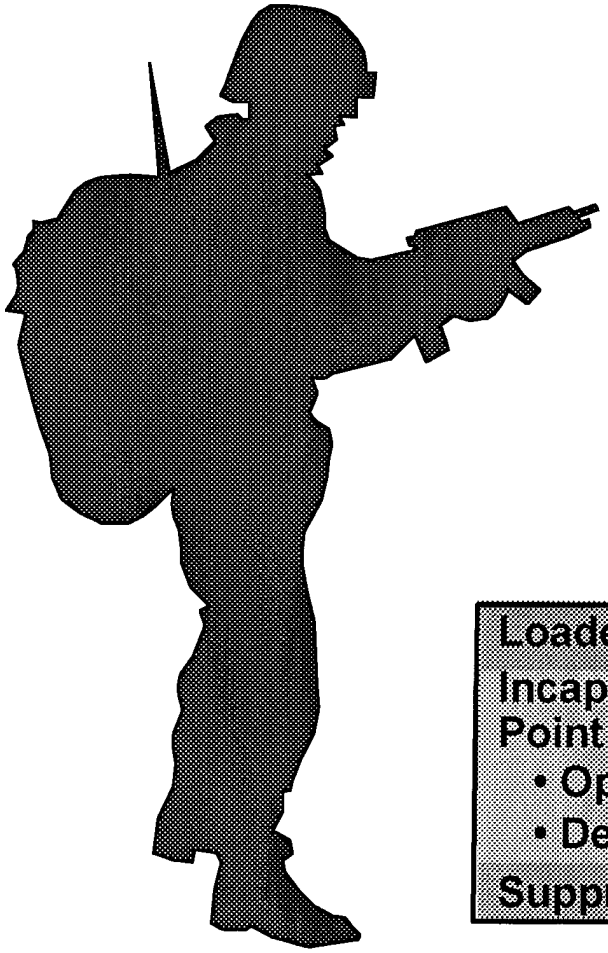
ALLIANTTECHSYSTEMS

- Electro-Optical Fire Control
  - Direct View Optics
  - Laser Range Finder
  - Environmental sensors
  - Electronic Compass
  - Video Sighting
  - Auto-Tracking
  - Thermal Viewing
  - Ballistic Computer



- Improved Ergonomics
- Reduced Soldier Load
- Target Hand-off
- Separable KE Module, HE Module & Fire Control

Objective Individual Combat Weapon Goals



- High P_i At Increased Range
- Full Defilade Target Capability
- Day or Night Fire Control
- Fully Integrated Weapon System
- Ergonomically Sound
- Affordable

	ATD Threshold (1999)	Fielding (2006)
Loaded Weight*	< 18 Pounds	< 14 Pounds
Incapacitation: Point Target (P_i)		
• Open Terrain	> .5 @ 300 M	.5 - .9 @ 500 M
• Defilade	> .2 @ 300 M	.4 @ 500 M
Suppression	Squad @ 1000 M	Squad @ 1000 M

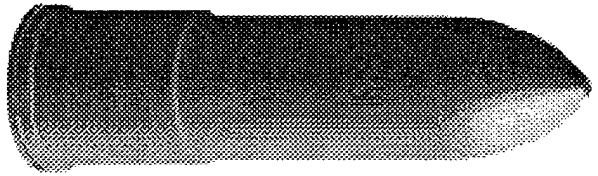
* 6 HE/30KE

More Than Five-fold Increase in P_i From M16 Baseline

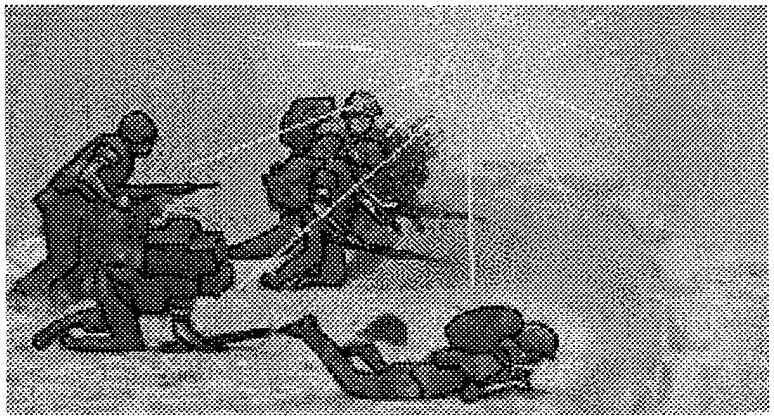
Munitions Technology

20 MM HE
(OICW Round)

- Microelectronics
  - Provide Air Burst Capability
- 6-10 rounds in Weapon
- Dispersion < 1 mil (Y)
- Max Range: 1000 Meters
- 300+ Lethal Fragments
- < 0.20 Lbs

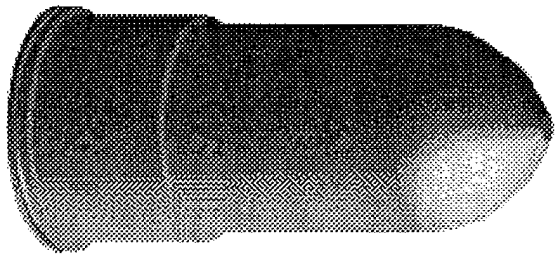


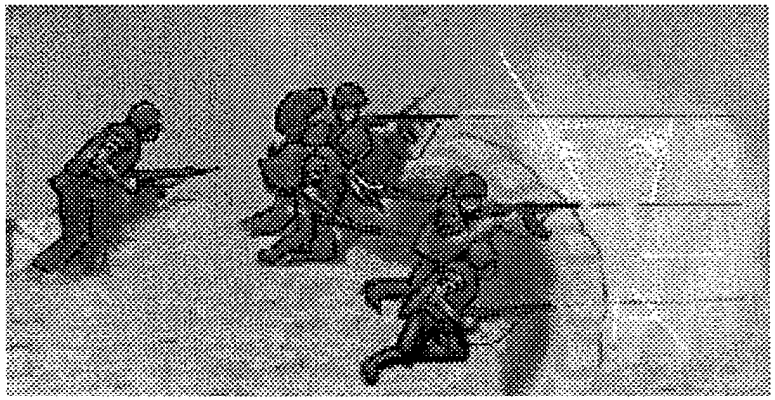
✓ Air Burst Provides Four to Five Times the Effect on the Target



40 MM HE
(Current Round)

- Point Detonation Only
- Single Round in Weapon
- Dispersion >15mils (Y)
- Max Range: 300 Meters
- 0.51 Lbs

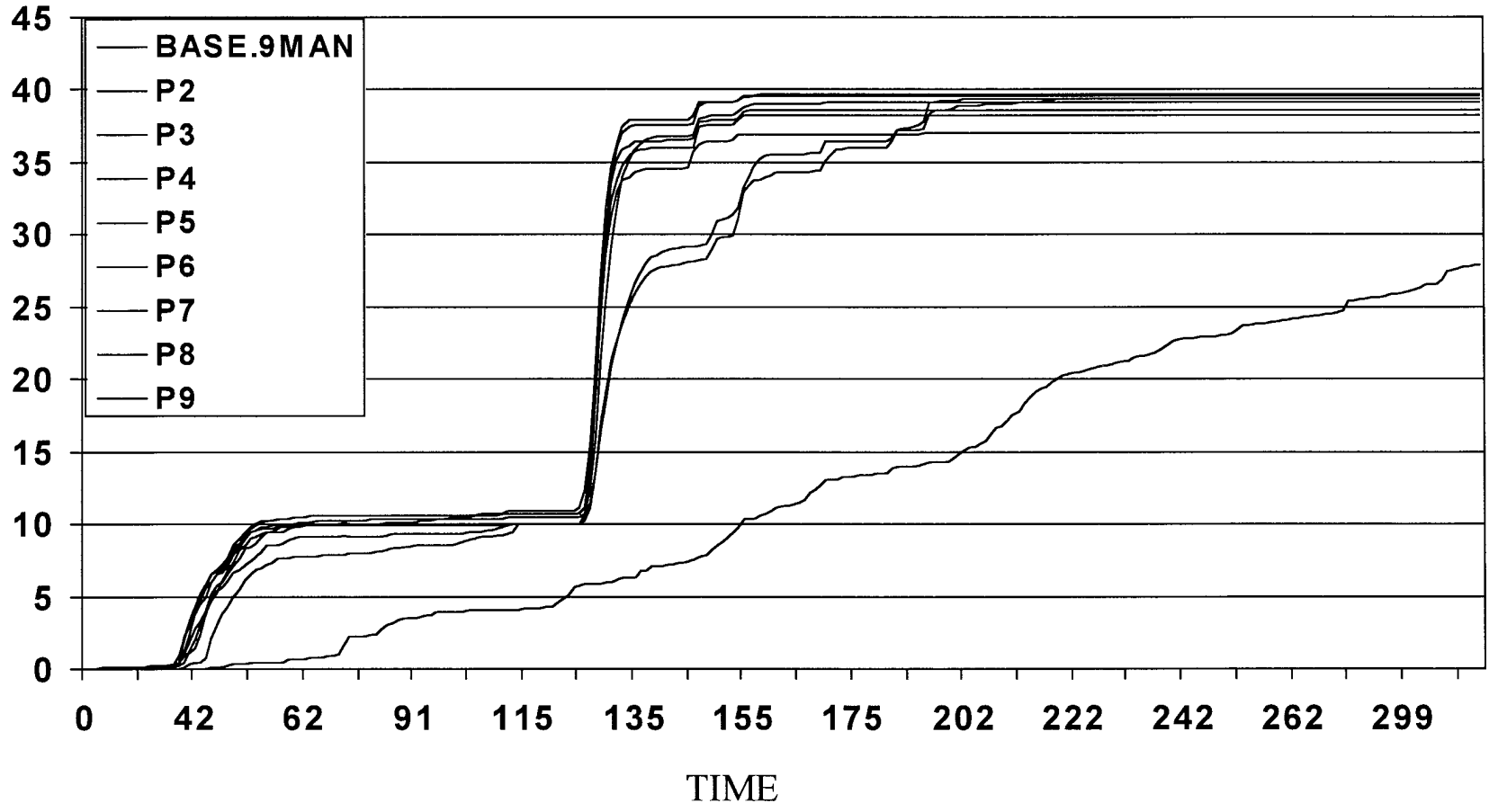




✗ Ground Burst: Effects Attenuated by Trajectory and Ground

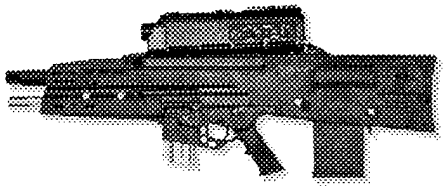
TRAC WSMR

TRAC-WSMR Force on Force Engagement
[Blue In Offensive]
NINE MAN CUMMULATIVE BLUE KILLS



OICW Integration with Force XXI Land Warrior





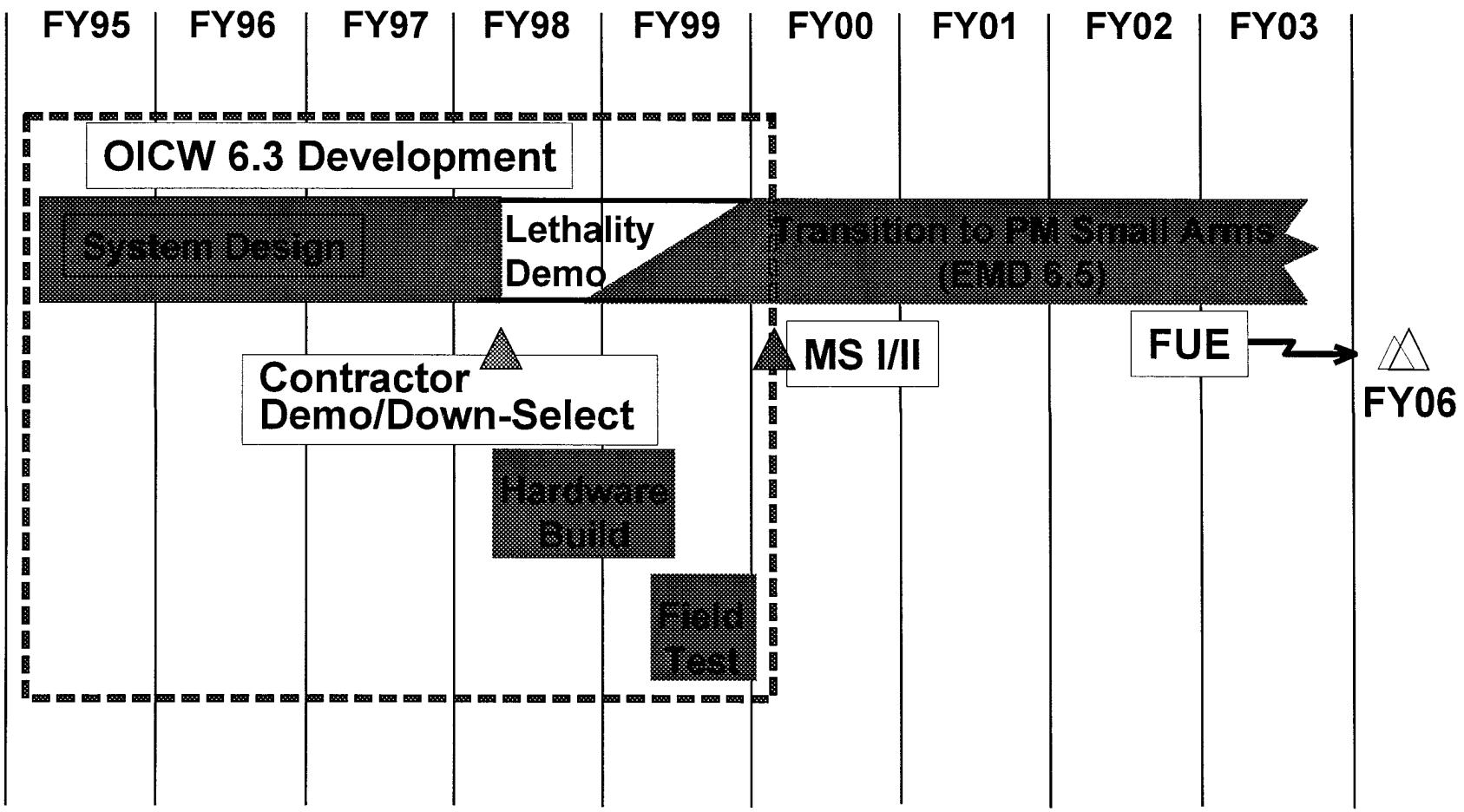


- Ergonomic Soldier-Weapon Interface
- Separable KE & HE Weapon Modules
- Weapon Video/Data Link
- Heads-Up Display
- Forward Observer Role
- Target Hand-Off
- Combat ID
- View/Fire Around Corners



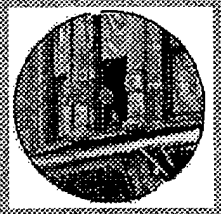
- OICW Fire Control Leveraging
  - Direct View Optics
  - Laser Range Finder
  - Ballistic Computer
  - Environmental Sensors
  - Electronic Compass
  - Video Sighting
  - Laser Pointer
  - Adjusted Aim Point
  - Embedded Training
  - Auto-Tracking
  - Thermal Viewing

OICW ATD Acquisition Roadmap



Alliant Prototype System

Where We Are Today—Concept Solution





Thermal Module

Fire Control with Laser Range Finder, Video, Day Optics, and Tracker

Charging Handles

HE Case Eject

20mm HE Barrel

Battery in Butt Stock

A 20mm KE Barrel

KE Case Eject

Bayonet Attachment

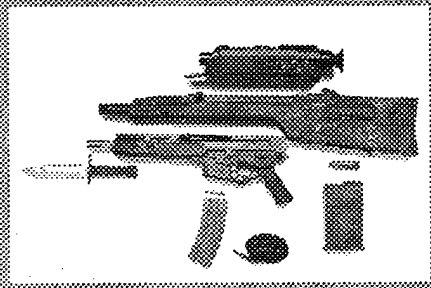
10 rnd KE Magazine

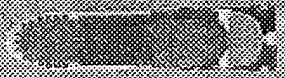
Laser Button

Safety

Barrel Selector Switch

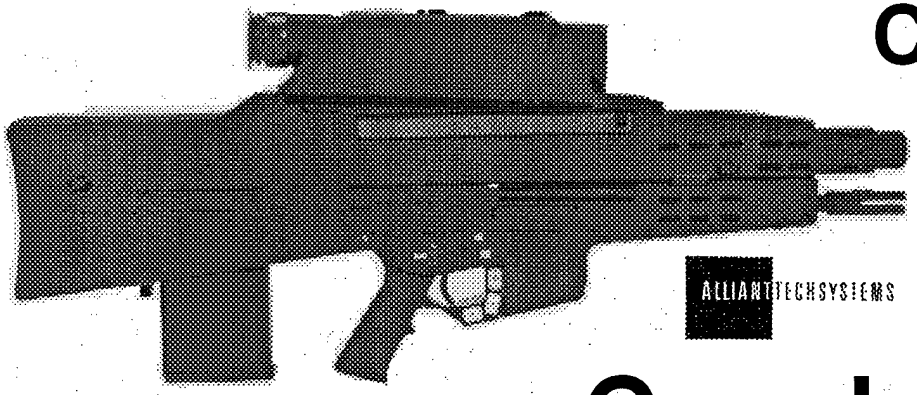
10 rnd HE Magazine





20mm Bursting Munition

Objective Individual Combat Weapon (OICW)



Conclusions

- OICW Provides Quantum Leap Over Current Family of Weapons
- ATD Roadmap Provides Effective Means to Test/Validate Potential of OICW Lethality, Technology, Operational Utility and Affordability
- OICW Dramatically Improves Survivability & Lethality
- OICW Provides U.S. Forces Dominant Overmatch Capabilities

TACOM

Mobility and Firepower for America's Army

OBJECTIVE CREW SERVED WEAPON (OCSW)



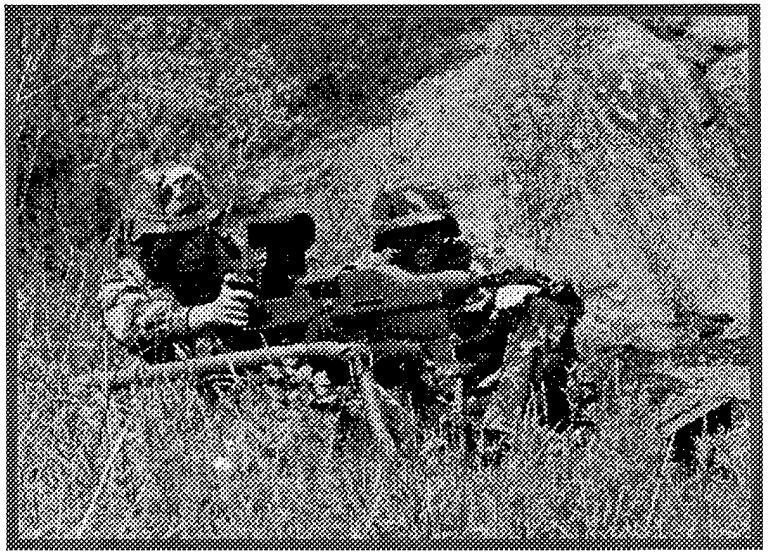
NDIA Small Arms Systems Section Annual Conference 16-18 June 1998

John J. Cline
OCSW DPO, JSSAP
DSN 880-6906

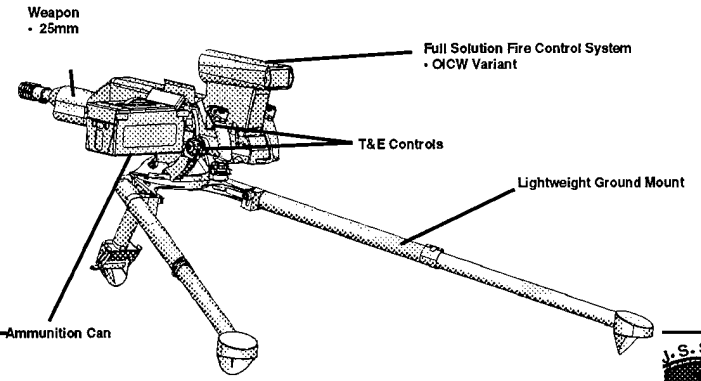
Tank-automotive & Armaments COMmand

OCSW Concept

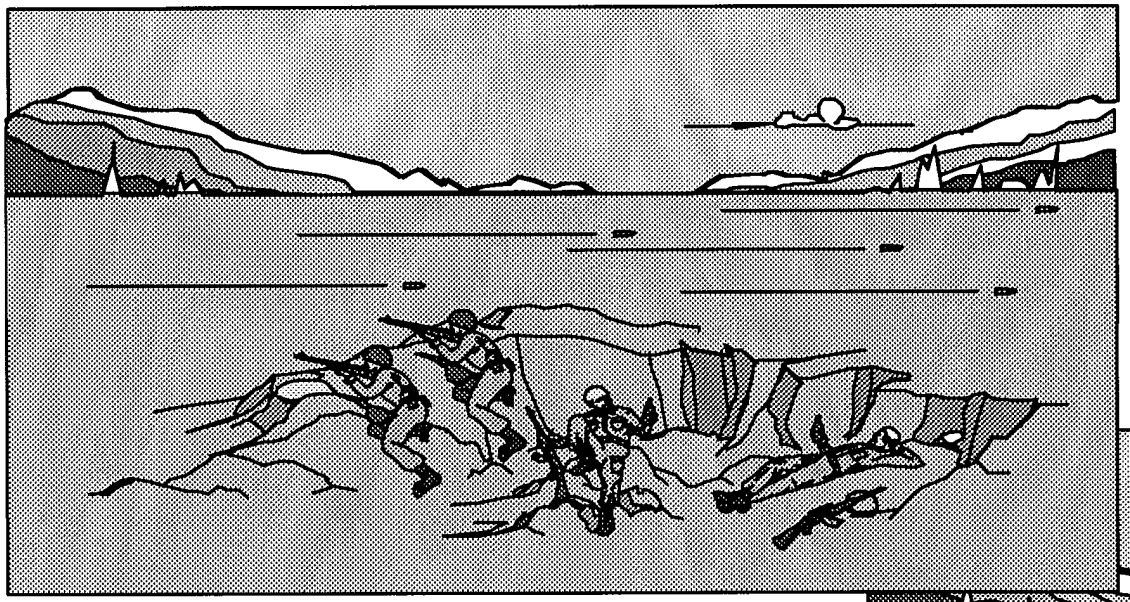
Lightweight, Fully Stable OCSW Weapon System



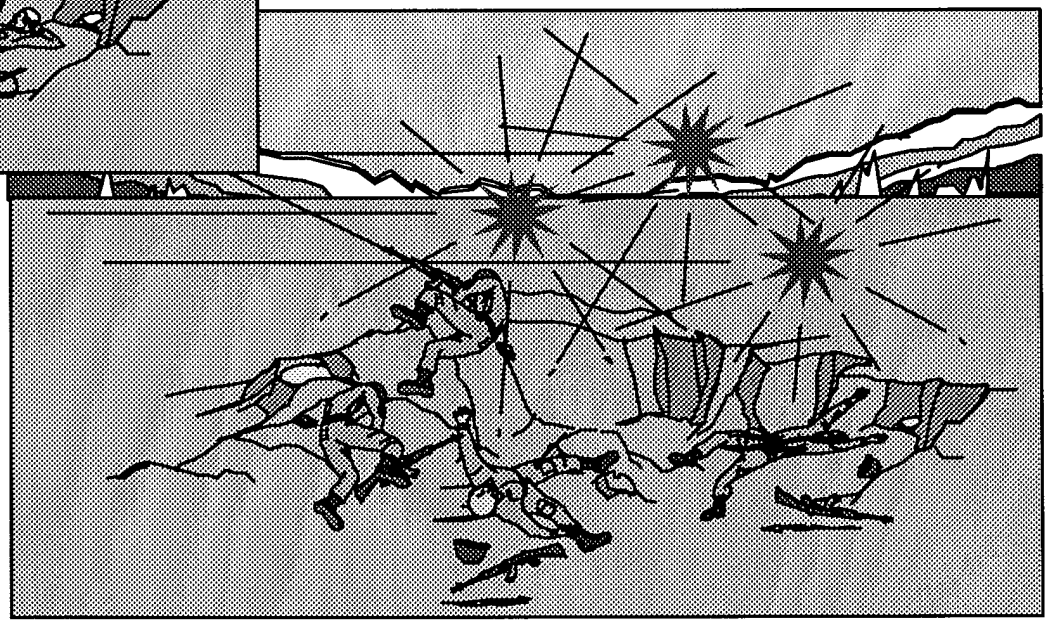
- Decisively Violent & Suppressive Out To 2,000 Meters
- 25mm Airbursting Munition
- Compact/Lightweight System
  - 2 Man Portable & Vehicle Mountable
- 260 Shots Per Minute: Automatic Or Semi-Automatic Fire
- Right Or Left Ammunition Belt Feed
- Total Weight -- 36.6 lbs.
  - Gun - 23 lbs.
  - Mount - 9 lbs.
  - Fire Control - 4.6 lbs. (est.)



There Is No Hiding From Air Bursting Munitions



KE Ammunition Can
Only Suppress Personnel
In Defilade



Air Burst Ammunition Kills

The OCSW Team

JSSAP	PRINCIPAL MEMBERS
Army	COLHobbs
Marines	Col Phillips
Air Force	COL Eldard
Navy	Cmdr Huss
Coast Guard	CAPTt Hail
SOCOM	COL Voorhees

GOVERNMENT COMMUNITY

- USER NEEDS
- GOVERNMENT TECHNICAL RESOURCES

PRIMEX

- PRIME CONTRACTOR
- SYSTEM INTEGRATION
- SYSTEM ANALYSIS
- AMMUNITION

DAYRON

- REMOTE SETTABLE AIR BURST FUZE

GENERAL DYNAMICS ARMAMENT SYSTEMS

- WEAPON
- GROUND MOUNT
- AMMUNITION CONTAINER

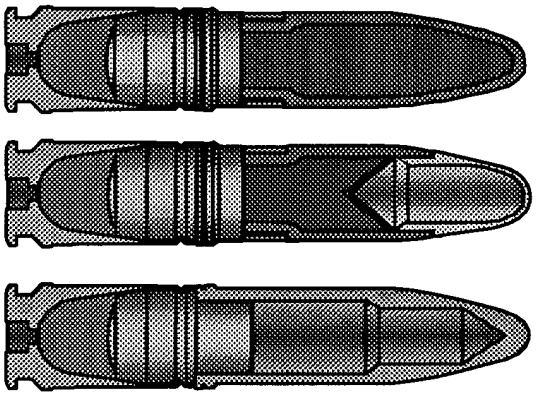
CONTRAVES-BRASHEAR SYSTEMS

- FULL SOLUTION FIRE CONTROL

OCSW System Baseline

Full Solution Fire Control:	**Derived from OICW**
Caliber:	**25mm**
Cartridge Weight:	**0.368 lb (167 grams)**
Projectile Weight:	**0.291 lb (132 grams)**
Impulse:	**13.4 lb-sec**
Chamber Pressure:	**40,000 psi**
Muzzle Velocity:	**1393 ft/sec**
Maximum Effective Range	**2,000 m**
Time of Flight to 2,000 m	**8.9 sec**
Maximum Range	**3,600 m**





SYSTEM WEIGHT UNLOADED: (36.6 lb)

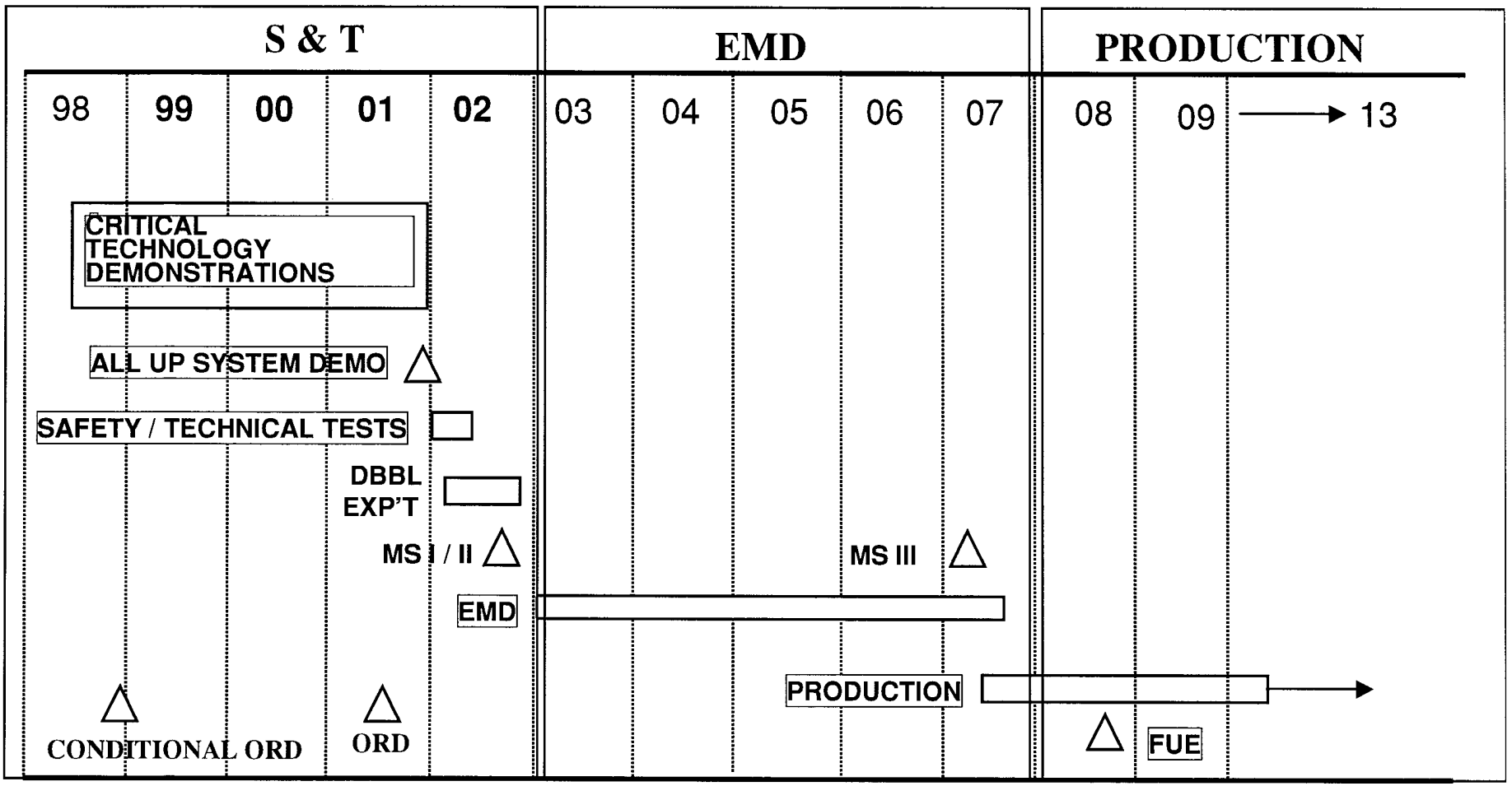
GUN WEIGHT	**23.0 lb**
MOUNT WEIGHT	**9.0 lb**
FIRE CONTROL WEIGHT	**4.6 lb**

ROUNDS AVAILABLE IN TRANSPORT MODULES

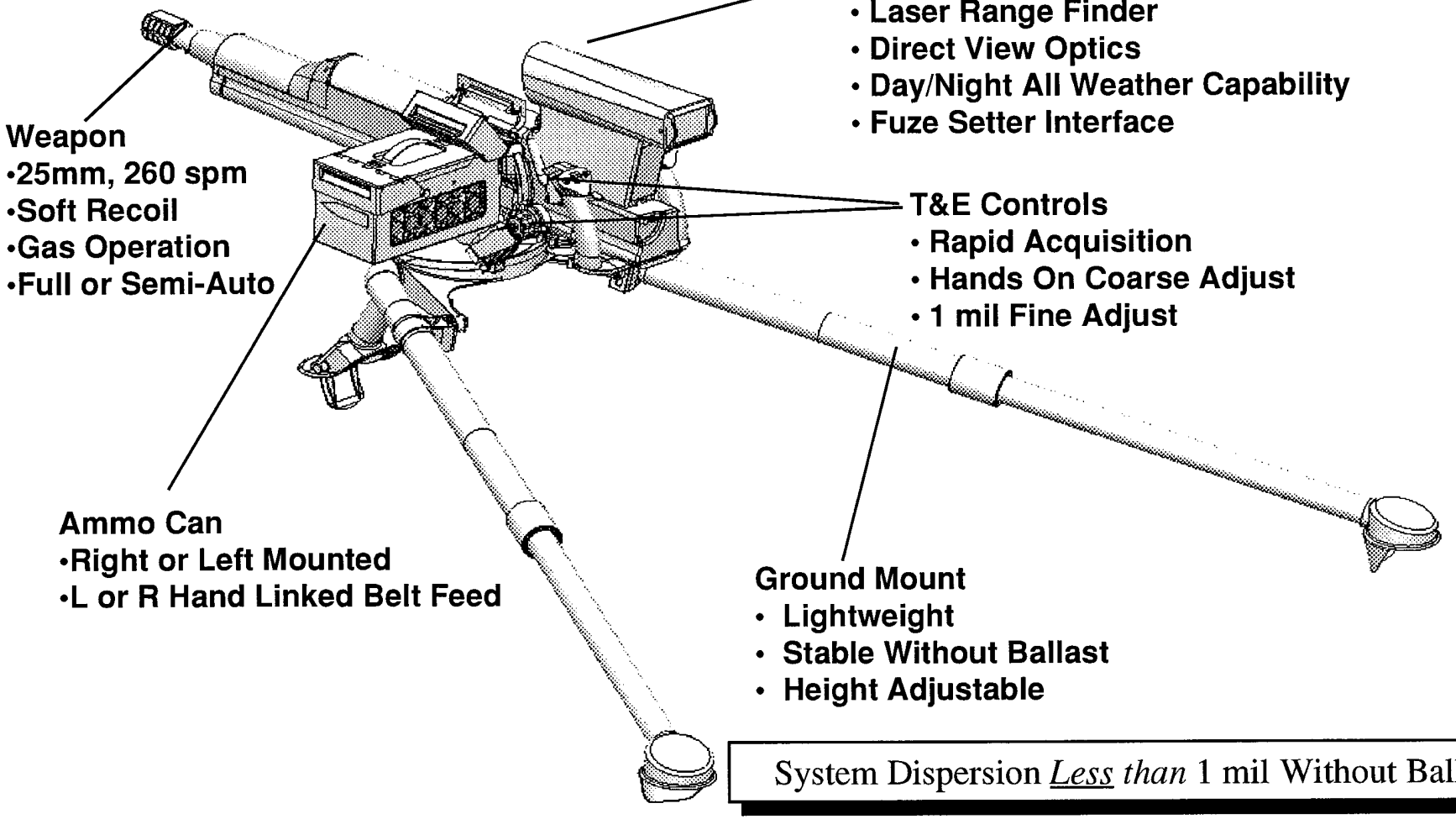
Two 35.0 POUND MODULES 74 ROUNDS

Three 35.0 POUND MODULES 151 ROUNDS

OCSW Program Schedule



OCSW
Ground Mount Configuration



Full Solution Fire Control
- Laser Range Finder
- Direct View Optics
- Day/Night All Weather Capability
- Fuze Setter Interface

Weapon
- 25mm, 260 spm
- Soft Recoil
- Gas Operation
- Full or Semi-Auto

T&E Controls
- Rapid Acquisition
- Hands On Coarse Adjust
- 1 mil Fine Adjust

Ammo Can
- Right or Left Mounted
- L or R Hand Linked Belt Feed

Ground Mount
- Lightweight
- Stable Without Ballast
- Height Adjustable

System Dispersion *Less than* 1 mil Without Ballast

Objective Crew Served Weapon System



Lightweight 25mm Weapon System

23.0	lb gun
9.0	lb mount
4.6	lb fire control
36.6	lb System

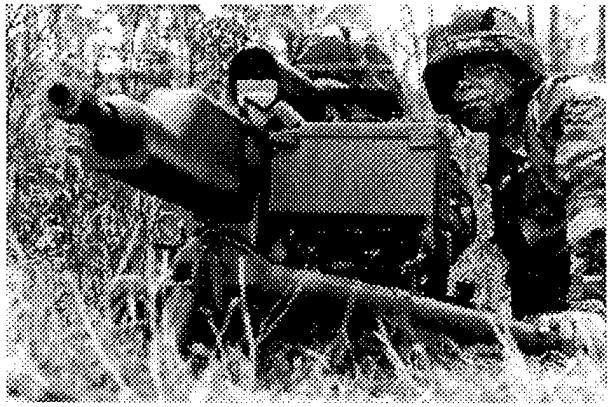
- Decisively violent and suppressive out to 2000m
- Remote settable air burst fuze
- Full solution day/night all weather fire control
- 260 shots per minute, auto or semi-auto
- Fully stable accurate fire without ballast
- Compact, 2 man portable, vehicle mountable

OCSW
The Light Infantry Weapon System



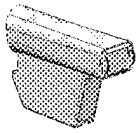
Easily Deployed By A Crew Of Two

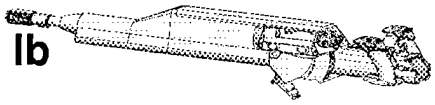




Transport Modules

Fire Control 4.6 lb





Weapon, Pintle 26.0 lb

Module A: 30.6 lb



Tripod Less Pintle 6.0 lb

Ammo Boxes
2 @ 14 lb ea = 28 lb



Module B: 34.0 lb

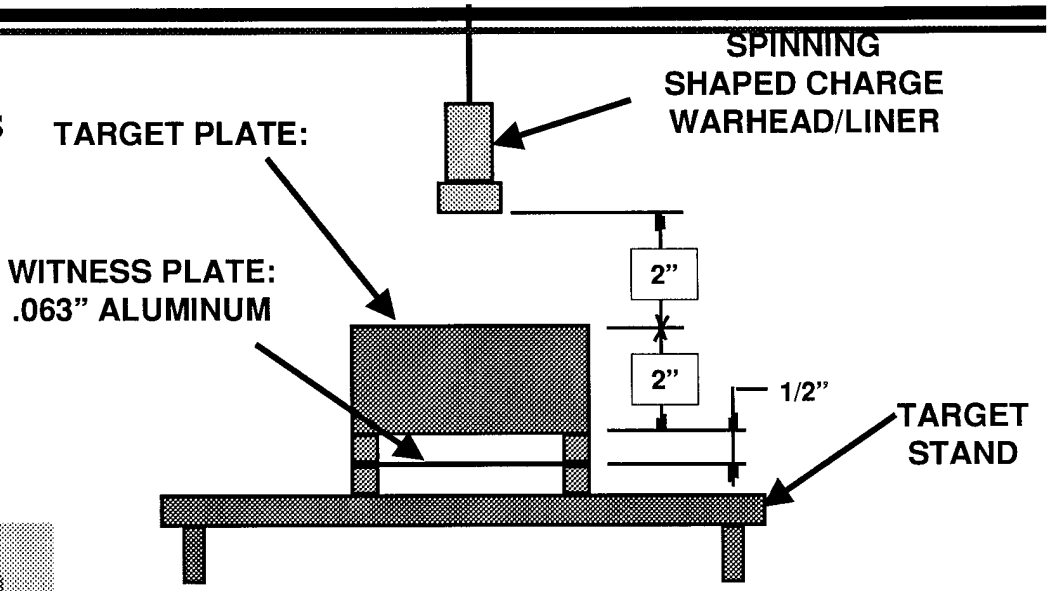
PRIMEX TECHNOLOGIES

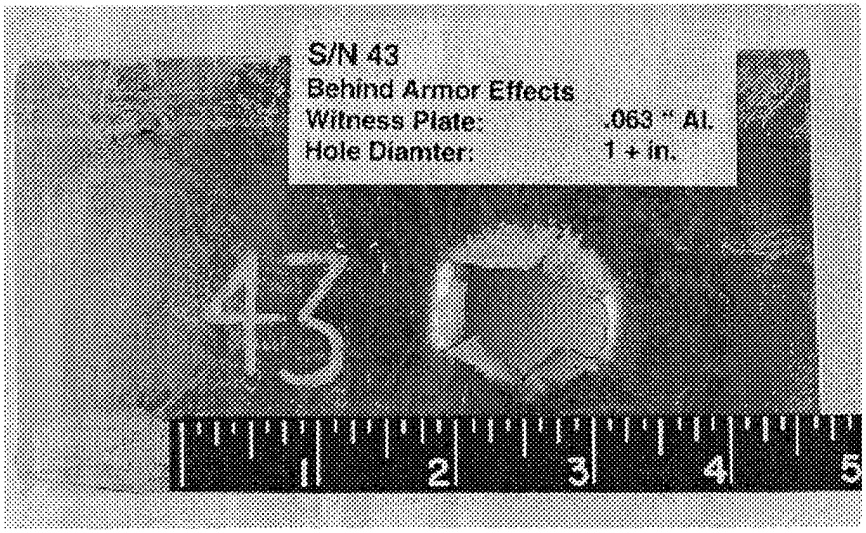
GENERAL DYNAMICS ARMAMENT SYSTEMS

Dayron

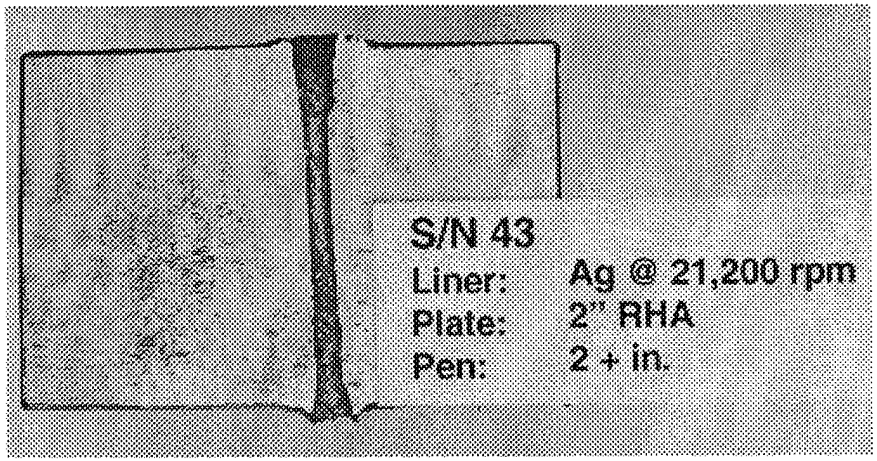
OCSW Armor Piercing Warhead Performance

- Wide Angle, Shallow Cone, Shaped Charge Liner Consistently Penetrates 2.0 inch RHA with Sizable Hole in Witness Plate
- 15 gram LX-14 Explosive
- 2.0 inch Standoff
- 21,000 - 28,000 RPM Spin





Behind Armor Witness Plate

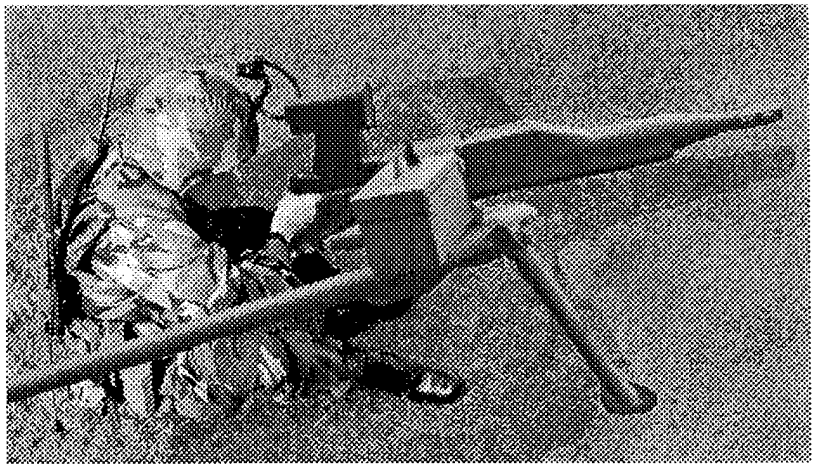


Target Plate

OCSW
Sensor -to- Shooter Linkage

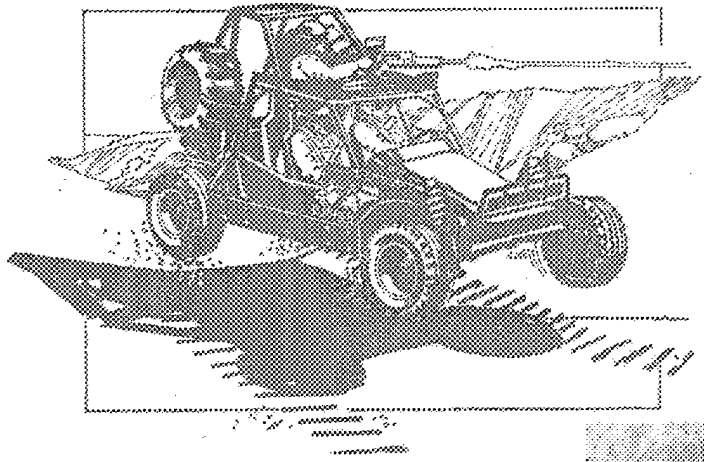
- **OCSW is a Lethality Component of Land Warrior**

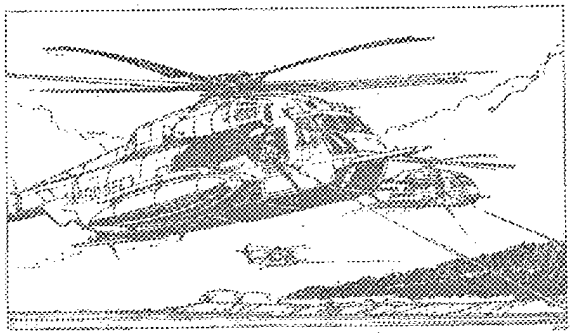


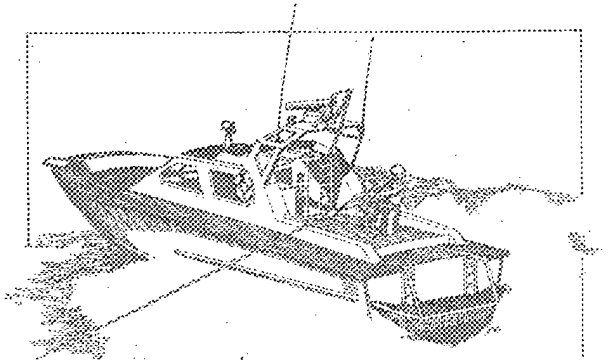


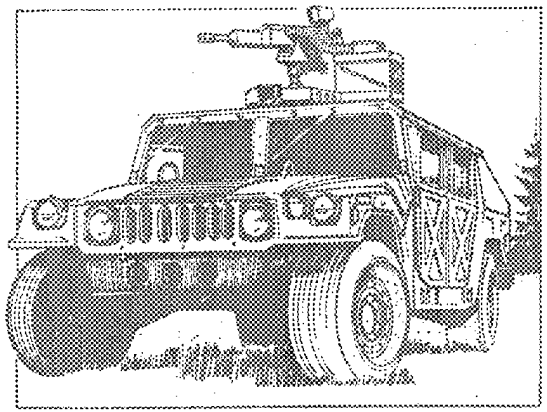
The OCSW System will provide a Sensor-to-Shooter Linkage via Force XXI Land Warrior interface

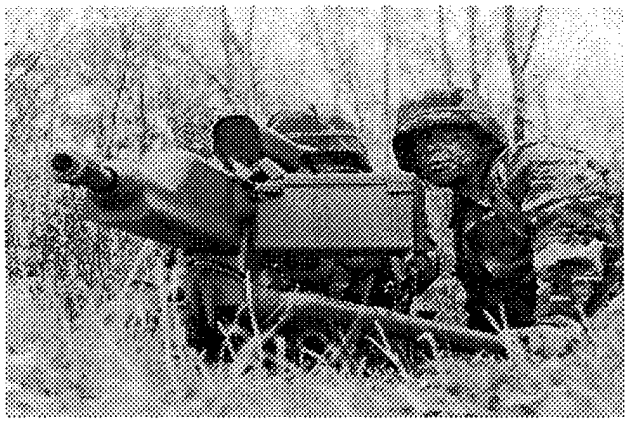
OCSW Vehicle Applications

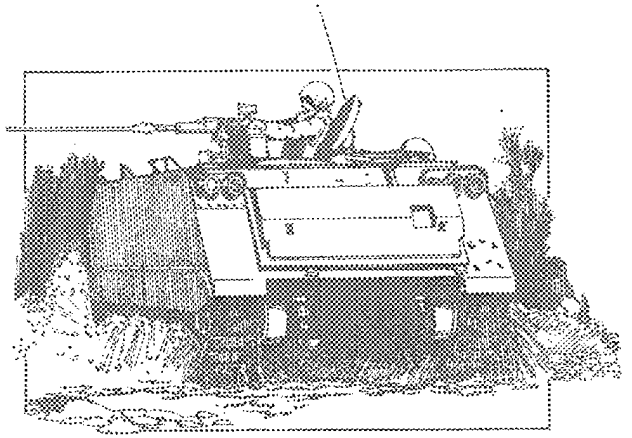












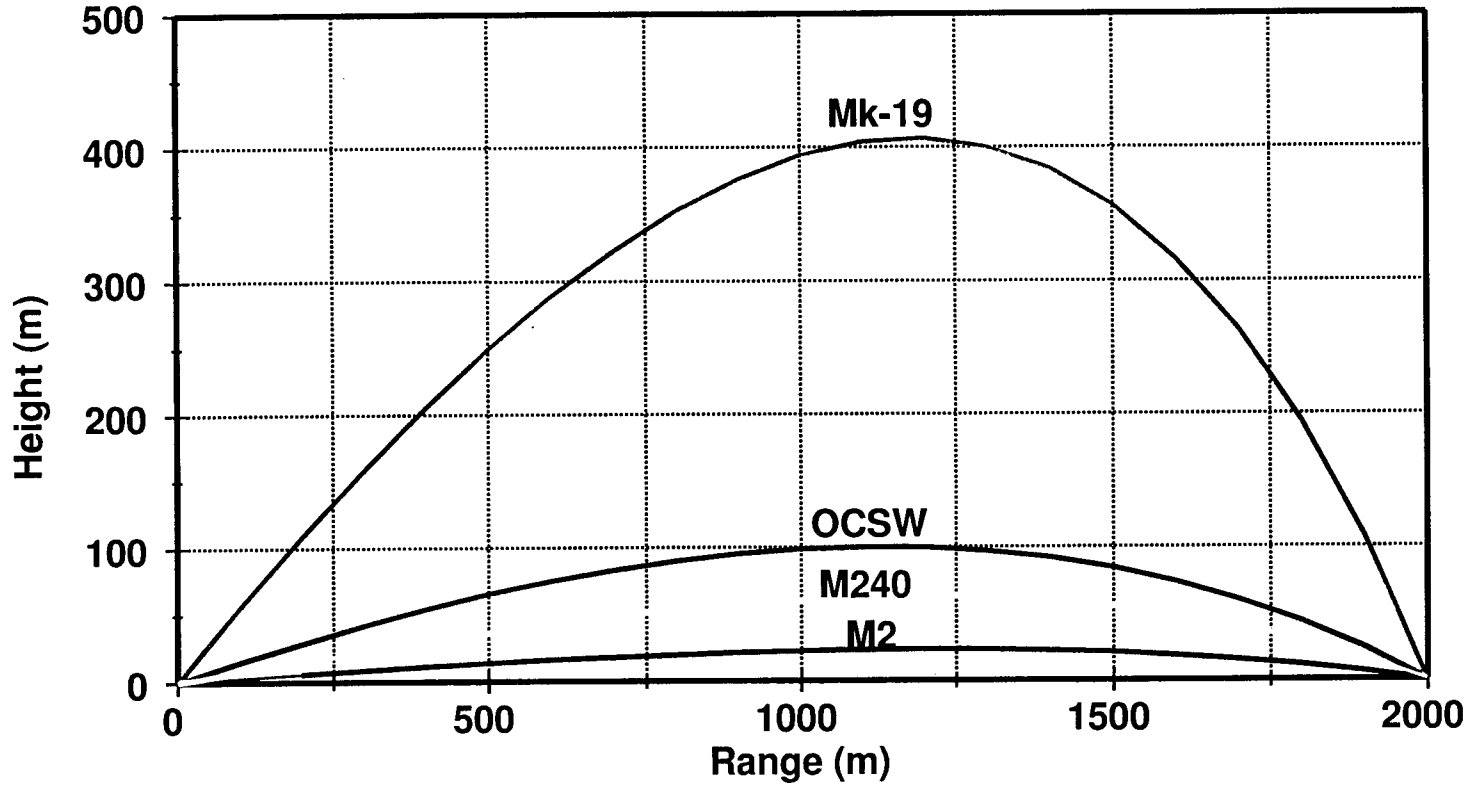
The OCSW Can Be Easily Adapted as Primary / Secondary Armament and May Be Quickly Dismounted for Perimeter Defense

PRIMEX TECHNOLOGIES

GENERAL DYNAMICS ARMAMENT SYSTEMS

Dayron

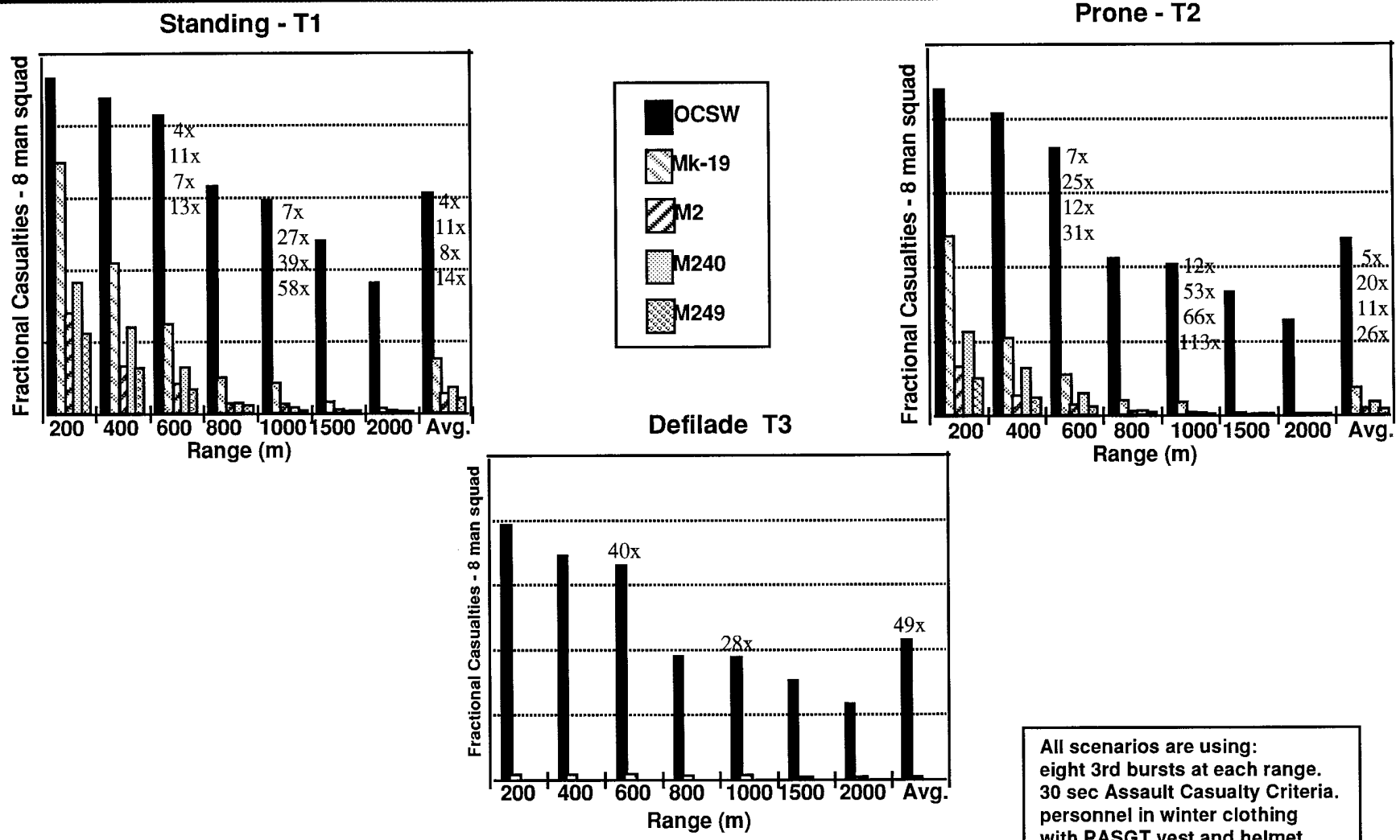
Ammunition Trajectory Comparisons



OCSW Provides the User With Increased Stand-Off Lethality and Reduced Engagement Time

TOF (sec)	500m	1000m	1500m	2000m
OCSW	1.55	3.55	5.97	8.89
M2	0.62	1.47	2.65	4.24
Mk-19	2.78	6.49	11.39	17.99
M240	0.77	2.19	4.18	6.68

Baseline Fractional Casualties for All Systems



All scenarios are using:
eight 3rd bursts at each range.
30 sec Assault Casualty Criteria.
personnel in winter clothing
with PASGT vest and helmet.

System Comparisons

System	40mm Mk 19 Mod 3	Cal .50 M2HB	7.62mm M240	25mm OCSW
Weapon Weight (lb)	75.6	84.0	24.2	23.0
Mount Weight (lb)	65.4	46.1	19.2	9.0
Fire Control (lb)	N/A	N/A	N/A	4.6 (est)
Unloaded System Weight (lb)	141.0	130.1	43.4	36.6
Ammunition Weight (lb / Round)	1.24	.38	.10	.45

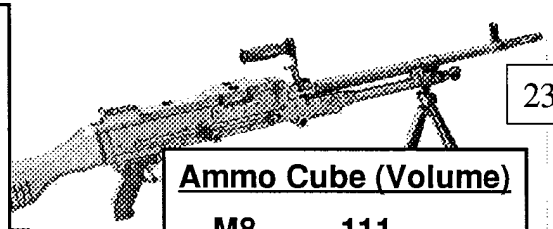
Ammunition Load

Lbs Ammo / Kill	111	117	25	3
Lbs Ammo / 60 sec Suppression	157	133	28	12

A Lightweight System with Airburst Munitions is Key to OCSW Effectiveness

OCSW Payoff - Anti-Personnel Role
(Typical Marine Infantry Battalion)

30 Day Supply (Rds)	
M8	21,060
M430	13,740
M80	60,720
Total	95,520

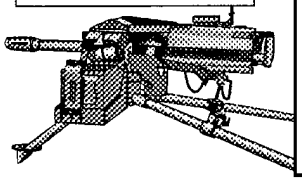


23 Each M240

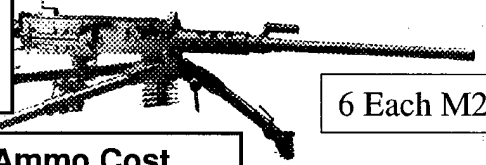
Ammo Cube (Volume)	
M8	111
M430	309
M80	105
Total	525 cu.ft.

39 Weapons = 3,188 Pounds
39 OCSWS = 1,427 Pounds

10 Each Mk19



Kills	
M8	69
M430	154
M80	256
Total	479

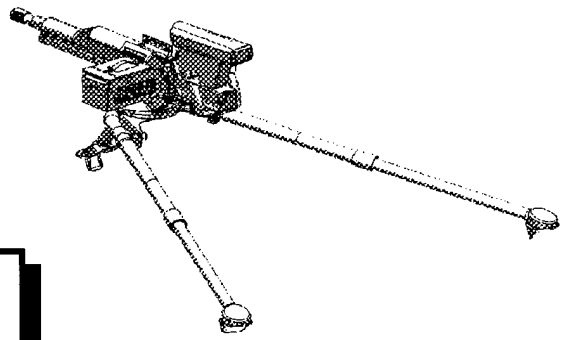


6 Each M2

OCSW		Comparisons
Rounds	3,170	30x less
Kills	479	same
Ammo Cube	54	9.7x less
Ammo Weight	1,429	22x less
Ammo Cost	$69,428	4.25x less

Ammo Weight	
M8	8,098
M430	17,032
M80	6,264
Total	31,394 lb.

Ammo Cost	
M8	$ 42,120
M430	219,840
M80	33,396
Total	$295,356



Substantially Less Weight and Volume to Get to the Conflict With a Significant Improvement in Cost Effectiveness

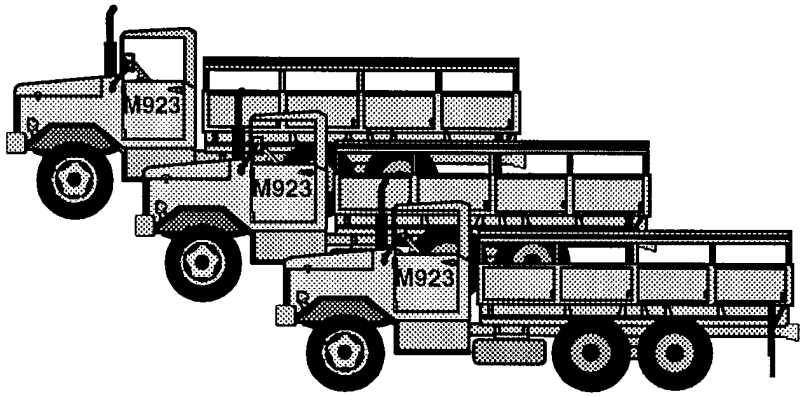
OCSW Deployment

(Typical Marine Infantry Battalion)

Logistics

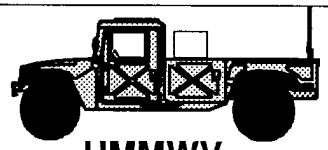
- Conventional Ammo
  - Weight = 31,394 lbs.
  - 9.6 Pallets / 700 Boxes
  - Avg. Box Wt. = 45 lbs.
  - Ammo Cost = $295,356

3 Truckloads (5-Ton) / 3 Drivers



- Equivalent OCSW Ammo
  - Weight = 1,431 lbs.
  - 1.2 Pallets / 103 Boxes
  - Avg. Box Wt. = 14 lbs.
  - Ammo Cost = $69,428

1 Truckload / 1 Driver



HMMWV

OCSW Allows Significant Reductions in Logistic Support and Equipment

OCSW Summary

- Superior Kill Capability
- Defeats Targets in Defilade
- Truly 2 Man Portable System
- No Sandbag Ballast Required
- Reduced Logistics Support
- Cost Effective



- Maximizes the Effectiveness and Survivability of the U.S. War Fighter!

OCSW - Revolutionary Lethality for the 21st Century Warfighter

TACOM

Mobility and Firepower for America's Army

J.S.S.A.P. JOINT SERVICE SMALL ARMS PROGRAM

Objective Family of Small Arms Enhancements



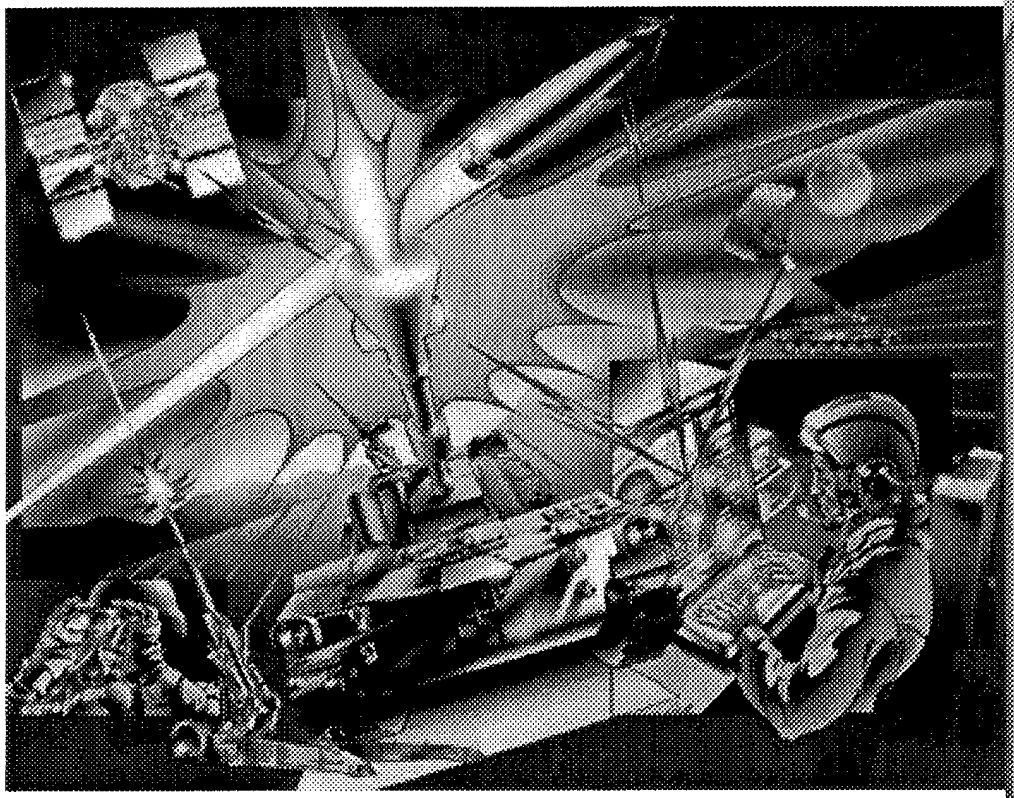


Vernon E. Shisler
System Manager
Objective Family Small Arms
U.S. Army ARDEC
Joint Service Small Arms Program (JSSAP)
Picatinny Arsenal, NJ 07806-5000
973-724-6009

Tank-automotive & Armaments COMmand
Committed to Excellence

Joint Service Small Arms Program

What's Beyond OICW & OCSW for JSSAP?





Series Future Small Arms Conclaves

Products

- Technologies worthy of detailed assessment
- Assessments of promising technologies viz-a-viz
  - Objective Family Upgrades
  - Follow-on Small Arms Systems e.g.
    Army After Next
- Roadmap for 21st Century Exploratory Development

Joint Service Small Arms Program

What's Beyond OICW & OCSW for JSSAP?

- Enhancements to the Objective Family
  - Conducted in Parallel to Development Program
  - Reduce Developmental Risk
  - Provide for Performance Growth and Upgrades
- Investigate Leading Technologies for Beyond OICW
  - Support Army After Next

Series Future Small Arms Conclave

Who is Involved?

- **Technology Leaders**
  - **Government**
  - **Industry**
  - **Academia**
- **Military Planners**
- **Futurists**



Conclave #1

- Held 9-10 July 1997

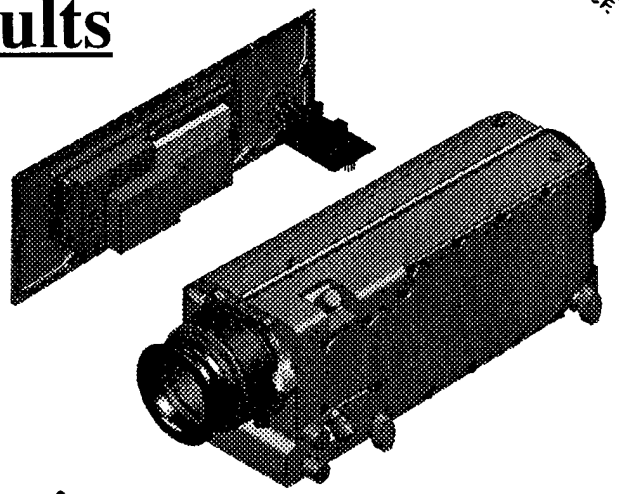
- Focused on Improvements to the Objective Family of Small Arms

- Provides Risk Reduction to the EMD Program FY00-05

- Sets Stage for Product Improvements and Block Insertions to OICW, OCSW and Land Warrior.

Conclave #1

Emerging Results



Sensors / Electronics:

- Multi Function Laser
  - Ranging, CID, Training, Pointing
- High Power CPU for Additional Functions
- Advanced Target Detection & Image Processing
- Enhanced Power Management
- Aim Point & Image Stabilization
- Link to Other Battlefield Sensors
- Battle Damage Assessment / Replay

Conclave #1

Emerging Results

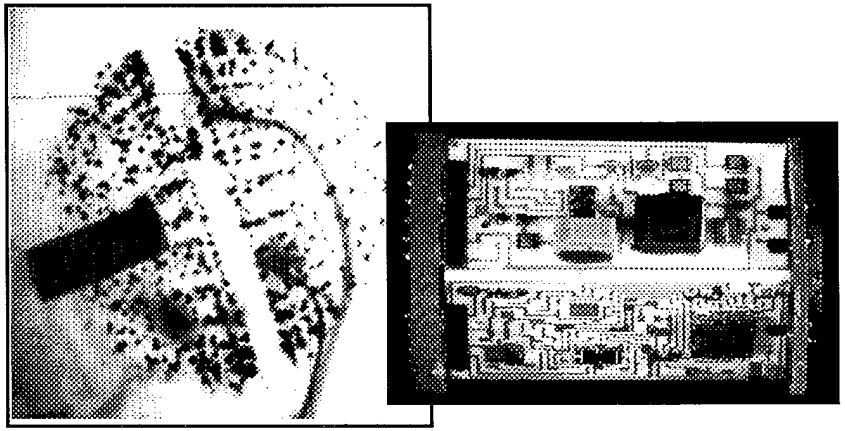
Human Factors:

- Individualizing Weapon to User
- Stronger Human-Weapon Relationship
- Indirect Sighting
- Voice Recognition and Command
- Built-in Field and Maintenance Training
- Weapon Status Monitor
- Further Recoil Mitigation



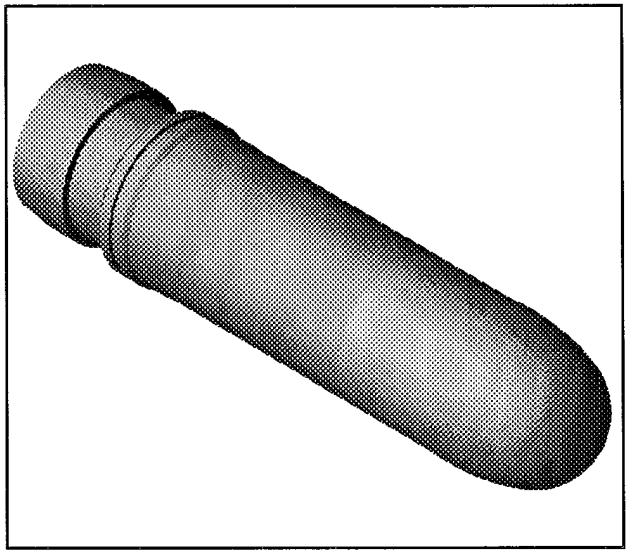
Conclave #1

Emerging Results



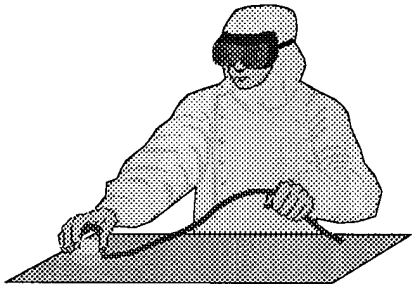
Lethality / Incapacitation:

- Fuze Size and Weight Reductions
  - Apply Savings to Warhead
- Directed Fragments
  - Alternate Selectable Initiation Points
  - Asymmetric or Deformable Warhead
- Insensitive Munitions
- Increased Behind Armor Effects
- Defeat of Enhanced Body Armor



Conclave #1

Emerging Results



Other Considerations:

- HE Barrel
  - Thinner Barrel Overwrapped with Polymer Matrix Composite
- KE Barrel
  - Metal Matrix Composites and Ceramics
- Weapon as a Launch Platform
  - Sensors for Targeting and Info Gathering
  - Anti-Materiel Payloads
  - Non-Lethal Devices
- Enhanced Thermal and Acoustic Management

Objective Family Enhancement Program

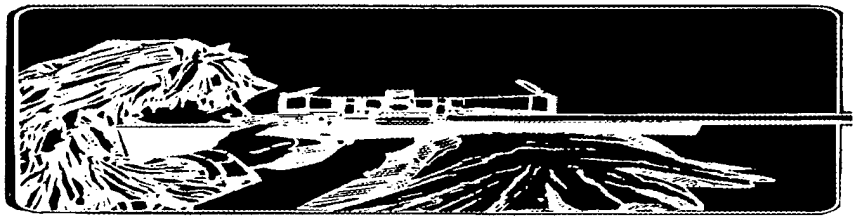
Summary

- Further Assessments and Planning Sessions Will Evolve the Enhancement Program
- Efforts Will Begin in FY00 When OICW is Transitioned to PM Small Arms for Development
- Efforts Will be Coordinated With the OICW & OCSW Development to:
  - Transition at First Unit Equipped
  - Provide Follow-On Block Up-Grades





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TACOM-ARDEC

Objective Sniper Weapon (OSW) Technology Program Course Correction

Presented By:
Dennis Conway
U.S. Army TACOM - ARDEC
(973) 724 - 7061

June 16, 1998

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PURPOSE

TACOM-ARDEC

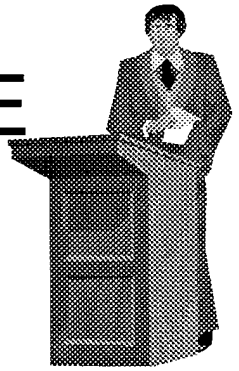
To Update the Small Arms Community on Current Thinking Associated with Technology Investigations Supporting the OSW Program

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OUTLINE

TACOM-ARDEC

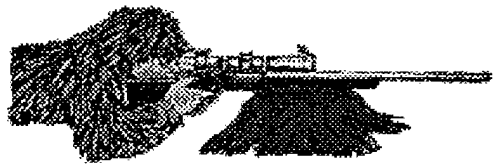
- BASELINE PROGRAM
- LONG RANGE SNIPER RIFLE DEMONSTRATION
- CUSTOMER FEEDBACK
- METHODOLOGY USED TO IDENTIFY EMERGING CONCEPTS
- TECHNOLOGY PROGRAM COURSE CORRECTION
- SUMMARY



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OSW ENHANCED INCAPACITATION/DESTRUCTION

TACOM-ARDEC

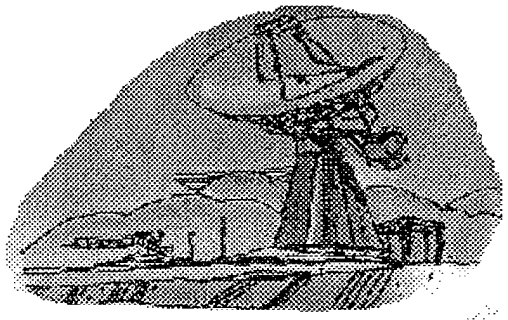




Personnel protected by Body Armor



Light Vehicles, Personnel in Fortifications



High Value Materiel

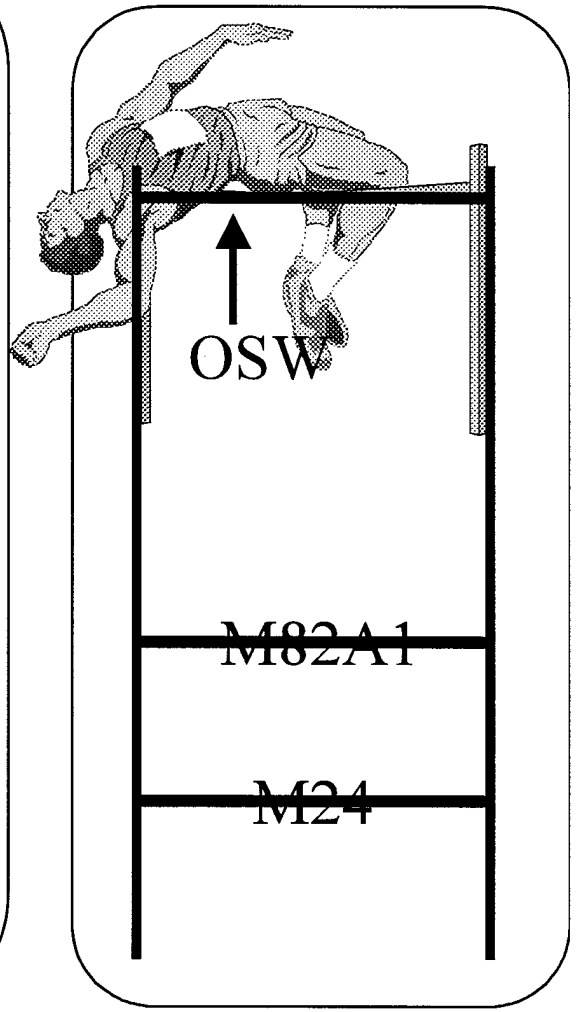
Leap Ahead in Capability

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OSW JOINT SERVICE GOALS

TACOM-ARDEC

Weight (lbs)	Less than 15 lbs; 10 lbs desired
Probability of Hit {P(h)} Range (m)	P(h) = 1.0 against personnel out to 1000M required, 1200M desired P(h) = 1.0 against materiel (4' by 4'target) out to 1500M required, 2000M desired
Targets	Individual personnel w/body armor; personnel in fortifications; light vehicles; high value materiel
Time Frame	2010
Operational Environment	All weather, 24 hr, air, land, sea



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TECH BASE EFFORTS

TACOM-ARDEC

OSW Tech Assessment Info / Results

Horizontal Tech Insertions:

- White Feather
- USA / USMC Sniper Schools
- M118 Long Range Sniper Ctg
- OICW
- Med Sniper Rifle
- SEP Heavy Rifle
- Commercial Sources

Wind Sensing

Baseline Performance

Weapon Parameters

Ammunition Parameters

Baseline Performance Experiment

Creative Problem Solving

Front End Analysis

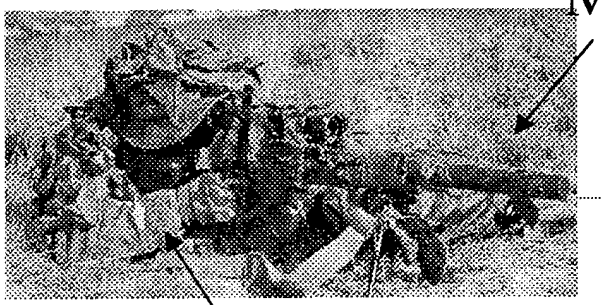
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Baseline Performance Experiment
18 Sep - 10 Oct 98

TACOM-ARDEC

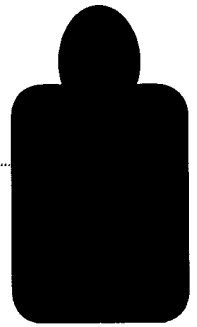
Burroughs Range
Ft Benning,GA

- Repeated Measures Experiment
- Known and Unknown Range-to-Target
- Known and Unknown Wind
- Stationary and Moving Targets
- Cold Barrel/2 Rounds
- Excursions Planned w/Laser Rangefinder



M24 Rifle

M118 LR Ammo



Test Subjects: Sniper School Class
- 3/75th Rangers
- 10th Mountain

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OSW PROGRAM RESTRUCTURE

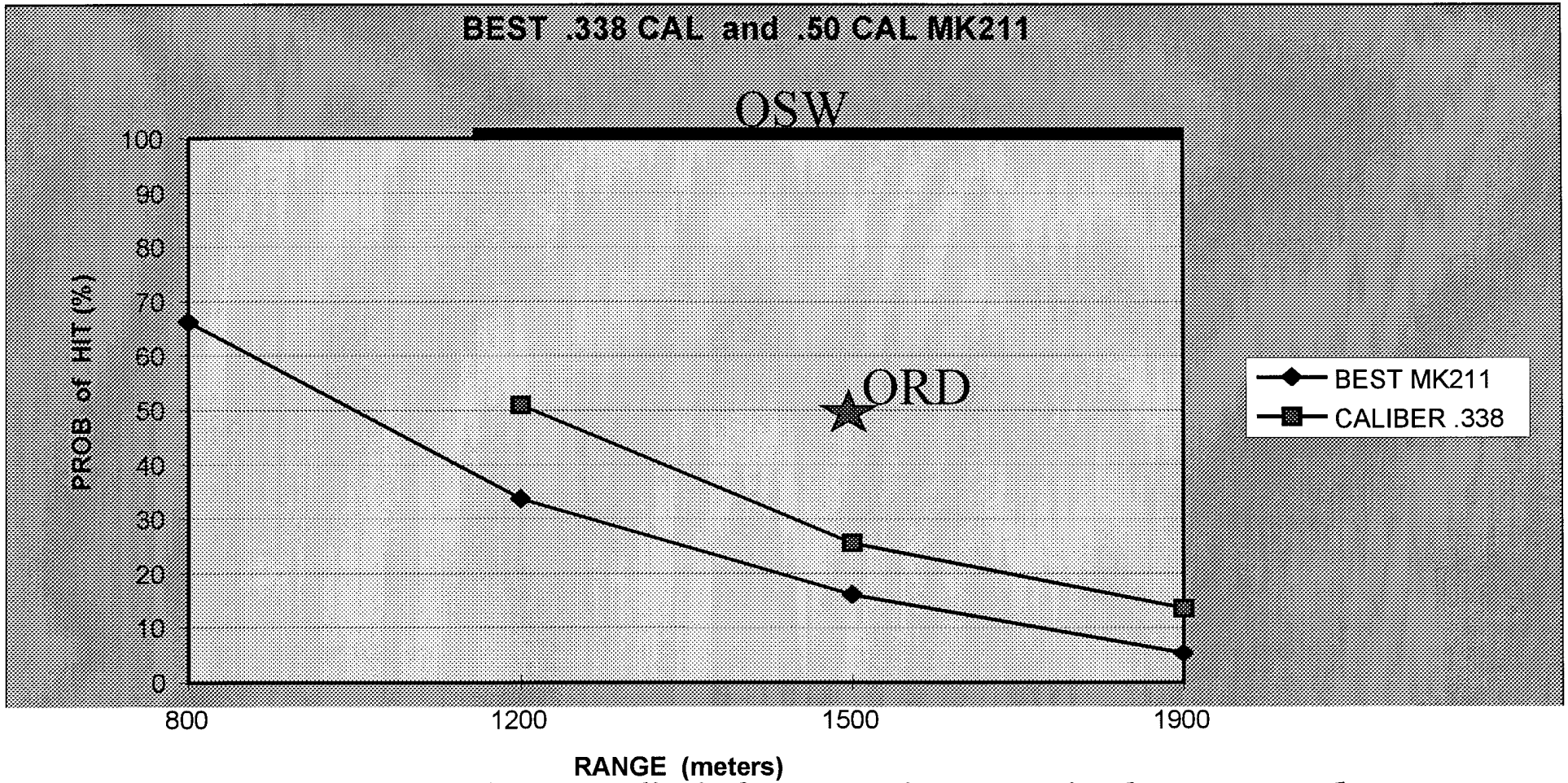
TACOM-ARDEC

- **Results of Long Range Sniper Rifle Demonstration**
- **JSSAP Management Committee Feedback**

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Long Range Sniper Rifle Demonstration
Key Findings

TACOM-ARDEC

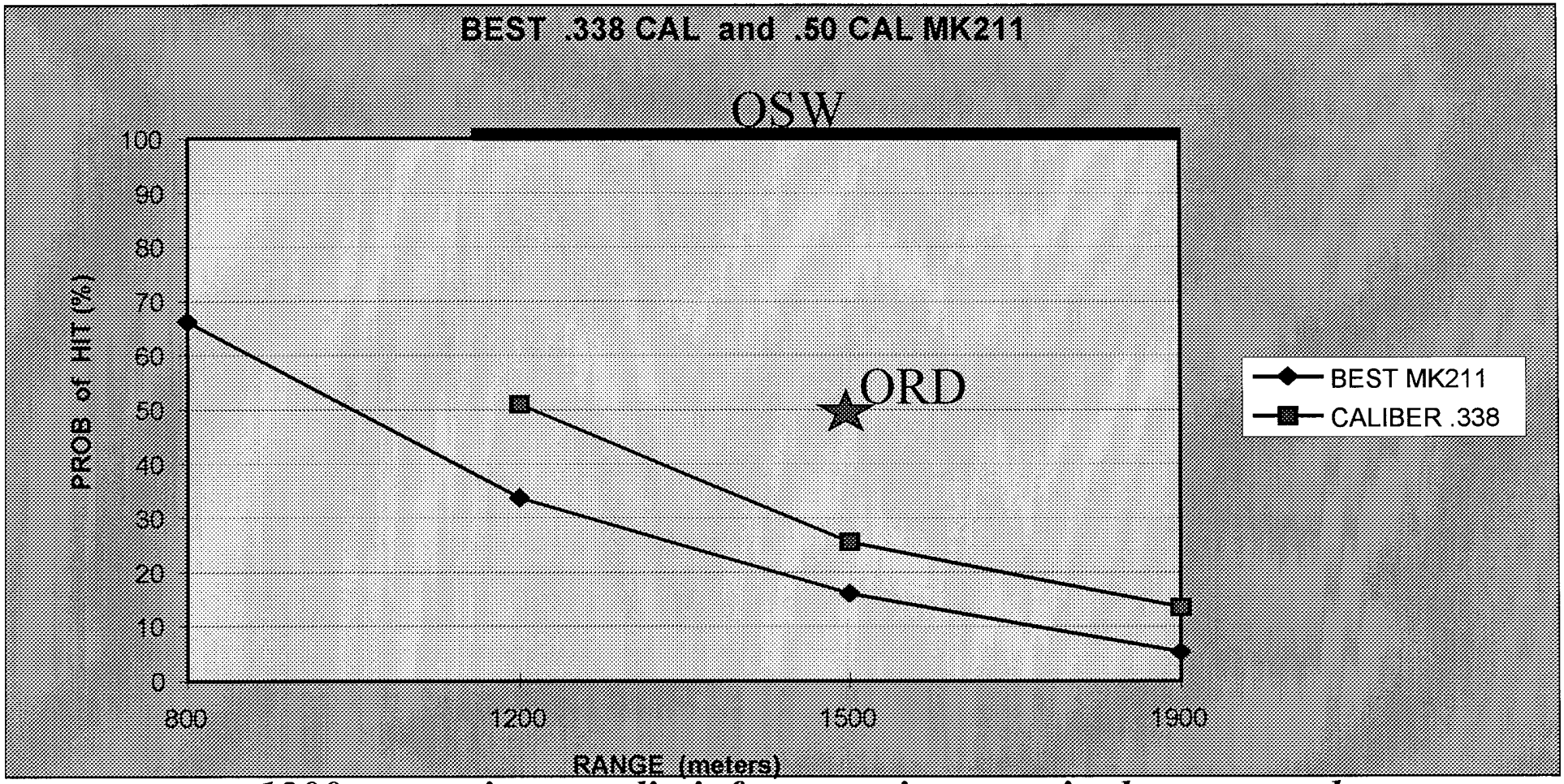


1200 meters is upper limit for engaging mansized targets under optimum conditions with conventional sniper systems

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Long Range Sniper Rifle Demonstration
Key Findings

TACOM-ARDEC

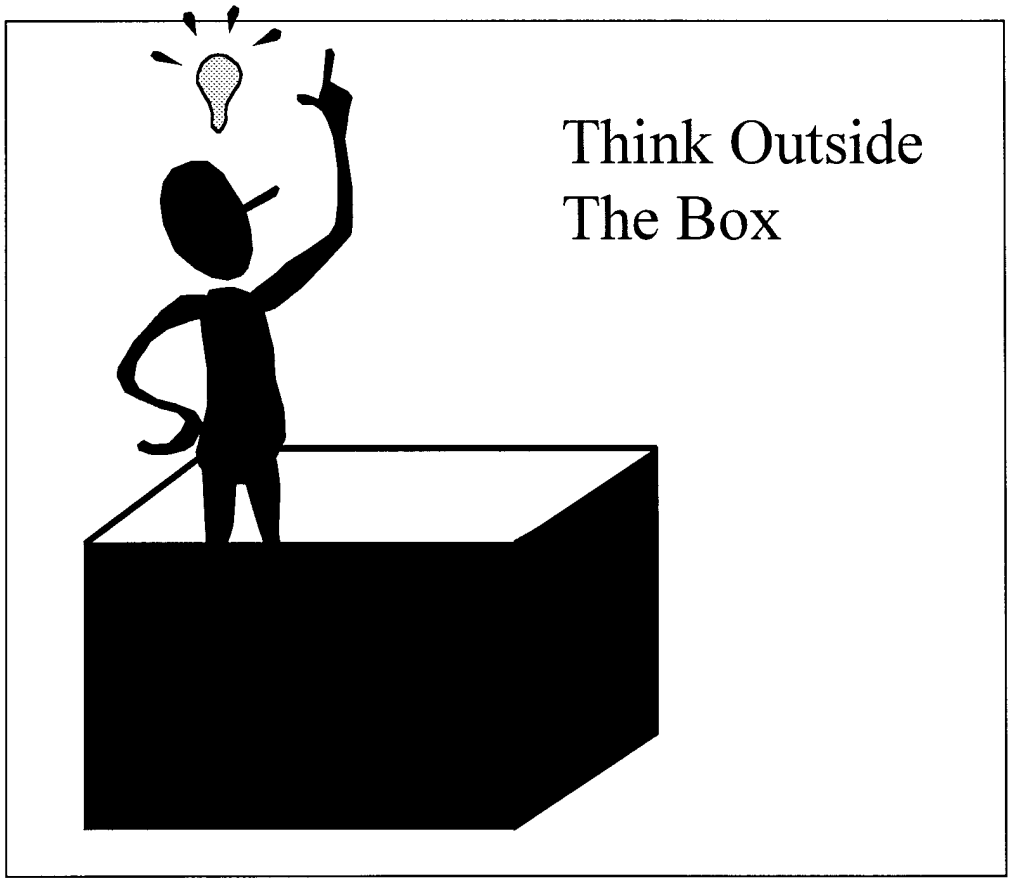


1200 meters is upper limit for engaging mansized targets under optimum conditions with conventional sniper systems

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OSW - The Voice of the Customer Heard Loud and Clear

TACOM-ARDEC



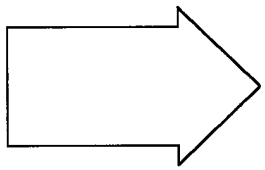
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OSW Emerging Technology Solutions

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Methodology

- Multi-Functional Teams
- Brainstorming
- Advanced Idea Generation
- Decade Guessing
- Houses of Quality



Concepts

- GNAT- Thermal Heat Sensor
- Continuous Course Correction
- Bursting Munitions
- Soft Launch/Rocket Assist
- Fire and Forget
- Multiple Payloads
- Directed Energy
- Micro Cruise Missile
- UAV
- OICW Variant
- Full Solution FC/Sensor Suite
- GPS

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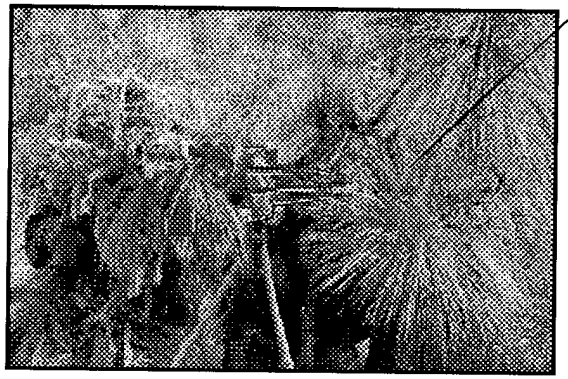
OSW - Concept # 1

TACOM-ARDEC

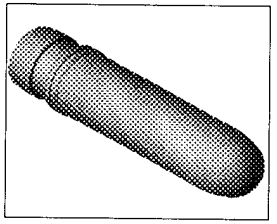
Uncorrected Flight Path



Corrected Flight Path



20mm Course Correcting Munition



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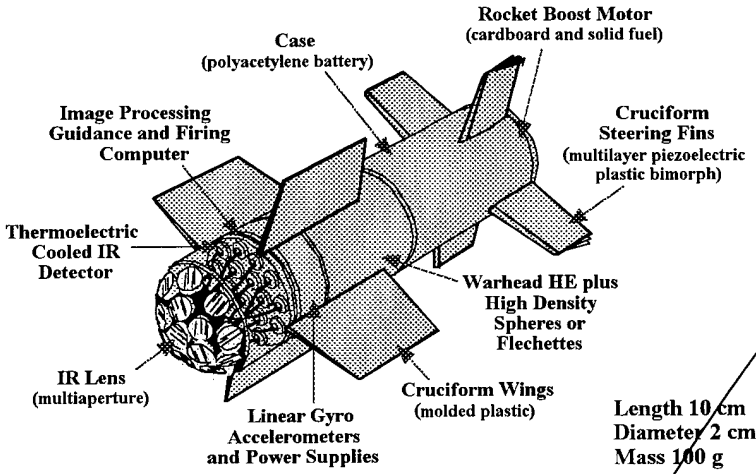
OSW - Concept # 2

TACOM-ARDEC

MST-8/May 98/OF-e56

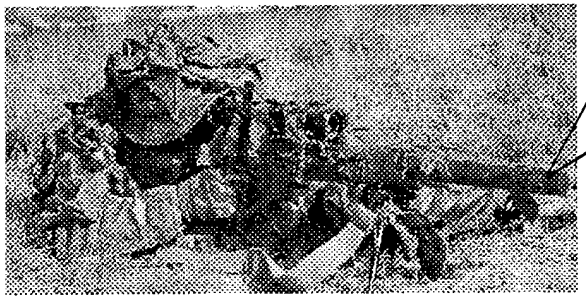
20mm Micro Missile

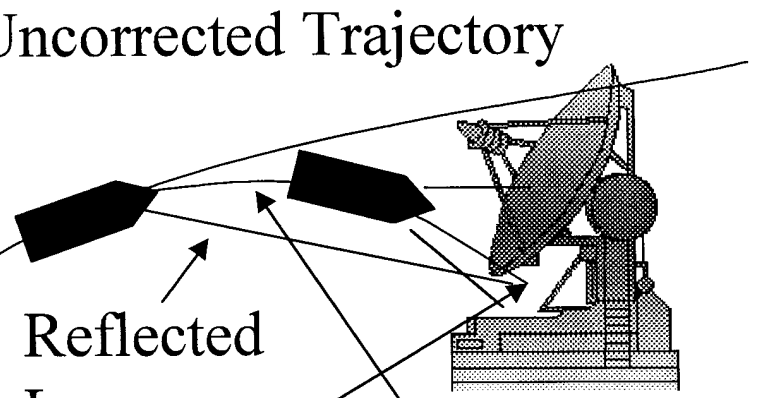
GNAT Micromissile Concept



Length 10 cm
Diameter 2 cm
Mass 100 g

Los Alamos
Materials Science and Technology

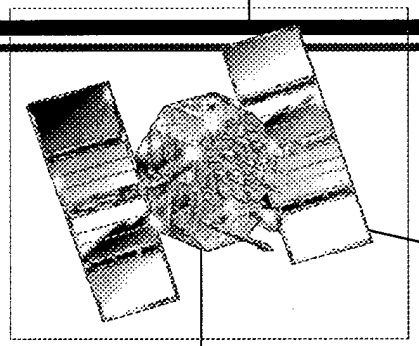




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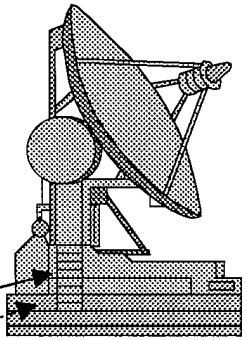
Revolutionary Concept

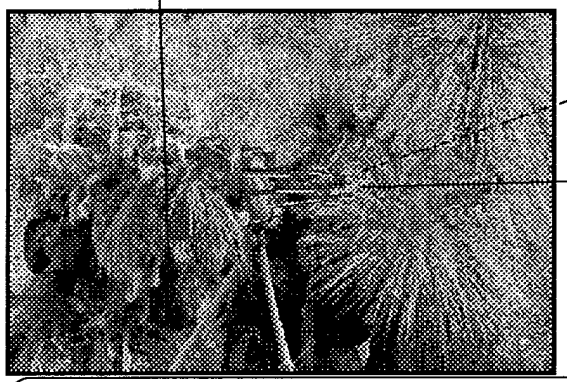
TACOM-ARDEC

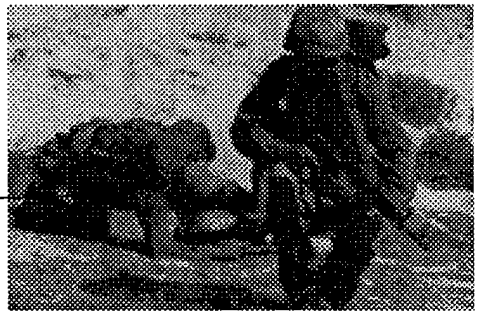


GPS

Remote Launch Platform







Individual Effectiveness with Extended Operational Flexibility

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SUMMARY

TACOM-ARDEC

- **It's a whole new ball game**







Military Operations in Urban Terrain Advanced Concept Technology Demonstration (MOUT ACTD)

Robert M. Pizzola

U.S. Army Armament Research Development & Engineering Center

Picatinny Arsenal NJ

201-724-7908 rpizzola@pica.army.mil

MOUT ACTD: The Environment, the Need

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

...the most likely, complex and resource intensive battlefield of the 21st Century

Non-Combatants & RestrictiveRules of Engagement

Modern Construction, Reinforced Walls



Densely Compacted Areas

High Rise Buildings

Electro-magnetic Interference

...reduced effects of US technology

Advanced technologies and concepts for MOUT dominance

MOUT ACTD Objectives

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Improve the Operational capabilities of soldiers and Marines in MOUT thru:

- Improved Command, Control, Communications, Computers and Intelligence (C4I)
- Improved Engagement (both lethal and non-lethal)
- Improved Force Protection

User Lead
(TRADOC,MCCDC)
Requirements Pull

CINC Sponsor: CINCSOC

DSB 1994 MOBA Study
Genesis



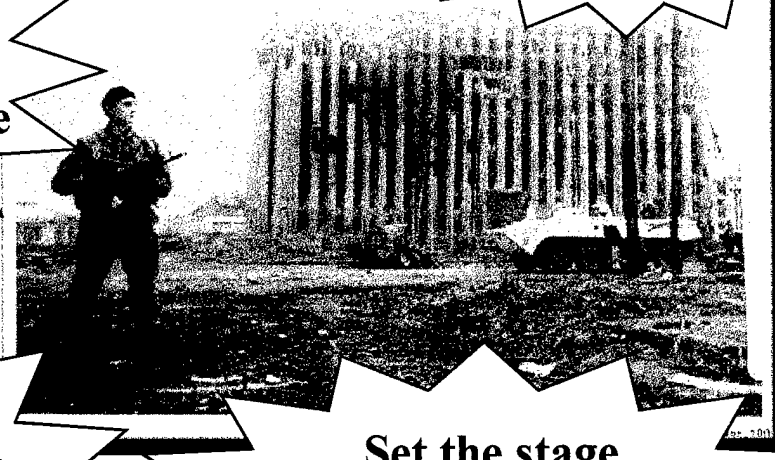
Advanced technologies and concepts for MOUT dominance

MOUT ACTD Mission

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Joint Army/Marine Corps Program

Evaluate advanced technologies to achieve technological dominance in MOUT



Provide residual capability to operational units including Tactics, Techniques and Procedures (TTPs)

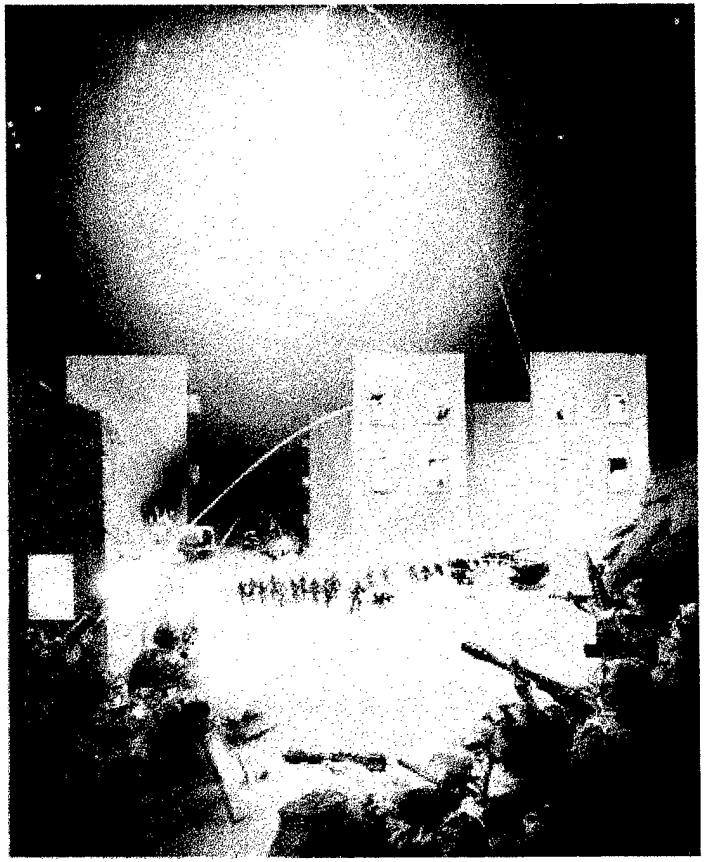
Set the stage for rapid acquisition of selected technologies

Advanced technologies and concepts for MOUT dominance

MOUT ACTD Technical Approach

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

- ID existing, emerging C4I, Engagement and Force Protection technologies
- Exploit NDI/COTS/GOTS items, mature R&D efforts and other TDs and ATDs
- Integrate components in MOUT System of Systems
- Use M&S to: facilitate systems integration; quantify combat performance; develop tactical employment
- Conduct live simulations/field experiments: assess technologies; operational concepts; TTPs



Advanced technologies and concepts for MOUT dominance

ACTD Characteristics

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

- **Allows the User to gain an understanding and evaluate the military utility of a product before committing to acquisition**
- **To develop corresponding concepts of operation and doctrine that make the best use of the new capability**
- **To provide residual operational capabilities to the forces**

...ACTDs provide a mechanism for intense involvement of the warfighters while incorporation of technology into a warfighting system is still at an informal stage...

Advanced technologies and concepts for MOUT dominance

MOUT ACTD

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

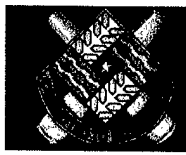
PROGRAM:

- Soldier System Command Program
- Major funding in FY 98, 99, 00
- Highly Visible OSD Level Program
- ARDEC has mission for 11 of 32 program requirements
- A Lethality study is being conducted to quantify how well existing weaponry performs in the MOUT environment

ARDEC GOAL:

- Search out and identify Engagement technologies relative to MOUT
- Act as Lead in Engagement Activities for the ACTD Manager
- Showcase Engagement products from Government and Industry

Advanced technologies and concepts for MOUT dominance



Engagement Requirements



Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Requirement number	Description	(Priority of 32)
R25	Non-lethal Munitions	(2)
R16	Detect booby traps	(7)
R27	Breach walls, floors, ceilings	(9)
R29	Precision Guided Mortar Family	(10)
R30	Non-explosive Breach	(16)
R34	Stun Grenades	(20)
R37	Point Munition	(21)
R31	Blunt Impact Training Munition	(22)
R21	Hands-free Sling	(24)
R8	Remote Marking	(26)
R24	"Soft" Round	(na)

Experimentation Plan

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

ARMY 1	**ARMY 2**	**RFPI**	**ARMY 3**
21 Jan 98	**27 May 98**	**22 Jul 98**	**09 Sep 98**
R#8, 12, 13, 26, 31	**R# 14, 15, 24, 35**	**R#12, 14, 15, 26, 30, 35**	**R# 3, 16, 31, 42**
ARMY 4	**ARMY 5**	**ARMY 6**	
01 Nov 98	**01 Feb 99**	**01 May 99**	
R# 5, 27, 40	**R# 8, 29, 37, R#26 revisit**	**R# 1, 3, 41, R# 13 revisit**	
USMC 1	**USMC 2**	**USMC 3**	**USMC 4**
27 Apr 98	**01 Aug 98**	**01 Jan 99**	**01 Apr99**
R# 10, 30	**R# 11, 28, 34**	**R# 2, 7**	**R# 4, 6, 33, 36**

Advanced technologies and concepts for MOUT dominance

Experimentation plan

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Http://yorktown.dc.isx.com/mout/ -- MOUT ACTD Web Site URL, Deficiencies and Requirements listed

OTHER EXPERIMENTATION:

JOINT 1	JOINT 2	ATE*	CAPSTONE
01 Jul 99	01 Sep 99	3Q00	4Q00
Integration	Integration	Adv. Technology Excursion	Final at JRTC

VENUES:
ARMY - McKenna MOUT Site, Ft. Benning
USMC - Camp LeJeune, NC MOUT Site
Joint Readiness Training Center (JRTC), Ft. Polk, LA

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Engagement Needs

R-31 for a Blunt Impact Training Munition

A solution which requires no weapon modifications is preferable to the current solution for which the upper receiver must be modified.

R-8 for Remote Marking

A marker material which provides high daytime visibility, ultraviolet reflection, a thermal and a low visible light signature with a duration measured in hours is desired.

R30 for Non-explosive Breach

A quick and stealthy means to open large numbers of interior doors (repeating use) is desired.

Engagement Needs

R-16 for booby trap detection

A very difficult problem; the materiel solution for one type of booby trap could well be the cause for initiation of another type. The search for materiel solutions continues.

R-37 for a point munition

There is no single solution to breach (man-sized hole) 36" of reinforced concrete, defeat bunkers, and defeat armored vehicles (100mm RHA). Partial solutions exist.

Selected Materiel Solutions

R27, 37 for breaching walls; R30 for breaching doors

Firesticks, Ti-B-Teflon hand-held rods producing a heat flux of 10 million Watts/sq. cm. at 7200 deg. F has been found for rapid rebar removal as well as melting of locks, hinges, burglar bars, etc. This is expected to be faster than explosive methods. There is no support equipment involved.

R37 for breaching 36" reinforced concrete (man-sized hole)

An explosive with the same approximate density of steel has been submitted as a materiel solution. It is coupled to the wall effectively by a high pressure backing charge.

The Way Forward

Military Operations in Urban Terrain Advanced Concept Technology Demonstration

MOUT ACTD Web Site URL - http://yorktown.dc.isx.com/mout/

New Product Submission Form found there.

Your method to enter a potential materiel solution for consideration.

If you have a "better mousetrap", a means will be found to experiment with your materiel solution, even for requirements where the Army or Marine Corps experiment has already been executed.

Advanced technologies and concepts for MOUT dominance



Thank You



Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Aerojet
Alliant Techsystems
Defense Technology Corp.
GIAT Industries
High Energy Access Tools
IMI Services, USA, Inc.
Lockheed Martin Corp.
Longbow, Inc.
MK Ballistic Systems
Monterey Bay Corp.
Olin-Winchester
Ordnance Technology Associates
Orlando Technology Inc.
Powell River Laboratory
Rafael, Inc.
Schiebel Instruments, Inc.
SNC Industrial Technologies
Talley Defense systems
Tippman Pneumatics Co.
and many others

Advanced technologies and concepts for MOUT dominance

The Joint Service Small Arms Program (JSSAP)

Lighter Smaller Faster Deadlier



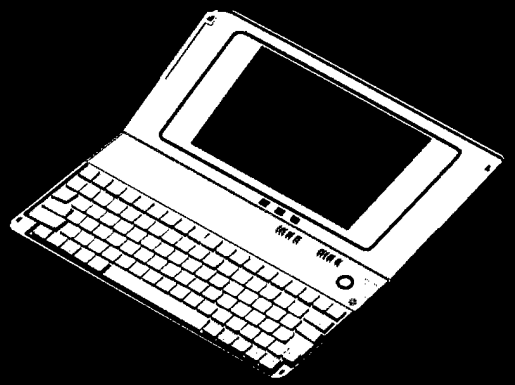
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ssmall@pica.army.mil

Briefing Agenda

- Objective of Program
- Background Information
- Methodology
- Products
- Plans (STO)
- Summary/Plans





Objective of Program



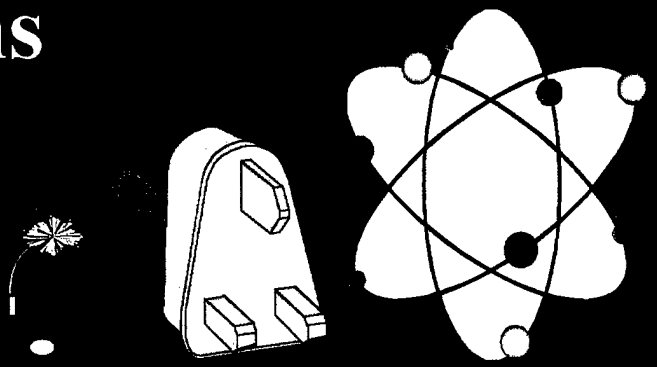
- To conceptualize and quantify the potential of a lethality system for the individual warrior of the Army After Next

- **Background Information**
  - The Future Conclave OICW & OCSW Conference (July 1997)
  - The Future Conclave "Blue Sky" -2020 Conference (September 1997)



- The Future Conclave "Blue Sky" -2020
- Methodology: Four Subgroups
  - Capabilities
  - Human Factors
  - Lethality Mechanisms/Target Coupling
  - Energy Considerations





Light Fighter Lethality Workshop

- **Products (Results of Subgroup Discussions):**
- **Capabilities Subgroup:**
  - **Greater accountability of the soldier**
  - **Improved sensing system, and environmental factors**
  - **A multi-faceted engagement process**
  - **A new paradigm beyond "shoot, move and communicate"**



Light Lighter Lethally Ever Next

- Products (continued):
- Human Factors Subgroup:
  - Human-weapon fusion as an interactive melding
  - Individualizing weaponry
  - Status monitoring, indirect sighting; jitter and security control
  - Embedded training

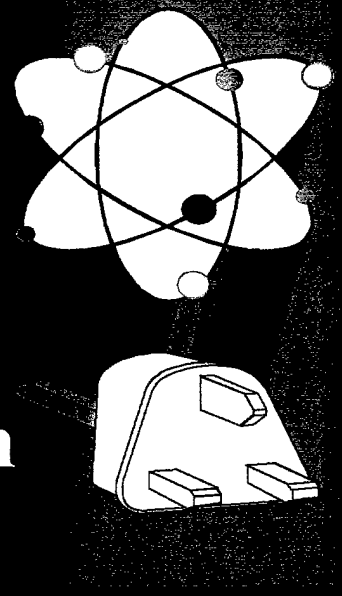
Light Lighter Lethality Fire Next

- Products (continued):
- Lethality Mechanisms/Target Coupling Subgroup:
  - Small caliber, high velocity, bussed warheads for long range engagements (with low recoil)
  - A greater lethality radius/footprint
  - Guided projectiles

Lighter Lighter Lethality Over Next



- Products (continued):
- Energy Considerations Subgroup:
  - A power system architecture c/o:
    - Prime energy store
    - Power distribution and conversion hardware
    - Intermediate energy storage elements
    - Intelligent power controller
    - Energy recovery elements
    - Self-protection elements



Light Fighter Lethality After Next

- **STO Number: ARD-05: Light Fighter Lethality After Next**



  - **A complete lethality system**
  - **An organic lethality component (=/< 5lbs)**
  - **A seeker projectile**
  - **An open breech launch mechanism**

Light Lighter Lethality Next

- Summary
  - Goal
    - Ultra-light
    - Probability of incapacitation (=1.)
    - Organic lethality of dismounted soldier
  - Focused on AAN time frame
    - component demos FY 02-05
    - System demos FY 08-12
    - Fielding FY20-25

Lightweight Lethality Next

- **Future Activities:**
  - **Define a Science & Technology Objective (STO) Program**
  - **Protect available funding**
  - **Define and demonstrate the Lethality Component of lightweight soldier for AAN**
  - **A more agile/lightweight soldier**
  - **<5 lbs.. Lethality concept**



Lightweight Lethality Next

- Future Activities (continued)
- Demonstrate System Components
- Identify/fill data gaps
- Conduct Technology Searches
  - Individual soldier sensors
  - seeker projectiles
  - lightweight launch mechanisms



Light Fighter Lethality Overview



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Annual Report on International Efforts to Restrict or Prohibit

Military Small Arms: Economic Interests in Humanitarian Disguise

by

W. Hays Parks*

It has been my privilege throughout this decade to address you annually on international efforts to prohibit or restrict military small arms and ammunition. I regret that a last-minute family emergency prevented my attendance of last year's meeting to personally deliver my remarks. I preface my remarks by noting that they are offered in a personal rather than official capacity.

The focus of my remarks will be the continuing initiative by Switzerland and the International Committee of the Red Cross (ICRC) to cast Swiss economic interests in a humanitarian guise to prohibit certain types of current, lawful military small arms ammunition in order to sell Swiss-developed military ammunition.

A repeat of some of last year's summary[1] of the history of regulation of military small arms ammunition is necessary. In 1899, at the First Hague Peace Conference, Germany introduced a proposal condemning the new British caliber .303 Mark IV bullet, which was being produced at the Dum-Dum arsenal near Calcutta. German criticism was politically-motivated, and depended heavily on skewed German experiments using a different caliber, big-game hunting bullet substantially different from the British Mark IV. The German deception worked, and the conference (over U.S. and British objections) adopted the 1899 Hague Declaration Concerning Expanding Bullets that prohibits "bullets that expand or flatten easily in the human body, such as bullets with a hard envelope which does not entirely cover the core or is pierced with incisions." The United

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* Special Assistant to The Judge Advocate General of the Army; Member, U.S. Delegation to the United Nations Conference on Certain Conventional Weapons, Geneva, 1978-1980; Member, U.S. Delegation to the United Nations Review Conference for the UN Conventional Weapons Convention, Geneva and Vienna, 1994-1996; Member, FBI Wound Ballistics Committee, 1992-1993; and United States Representative to the International Workshop on Wound Ballistics, Interlaken and Thun, Switzerland, 7 and 8 October 1997. This paper reflects informal remarks offered at the annual meeting of the Small Arms Systems Division, National Defense Industrial Association, Columbus, Georgia, June 16, 1998. The comments are the author's personal views and do not necessarily reflect the official position of the Department of the Army or any other agency of the United States Government.

[1] "Update on International Efforts to Restrict or Prohibit Small Arms and Other Conventional Weapons," to be published in *News from The Institute for Research on Small Arms in International Security* (hereinafter *IRSAIS News*), Vol. 8, No. 3.

States never became a party to this treaty, but generally has applied it throughout this century (as have other nations) for the practical reason that, until recently, most military small arms would function reliably only with full metal-jacketed ammunition.

This scenario was repeated in the late 1970s as the United States developed and fielded the M-16 rifle with its 5.56 x 45mm projectile.[2] Sweden condemned the M-16 in part because of its opposition to U.S. military operations in Viet Nam, but primarily because the 5.56mm projectile represented a revolution in military small arms for which the Swedish small arms industry found itself totally unprepared. Swedish claims at a United Nations conference between 1978 and 1980 paralleled those of Germany in 1899. They relied upon skewed tests, and vastly exaggerated the wounding effects of the M-16 and its 5.56mm projectile. They were less successful in their endeavors, however, as the UN conference elected not to adopt an updated ban. As more nations adopted 5.56mm caliber weapons, NATO adopted the 5.56mm as a standard caliber (with the M855 [NATO SS-109] replacing the earlier U.S. M193 projectile), and the Soviet Union transitioned to 5.45 x 39mm-caliber weapons, the issue of the "illegality" of small-caliber weapons seemed to have run its course and died the death it deserved.

Enter the Swiss. In the late 1980s, Switzerland undertook two programs. First, it developed an improved version of the M193 as a competitor to the M855 projectile. Second, it consolidated small arms ammunition manufacturing at Thun in a state-of-the-art facility that can produce 500,000 5.56mm rounds per eight-hour shift – a capability clearly far greater than necessary for Swiss defense requirements, and equally clearly designed to compete in the international military ammunition market. But both accomplishments coincided with the end of the Cold War, and the bottom fell out of the small arms ammunition market.

Suddenly, the otherwise-marketless, Swiss-improved M193 took on a new guise through ICRC expressions of interest in a "humanitarian" bullet. The first evidence appeared at the 1990 ADPA small arms division meeting at Aberdeen Proving Ground, when an ICRC representative lectured the assembly on the "illegality" of certain small arms ammunition.[3] Beat Kneubuehl, Head of the Swiss Defence Technology Service and designer of the improved, so-called "humanitarian" bullet, addressed the ADPA Small Arms Division annual meeting one year later on the same subject.[4] The ICRC maintained the initiative in other international fora.[5]

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[2] For a summary, see the author's 1990 presentation, "Political-Legal Factors in Small Arms Research and Development," republished in *IRSAIS News*, Vol. 2, No. 2 (February 1991), pp. 10-14.

[3] Gerard C. Cauderay, "Concerns of the International Committee of the Red Cross with Regard to the Effects of High-Energy Transfer Bullets and the Methodology of Research in the Field," subsequently published in *IRSAIS News*, Vol. 2, No. 1 (December 1990), pp. 14-16. A critique of the Cauderay paper by Dr. Martin L. Fackler was published in *IRSAIS News*, Vol. 2, No. 2 (February 1991), at p. 5.

[4] "On the Effectiveness of Small Arms Ammunition" (Atlanta, November 6, 1991).

To understand the basis for the Swiss-ICRC initiative, it is necessary to return to the 1899 Hague Peace Conference. The U.S. delegate opposed the German condemnation of the British Mk. IV, in part because it banned one form of bullet design – a bullet with an exposed lead core and skiving – while permitting others that might have similar terminal ballistics, such as a bullet designed to yaw early, or with a soft full-metal jacket that would fragment, or both. His arguments were soundly rejected by his fellow conferees. Thus the represented nations made a conscious decision that bullets that yaw or that may fragment on impact with soft tissue should not be banned.

Let me repeat and emphasize an historical fact I have mentioned in previous presentations: *Every military rifle projectile used in combat in this century will fragment on impact with soft tissue under certain conditions*. Mr. Kneubuehl developed his 5.56mm projectile to defeat Soviet body armor, not to diminish the terminal ballistic effects of the 5.56mm military projectile. When the Cold War ended the Warsaw Pact and its threat, Kneubuehl and the ICRC fashioned an argument that military small arms bullets that *might* fragment should be regarded as tantamount to dum-dums, and banned.

The present Swiss-ICRC argument is that the "gap" that has existed throughout this century needs to be closed with (a) an international prohibition of small arms projectiles that may yaw early and/or fragment on impact with soft tissue, and (b) the establishment of an international wound ballistics testing center at Thun, to be run by Kneubuehl. (Claims that Kneubuehl's bullet does not fragment in soft tissue have not been borne out in wound ballistic testing.) Their arguments are technically flawed, and Kneubuehl's wound ballistic tests were skewed to favor the ICRC initiative.[6]

This initiative attempts to address a problem that does not exist. The terminal ballistics effects of military small arms ammunition have been consistent throughout this century. Military fatalities from small arms wounds have diminished, not increased, and cannot compare with the wounding effects of military weapons a century ago. Nor can the wounding effects of military small arms compare with those of other weapons, such as artillery, land mines,[7] or the Claymore mine. The ICRC-Swiss initiative also conveniently ignores the obvious: military weapons are designed to kill or disable.

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[5] See, *e.g.*, ICRC, "The ICRC and Its Work in Relation to Conventional Weapons and New Weapons Technologies," United Nations General Assembly, 46th Session (October 30, 1991); and "Prohibitions or Restrictions on Certain Conventional Weapons and New Weapons Technologies," paper prepared for the XXVIth Conference of the International Conference of the Red Cross and Red Crescent, Budapest, November-December 1991, pp. 27-28.

[6] For a recent critique, see Martin L. Fackler, "Civilian Gunshot Wounds and Ballistics: Dispelling the Myths," *Contemporary Issues in Trauma* 16,1 (February 1998), pp. 17-28, and particularly his discussion of the Swiss "high-velocity myth," "kinetic energy deposit" and "energy transfer" theories at pp. 18-23.

[7] Recent international efforts to ban antipersonnel land mines were not based upon the severity of their wounding effect when used against combatants, but rather on the risk posed to civilians due to the indiscriminate effect of their irresponsible use by warring factions in internal conflicts in less-developed nations.

Yet the ICRC and the Swiss persisted, proposing a new protocol to the 1980 United Nations Conventional Weapons Convention at its first review conference, held between 1994 and 1996. Response from other delegations ranged from strong opposition (including the United States) to disinterest, and the Government of Switzerland withdrew its proposal before the conference concluded. An ICRC attempt at its own conference to raise the issue anew was not supported by participating nations.

The ICRC-Kneubuehl proposal was renewed through a Swiss-sponsored international workshop on wound ballistics held in Interlaken in October 1997. It was my privilege to represent the United States. At my request, Dr. Martin L. Fackler, a leading expert in wound ballistics, joined me. Our participation was preceded by a strong demarche by the Department of State to other governments advising them that the United States believed the Swiss initiative lacked scientific and evidentiary support, and represented a misplaced priority of effort.

The program included presentations by Kneubuehl, two ICRC representatives, a review of the legal issues by my Netherlands Ministry of Defense counterpart, and a tour of the Swiss Low Noise Ballistic Ranges at Thun.

Kneubuehl's presentation contained serious technical flaws, all skewed to support his efforts. It was critiqued by Dr. Fackler in the *Wound Ballistics Review*.[8] The "case studies" by ICRC representatives were similarly flawed, describing treatment of gunshot wounds in less-developed nations by small arms of unknown type, caliber, or condition, at unknown ranges, of less-fit civilians receiving initial treatment at times ranging as high as one week after wounding – hardly an effective scientific study, or comparable to modern medical treatment on the conventional battlefield. The Dutch legal representative concluded that the time for the ICRC-Kneubuehl proposal "was not ripe," a conclusion I supported in remarks I was asked to give by the presiding officer.[9] My British counterpart and others supported my remarks in turn. There was no support for the ICRC-Swiss initiative.

The ICRC-Kneubuehl initiative addresses a non-existent problem. It took 50,000 rounds to wound a single enemy soldier during the Viet Nam War. A 5.56mm bullet may fragment on impact with soft tissue, depending upon the variables I listed in last year's presentation, such as range, degree of projectile yaw at impact, and length of wound tract. The probability of a M855 bullet fragmenting in soft tissue may be in excess of one in 500,000. Even if it does fragment, its effects still pale when compared to other, lawful battlefield wounding mechanisms. Yet the ICRC and Kneubuehl labor on, portraying any

[8] Martin L. Fackler, "International Workshop on Wound Ballistics, Interlaken, Switzerland, 7-8 October 1997," *Wound Ballistics Review* 3,3 (1998), pp. 42-43.

[9] Statement by the United States Representative at the International Workshop on Wound Ballistics, Interlaken, 8 October 1997. Copies available from the author.

change in bullet design – such as an improved ballistic co-efficient to enhance accuracy – as something sinister and evil. It also is an effort badly misdirected. The problem in internal conflicts in Angola, Rwanda and other parts of sub-Sahara Africa, the former Yugoslavia, Kosovo, and elsewhere, is illegal use of lawful weapons, not a military small arms projectile that might fragment once in every half-million rounds fired.

Like the Energizer bunny, the ICRC and Kneubuehl effort keeps on running. The letter forwarding the official report of the workshop inexplicably and inaccurately concludes, "the Workshop showed that there seems to be no disagreement on the fact that there are weapon systems that can have effects which resemble those of the outlawed dum-dum bullets. Furthermore, there was evidence that there is a need to further analyse and weight (*sic.*) the question of military necessity versus humanitarian requests, and to establish a common standard testing methodology."[10] This conclusion is totally inconsistent with my workshop observations.

There is a simple reason for the continued Swiss-ICRC effort. Swiss Ministry of Defense armaments facilities, including the Thun ammunition manufacturing plant, are in the process of being privatized.[11] The Government of Switzerland will subsidize the Swiss military small arms ammunition program during its transition period, selling ammunition at a substantially discounted price to gain entry into the international military small arms ammunition market.[12]

The ICRC-Kneubuehl effort through this decade is keyed to this transition, and is a part of it. It endeavors to establish a new international legal standard that only Kneubuehl's 5.56mm projectile will meet, thus facilitating the Swiss Munition Enterprise's capture of the international military small arms ammunition market. The reason the ICRC and Kneubuehl persist in their endeavors has been acknowledged by official Swiss sources: to preserve the Swiss small arms industrial base, and Swiss jobs. In a word, the "humanitarian" concern expressed by the ICRC is bogus.[13]

As I indicated last year, the threats in our world have increased, not diminished, since the end of the Cold War. The threats also have changed, as has the way the public

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[10] Letter of Joerg Koehler, General Staff, Global Arms Control and Disarmament, General Staff (April 9, 1998), forwarding "International Workshop on Wound Ballistics – Documentation."

[11] They will become a part of the Swiss Munition Enterprise.

[12] The subsidy will be fifty per cent. Thus a 5.56mm military small arms round that normally would sell for (for example) fifty cents per round would be sold for $.25, with the Government of Switzerland paying the other $.25. This subsidy would be phased out once the Swiss Munition Enterprise has gained entry into the international military small arms ammunition market.

[13] It also is inconsistent with the ICRC Fundamental Principles, which (among other things) are a condition for government contributions to the ICRC. The ICRC Principle of *independence* requires that it maintain its autonomy from the Government of Switzerland. It appears it has not done so in this case.

and national and international leadership expect military forces to respond to them. Our military forces are expected to address each threat quickly, with minimum civilian and friendly force casualties. Simultaneously, environmentalists are calling upon the police and military to develop, acquire and use environmentally safer ammunition.[14]

The military will be expected to employ environmentally safer, reduced ricochet, enhanced accuracy ammunition in missions across the conflict spectrum. In military operations in urban terrain (whether in peace operations or conventional international armed conflict), peace operations, and other missions such as counterterrorism, our ammunition will need to meet all of these requirements while also minimizing over-penetration risk, simultaneously defeating terrorists or other threats wearing body armor. We cannot deploy our troops with multiple loads of ammunition, requiring them to change magazines according to the threat of the moment. We must come up with a single, all-mission projectile.

The Kneubuehl-designed 5.56mm bullet cannot meet the various requirements and threats I listed in the preceding paragraph. Indeed, it is a move in the exact opposite of the direction I see occurring. Mr. Kneubuehl designed a bullet for a NATO-Warsaw Pact confrontation on a battlefield virtually devoid of civilians, a threat and scenario that, for the most part, ended a decade ago. Over-penetration risks are greater, increasing the risk to hostages, to hostage rescue personnel, or to innocent civilians in peace operations, military operations in urban terrain, or other operations where civilians may be present. Both the M855 and the Kneubuehl projectile may be regarded as obsolete in the future because neither is environmentally safe, and their overpenetration characteristics pose too great a risk to innocent civilians.

We have the technical capability to meet what I have suggested will be the requirements for a military small arms projectile for today's – and future – threats and scenarios. The opportunity is in your hands. It will depend in large measure, however, on the degree to which you are prepared to wrest the moral high ground from the ICRC, Swiss industrialists, and the Government of Switzerland.

Understand the challenge: one source estimates that the ICRC spent more than thirty million dollars in U.S. Government donations in its successful campaign to ban landmines, which it sees as a valuable precedent for its small-arms initiative.[15] It seems likely that it is prepared to spend as much, or more, to benefit Swiss economic interests. It may succeed, if you permit it.

Thank you for your time.

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[14] See, *e.g.*, Paul S. Scarlata, "Next Wave Indoor Ammo," *American Rifleman* (April 1998), p. 31.

[15] Major General Jarvis D. Lynch, USMC (Ret.), "Landmines, Lies and Other Phenomena," *United States Naval Institute Proceedings* (May 1998), pp. 44-49, at 48.

International Small Arms Disarmament: Menace or Challenge

by
Virginia H. Ezell

It would do no good to stand here and list the more than 600 organizations that have taken on the task of monitoring worldwide small arms proliferation. Four years ago I presented a paper here describing the aspirations of a small group individuals and organizations who had gathered near Harvard Yard in the cold days of February 1994. The aim of their meeting was simply to get together to discuss the various issues relating to small arms transfers, exchange business cards and ideas. Today the network of activists which began in 1994 is bigger, stronger and more vibrant. They have taken the issue, defined the problem and the terms of discussion for the media, governments, and "civil society." To a great extent they control the international debate, if there is one, on small arms transfers.

The difference between now and four years ago is that a movement of the few who took this topic seriously has burgeoned into a cottage industry of the many. Their goals are varied, from strict controls over small arms transfers to moratoria on the trade and production. The results of their work will affect how, or even perhaps whether, you do business in the future.

The largest organizations with infrastructures which facilitated fund raising to support their early campaigns have been from the traditional disarmament community: the British American Security Information Center (BASIC), the Center for Defense Information (CDI), Worldwatch Institute, Saferworld, Human Rights Watch, and the Monterey Institute for Strategic Studies. Each of these organizations has a web site for dissemination of information as well as a means of self-promotion. They each have a program entitled "small arms" or "light weapons project" through which they coordinate activities in this arena. They all have several people on staff working full time on various aspects of the problem of small arms proliferation. Several organizations not usually associated with disarmament, for example relief agencies such as OXFAM and the International Committee for the Red Cross, have more recently joined in this international movement.

In the beginning, the early proponents of international small arms disarmament had a single idea: all guns are bad. They appeared to be voices in the wilderness, the geopolitical situation was in a state of transition from a nuclear stand-off to a Post-Cold War multi-polar world. Their first obstacle was to fix the attention of world leaders on the issue of small arms as a serious problem which threatens world peace. To achieve their ultimate goal, leaders within the original disarmament network determined to change international norms concerning small arms.

Norms are part of a belief system. They make up the foundation on which issues are understood and establish the context within which a group defines itself and the world around it. Norms represent a group's paradigms. They help distinguish good from evil.

In this instance, the international disarmament organizations proposed to make it socially unacceptable for nations to have infantry weapons. Unlike earlier pacifist movements, the disarmament community of the 1990's intended to go beyond appealing to the decision-makers and raise the consciousness of individual citizens. To do that they needed media attention. To get that they needed money.

A brief review of the largest grants is one measure of their success. Since 1995 grants to various disarmament groups have exceeded $6 million. This is in addition to the $5 million grant presented to Human Rights Watch to establish its small arms project in 1991. Most of the money has been targeted for specific programs to study the problem of small arms proliferation rather than general operating funds.

For example, the Rockefeller Foundation presented the Human Rights Watch with a grant of $500,000 "for continued support to create new norms and attitudes toward the proliferation and use of arms." The Carnegie Corporation of New York gave the Arms Control Association (ACA) $100,000 for a "program on arms control and national security for the Washington press corp." The Kendall Foundation also gave the ACA $50,000 "to advance public understanding and support for arms control." Saferworld received over $17,000 in one grant from the MacArthur Foundation to "coordinate activities in Europe and the United States that promote an international arms trade code of conduct." BASIC received a two-year $150,000 grant from the MacArthur Foundation for work "toward networking in policy analysis and public education activities focused on regional security in Europe and conventional arms trade." The Cowell Foundation gave the Human Rights Watch $18,000 to support that organization's Project to Ban Blinding Lasers. They also gave an organization called Ploughshares a two-year grant of $40,000 for the conventional arms portion of that group's Mainstream Media Project. The list goes on.

Another measure of their success might be to look at the various international agreements that have been drawn up and signed over the past several years. In November 1997 the members of the Organization of American States (OAS) agreed to a small arms proliferation convention "against the illicit manufacturing of and trafficking in firearms, ammunition, explosives, and other related materials." Although each of the members has signed the treaty, to date only a handful have ratified it. This treaty generally proscribes the methods of arms transfers between the members. It calls for sharing of information between various law enforcement agencies of the member states. (Inter-American Convention Against The Illicit Manufacturing of and Trafficking in Firearms, Ammunition, Explosives and Other Related Materials, Article II, November 1997.)

The OAS convention is the first international agreement specifically oriented toward regulating small arms transfers. Other international agreements, the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, the United Nations Transparency in Armaments Initiative, and the Convention on Conventional Weapons, were designed to control trade in conventional weapons excluding small arms.

The disarmament community has been campaigning to include small arms in these agreements and conventions. According to Geraldine O'Callaghan, a small arms specialist at BASIC, the OAS convention is a good beginning which should be used as a template for similar regional agreements. In a recent meeting to discuss the progress in the field of small arms disarmament, in her remarks O'Callaghan said that because illegal transfers began as legal ones, "we cannot allow the legal and the illegal to be separated."

Based on what some consider a controversial resolution from the United Nations' Economic and Social Council (ECOSOC), disarmament groups now are calling for the international community to link crime and conflict. According to one analyst the "breakdown of national boundaries has

ended the distinction between conflict and crime. Firearms are the weapon of choice for combatants and criminals alike." (statement by Geraldine O'Callaghan, at UN Commission on Crime Prevention and Criminal Justice 7th session, Vienna, Austria, 21-30 April 1998)

The ECOSOC resolution recommends "measures to regulate firearms" based on ECOSOC'S Commission on Crime Prevention. It includes provisions for identifying arms throughout the transfer process. In addition to traditional serial numbering, weapons will be marked at each stage in the transfer process to help identify not only the source of supply but the route the weapons took before reaching their final destination.

While the Inter-American convention addresses the illicit trade it does not relate to internal human rights violations resulting from small arms abuses nor does it address domestic civilian small arms issues. At the same meeting, Dr. Natalie Goldring, also from BASIC, said in reference to the United States as a major supplier of conventional weapons, "failure to regulate internally is open season to illicit traffickers." She suggested that without strong internal regulations governing firearms ownership the United States represents a possible major source of supply in the illicit traffic in small arms in Latin America.

Finally, another measure of their success might be in the number of international or supranational organizations which have entertained discussions on this topic. As mentioned, one international organization known as the Wassenaar Arrangement concentrates not only on conventional weapons transfers but includes technology transfers as its mandate. Transparency in arms transfers is the main aim of this successor to the Cold-War era CoCom group (Coordinating Committee). Although small arms have yet to be added to the list of controlled items, some members, primarily Japan, have called for inclusion of small arms on the list.

United Nations Secretary General Koffi Anan has expressed an interest in the problem of small arms proliferation. Within the UN secretariat the Department of Disarmament Affairs includes a section dedicated to investigating aspects of small arms proliferation. Anan convened a panel of small arms experts to study the issue. Their report, issued in 1997, called for a number of actions from members of the United Nations.

Among it findings the panel reported that "accumulations of small arms and light weapons by themselves do not cause the conflicts in which they are used. The availability of these weapons, however, contributes towards exacerbating conflicts by increasing the lethality and duration of violence, by encouraging a violent rather than a peaceful resolution of differences, and by generating a vicious circle of a greater sense of insecurity, which in turn leads to a greater demand for, and use of, such weapons." (para. 10, UN DOC A/52/298, "Report of the Panel of Governmental Experts on Small Arms"). The panel recommended identification and destruction of surpluses, improved methods of marking weapons, restricting manufacturing and trade to designated authorized dealers and manufacturers, and use of the OAS convention as a model for other inter-regional agreements on illicit arms trafficking. (para. 79, ibid.)

Most recently the members of the Economic Community of West African States (ECOWAS) agreed to a three-year moratorium on arms transfers into and out of the region. The government of Mali initiated the call for a moratorium on small arms imports and exports in the region. The move was headed by Mali President Alpha Omar Konare who said that arms supplies of rifles and other small arms were a threat to stability. His call for a moratorium is consistent with earlier actions taken by the current government. In March 1996 with great international fanfare

the government, with cooperation from opposition leaders, burned weapons surrendered by former anti-government militiamen as part of a peace agreement. The arms moratorium was signed in March 1998. (Reuters, 27 March 1998)

Also within the United Nations, the Crime Prevention and Criminal Justice Division in ECOSOC also has initiated programs focused on the study of small arms proliferation. Most recently a commission on crime prevention and criminal justice submitted its report on firearms regulation. This report dealt primarily with civilian firearms ownership as well as manufacturing and trade. The focus was on law enforcement issues affecting control of the illegal use of firearms. From their findings the ECOSOC presented in April 1998 a draft resolution to strengthen legal institutions and measures to regulate firearms transfers and manufacturing. In May 1998 the United States government presented a similar recommendation for consideration by the G-8 at their summit in the United Kingdom.

In Europe, the European Union is about to adopt a Code of Conduct relating to arms transfers. Based on an earlier version passed in 1991 by the European Council of Ministers, the European Code of Conduct is intended to prevent destabilizing small arms transfers through a policy of transparency. The problem with the code in its current state, say disarmament advocates, is that the decision to go ahead with any transfers continues to rest with the individual national governments. This leaves room for interpretation, and loopholes according to some analyses. (BASIC Reports No. 64, 4 June 1998).

In addition, the United States House of Representatives also passed its own version of a Code of Conduct concerning conventional weapons transfers. Whether the current version will pass in the Senate depends on which side of the debate is predicting the outcome.

It appears that there are only two organizations involved in the debate opposing and at times openly hostile to these various groups: the National Rifle Association and a relatively new group called the World Forum on the Future of Sport Shooting Activities (WFSA). The latter was initiated by members of the NRA concerned about the direction international efforts in the small arms debate were taking. WFSA members include the NRA, small arms and ammunition manufacturing associations, as well as European and international sport shooting associations. No figures were available on the NRA's investment in its own efforts as a non-governmental organization.

As you can see, disarmament projects are still in their early stages. The international community is only now catching up to the small arms disarmament movement. Governments and international organizations have taken on the task of controlling small arms transfers. The media turns to the disarmament community for information, interpretation and analysis of current events.

Not resting on their laurels, the various disarmament organizations have more in store. Things to look for in the future include:

Greater emphasis on linking legal and illegal transfers. In an attempt to influence public perceptions, they will continue to draw a link between combat and crime with analysis based on the hypothesis that world affairs now make it difficult to distinguish one from the other. Whether governments have made this leap is one question, but clearly these organizations have already done so.

There will be more pressure to include small arms transfers in existing or pending transparency programs. Using the OAS convention as a template they will show that transparency works. They already are calling for governments considering arms trade codes of conduct to incorporate transparency in those regimes.

At some point it is likely you will see representatives from industries involved in trade with the developing world getting involved in the debate. The issue of small arms transfers will be linked with the idea that a transfer leads to instability in a region or country. Instability is the current enemy which has replaced the old Soviet threat. It interferes with international commerce and development programs. The result could be a focus, at a minimum, financial support for small arms disarmament campaigns from major investors in third world development programs. It is in their interest to promote stability however it is being defined.

There will be more calls for additional moratoria similar to the one adopted in West Africa. Although there may be some question as to its effectiveness given the current situation in Guinea-Bissau, the outcome of that conflict and actions of the member states over the next three years will be the real test. Before that time the small arms disarmament community will put increased pressure to implement further moratoria as a means of stopping the trade.

There will be more pressure coming from the grassroots level. The aim will be to continue to galvanize public opinion at the national level to achieve the international goal of a highly regulated and restricted if not out right ban on the small arms trade. Those of you who attended the Eurosatory exhibition in Paris this year may recall the large number of protesters and their belligerent attitude at the front gates of Le Bourget. Compare that to the handful of quiet demonstrators there just two years ago.

Not only has the small arms disarmament community gotten control of the message, they have created an information need, a demand for information in this field. In the process they have established themselves as the sole source of supply for that information. The momentum is in their favor. The overall effect of these campaigns will change the way, perhaps even whether, the small arms industry does business in the future.

UPDATE ON RUSSIAN AND OTHER FOREIGN SMALL ARMS

by

CHARLIE CUTSHAW

Since last year's meeting there have been a number of significant developments in the Russian Small Arms community. Some are within the purview of my friend and colleague Mr. Valery Shilin of Izhmash, JSC. He will address his firm's new products during his presentation. probably most interesting to those here today is the fact that several of the small arms that we have seen only in photos or at arms shows finally were brought to the United States and we were given the opportunity to actually fire them. This was sponsored by the Marine Corps and Guns South, Incorporated (GSI) of Birmingham, Alabama. A report on those weapons follows. I took many photos on the range, but since photos do not reproduce well, I have chosen to use the excellent line drawings of Mr. Lyn Haywood of Security Design & Development, a UK firm. First the report on shooting impressions, then some other new developments of significance.

For several years the Russian firm TsNIITOCHmash has advertised several innovative rifles and pistols for sale on the international arms market, all designed to Russian military and police requirements. The weapons' innovations generated a great deal of interest in the West, but there were

no opportunities to actually fire them until mid-1997, when an agreement was reached between GSI, TsNIITOCHmash and the US government for the firearms to be evaluated by representatives of both government and industry. The weapons include a new high-capacity, high-powered pistol, a pistol that fires silent ammunition, a compact assault rifle, two suppressed rifles and two underwater firearms - a pistol and an assault rifle. There is also what must be the most unusual military knife in history.

The first weapon we will consider is the Gurza pistol, which created quite a stir when it first appeared in 1993. It has a magazine capacity of 18 rounds of a new 9x21mm (Russian nomenclature RG-054) cartridge that delivers terminal ballistic performance in the .357 magnum spectrum. This new cartridge is not the same as the western 9x21mm, which is based on the 9x19mm Parabellum round with performance levels to match. The 9x21mm Russian, as we have designated it to differentiate between it and the Western round, is based on the 9x18mm Makarov case. 9x21mm case head dimensions are identical to those of the 9x18mm in those 9x21mm Russian examples that have been examined by the author. Moreover, the 9x21mm Russian round was designed from the outset to defeat both soft body armor and car bodies. This reflects the crime problem in Russia, where criminals often wear body armor and

drive powerful automobiles. The nose of the 9x21mm Russian bullet has a steel penetrator protruding from the gilding metal jacket. According to Russian literature, this provides a penetration of 30 layers of Kevlar® and two 1.2mm thick titanium plates at a range of 50 meters. There is no reason to doubt this, as the Gurza bullets we fired into National Institute of Justice (NIJ) Level IIIA (.44 Magnum protection level) body armor at 50 meters during the tests were cleanly penetrated with the bullet passing deep into a heavy rubber mannequin over which the protective vest was placed.

The Gurza pistol itself is a curious design. Unlike other modern pistols whose frame is made entirely of polymer, the Gurza uses polymer only for the grip and trigger guard. The upper portion of the frame is constructed of steel. The boundary between the polymer lower and steel upper portion of the frame can clearly be seen in the accompanying photographs. Another unusual feature of the Gurza is its trigger action. The pistol uses a conventional external hammer, but the Gurza is not double/ single action as appearances would indicate. When the hammer of the Gurza is fully down, the trigger is completely disengaged from the sear mechanism. Placing the hammer in a half cock position actuates the trigger into "double action" mode where pulling the trigger brings the hammer to full cock and then drops it, firing the weapon. The

firing mechanism operates in single action (hammer cocked) on subsequent shots. The single action operation of the Gurza would be unacceptable to any Western military or police organization, as trigger pull in this mode is no more than 1.5 to two pounds with no take-up whatsoever! I was the first American to fire the Gurza and after my first double-action shot was caught totally by surprise by the light weight and sensitivity of the Gurza's single-action trigger, resulting in the pistol firing the moment my finger touched the trigger, causing the shot to miss the target. I was able to control the trigger for subsequent shots, but the trigger of this pistol is entirely too light for operational use by Western military or police. When asked about this, TsNIITOCHmash representatives stated that the light trigger pull was a requirement from the unspecified agency which originally requested the Gurza.

The Gurza has no external safety mechanisms other than a grip safety, visible at the upper portion of the pistol's backstrap and the trigger disconnector when the hammer is fully down. It is not known if there is a firing pin block. Locking is based on the "dropping block" principle as used in the Walther P38/P1 and in the Beretta Model 92 series. The magazine release is ambidextrous and releases by pressing forward with the thumb. When the release is pressed, the

magazine drops free. There were no stoppages whatsoever while the Gurza was fired hundreds of times by numerous attendees. In fact, reliability characterized all the weapons brought by TsNIITOCHmash. None had a single stoppage. The polymer grip of the Gurza is at a comfortable angle which appears to be close to that of the Colt M1911, considered by many to be nearly ideal. This writer found the pistol to be easy to control and muzzle rise to be quite manageable, despite the high - velocity cartridges. The only serious complaint about the Gurza is its single action trigger mechanism, which is so unusual as to be considered bizarre by virtually all present and categorically unsafe in single action mode.

Other than its ammunition, the PSS pistol brought for test by TsNIITOCHmash is a conventional blowback operated semiautomatic pistol. The PSS was designed to a special operations requirement and is unique in that fires a silent (not suppressed) cartridge. The only sound to be heard when the PSS is fired is the movement of the slide back and forth. It is odd in a pistol of this type that there is no means of locking the slide in place so that the sound of its movement is eliminated. Even with the movement of the slide, the sound level of the PSS approximates that of an air gun.

The PSS fires the SP-4 silent cartridge developed especially for it and the NRS-2 "Special Scout Knife"

described below. The captive piston technology involved in this unusual cartridge is not new; it was used during the Vietnam War for silent revolvers employed by American "tunnel rats." The silent cartridge eliminates both the weapon's muzzle blast and the bulky silencer "can" usually associated with suppressed weapons and allows the PSS to be a very compact pistol. The SP-4 cartridge piston propels a simple steel cylindrical bullet with a copper rotating band down the rifled barrel of the PSS. The piston's forward motion is stopped against the internal shoulder of the thick cartridge case, sealing the propelling gases inside. They are slowly and silently bled off. SP-4 casings examined by the author have no headstamp to identify their origin, although given the publicity attained by the weapons that fire the SP-4 cartridge, there can be little doubt as to the origins of such unusual cartridges.

The compact size of the PSS and its ability to fire in silence without requiring an external suppressor make it ideal for special operations missions. The pistol is also well - suited for police SWAT work where minimum noise levels are required. The PSS is easily concealable in a jacket pocket or in the issued shoulder holster that accompanies each pistol in its factory box. The PSS utilizes a steel frame, with polymer grips which also constitute the lower frame. There is no

conventional gripstock as in most Western designs. Operation of the PSS is straight blowback. There is a Makarov-style safety on the slide and functioning is similar to that of the Makarov. There are no unusual trigger mechanisms as with the Gurza. The PSS is pleasant to shoot, with little felt recoil and although TsNIITOCHmash claims an effective range of 50 meters, that is questionable given the subsonic velocity of the cylindrical steel bullet fired from the SP-4 cartridge, which is also fairly lightweight and has abysmal aerodynamics. This, coupled with a very short barrel length, does not indicate an effective range much greater than the distance which the PSS was fired during our evaluation - some 25 meters. Nonetheless, the PSS is a very effective pistol for its intended purpose of close range shooting in military special operations or police SWAT missions. Its lack of muzzle blast would also make it ideal for use in confined spaces.

The MA "*Vikhr*" Compact Assault Rifle is occasionally referred to in the Western press as a submachine gun, but this is not the case; a submachine gun by definition fires pistol cartridges, while the MA fires a "intermediate" caliber cartridge, the 9x39mm SP-5 and SP-6. Both of these "special" cartridges are derived from the venerable 7.62x39mm and fire a massive 250 grain bullet of great sectional density at subsonic velocity. The lead cored SP-5 is a full metal jacket

(FMJ) "ball" round, while the SP-6, with its steel penetrator, is armor-piercing. The MA is one of several recent Russian weapons that fire this new and apparently very effective round. Two of these, the AS suppressed assault rifle and the VSS suppressed sniper rifle were also tested during the TsNIITOCHmash visit and are discussed below. We will discuss effectiveness of the SP-6 round in more detail under the section on the AS and VSS.

The MA is a gas - operated compact assault rifle derived from the basic Kalashnikov, but with significant differences. (We should note that the A-91, a very similar compact assault rifle in 9x39mm and other calibers, is manufactured by Tula KBP.) The MA's selector lever, for example, is ambidextrous and has been moved to a position at the rear of and above the trigger guard where it can be manipulated by the operator without removing his hand from the grip. The receiver cover similar to that of the AKS-74U in that it is not detached when field stripping the weapon; when released, the cover pivots up at the front just behind the rear sight for access to the operating components. A major difference between the MA and similar weapons is that the MA is striker fired, rather than using a hammer. The design is otherwise conventional and follows the Kalashnikov AK-100 pattern, using primarily stamped metal and polymer components. The compensator at the

front of the barrel enables control to be maintained while firing on full automatic. The MA has no burst feature.

The ammunition is a critical component of the MA system. A conventional compact assault rifle firing 5.56x45mm NATO ammunition would have an unacceptable muzzle blast without a muzzle compensator because that cartridge's powder charge is designed to be consumed in a much longer barrel. The 5.56x45mm is also supersonic, which adds a sharp "crack" to the muzzle blast. The heavy subsonic bullet fired by the MA and other weapons in 9x39mm caliber eliminates this problem. Muzzle blast is reduced by lowering the powder charge to a level where it is consumed in the short barrel of not only the MA, but in the two suppressed assault weapons discussed below. Terminal effects are maintained by the heavy, high sectional density 250 grain bullet. The MA is not intended for long range work; its maximum effective range is only 200 meters, but this is significantly higher than pistol - caliber submachine guns, and is well within the range of most battlefield encounters and the MA is ideal for CQB use. At typical CQB ranges, the 9x39mm bullet would far surpass pistol caliber weapons in terminal effects. Magazines are of translucent polymer construction and are available in either 10 or 20 round versions, although efficacy of a 10 round

magazine in a weapon such as the MA is questionable. Like the other weapons demonstrated, the MA functioned flawlessly.

Because of their similarities, we will treat the VSS *"Vintorez"* (Thread Cutter) suppressed sniper rifle and AS *"Val"* (Rampart) suppressed assault rifle as one. The primary difference between the two is the furniture; the mechanism and functioning of both rifles are identical. Both rifles fire the 9x39mm round. The primary round for the VSS is the SP-5 FMJ due to its increased accuracy over the SP-6 AP. Conversely, the SP-6 is favored for use in the AS assault rifle, because of its better terminal ballistics. On the range, however, we fired SP-6 rounds from the VSS and were able to penetrate both sides of a US PASGT helmet at 150 meters, although the first shot missed. Using a magazine loaded with SP-5 FMJ rounds in the VSS, however, the author was able to hit several eight inch (203mm) steel targets at 150 and 200 meters with every shot. The claimed effective range of the VSS is 400 meters.

Like many similar Russian weapons, the AS and VSS were derived from the Kalashnikov, but with differences. The basic mechanism of both rifles is essentially that of the MA *"Vikhr"* described above. The only difference of note is the Kalashnikov-style selector switch on both the VSS and AS. Both rifles are select fire, and both are designed to be fired only with the suppressor installed. The trigger pull of both

rifles has extremely long take-up, a fairly crisp "break," but with significant backlash.

The suppressor is of the "dry" type, and although we were not allowed to disassemble it, certain inferences may be derived from our experiences with the rifles and from Russian publications on the subject. During our tests, several hundred rounds were fired through both the AS and VSS, both semi and full automatic, with no apparent degradation in suppressor effectiveness. The oil on the surface of the suppressors was literally burning off, but the suppressors remained effective. Illustrations of these suppressors in Russian small arms publications have shown them disassembled with angled baffles, but no "wipes" or other material to enhance sound suppression. The baffles are removed as a unit and are held in proper alignment by metal strips running the length of the baffle unit. A full analysis of the suppressors used by these rifles will have to wait until we have full and unlimited access to them.

Two weapons that have attracted a great deal of attention in the West are the SPP-1 underwater pistol and the APS underwater assault rifle. Save for the Heckler and Koch P11 underwater pistol, the Russian weapons are unique. Although comparisons are invidious, when one is dealing with weapons such as these, they are unavoidable, so we feel obliged to

briefly compare the H&K P11 and its Russian SPP-1 counterpart. Space does not allow a full comparison, but suffice it to say that based on available data, the capabilities of the two weapons are virtually identical, although the SPP-1 can be reloaded by the user with clips of four rounds while the P11 barrel unit must be returned to the factory for reloading. The P11 is fired electronically, while the SPP-1 uses a simple rotating firing pin similar to that of the 1874 Sharps four-barreled derringer. The H&K pistol has five shots rather than four, but given its cost and complexity, the Russian pistol appears to be a more cost effective and reliable design which may find acceptance in the Western special operations community once barriers to importation are overcome.

The APS underwater assault rifle, like the other weapons discussed herein, was derived from the Kalashnikov, but in its final form is significantly different from the original. The APS entered Soviet service in the early 1980's, but did not become known in the West until some ten years later and then only because the Russians began advertising it for sale. The APS rifle and PSS pistol both fire "darts" which are stabilized by the cavitation of water as they pass through it, rather than by spinning. Both weapons, therefore, are smoothbore. The APS rifle is gas operated, select fire and fires from the open bolt. The latter is due to that fact that

the barrel must be filled with water when the weapon is fired and firing from the open bolt is the only way to accomplish this. The fit and finish of the APS we examined was crude, although the weapon functioned flawlessly when fired. The SPP-1 pistol appears less crude, but still not up to Western standards, although it should be noted that Russian firearms manufacturers do not generally finish their military weapons to a particularly high standard.

We were not afforded the opportunity to fire the SPP-1 underwater pistol nor APS underwater rifle because to do so would have involved putting several dozen persons of varying firearms handling ability underwater with loaded weapons. Live firing was thus limited to two military divers who fired both weapons at underwater targets. Both weapons performed flawlessly and hit and penetrated the targets. It would appear that both of these weapons merit a complete evaluation by police and military forces who have a requirement for such items, as they fulfill unique requirements.

The final item we were allowed to observe, but not test fire, was the NRS-2 Special Scout Knife," which seems to be the answer to a question that nobody asked! The reason that none of the attendees was allowed to fire the NRS-2, was that the user must be very careful when firing it not to shoot off his fingertips! The NRS-2 fires one SP-4 silent cartridge,

but the position that must be used to fire the knife is such that it cannot be accurate at anything other than pointblank range, and it takes so long to get the NRS-2 properly positioned in one's hand to preclude losing one's fingers that it would appear to be far better to simply carry a PSS silent pistol and use the sharp end of the knife if one were to encounter close-in threats. Space precludes describing the loading and reloading procedures for the NRS-2, but suffice it to say that they are not conducive to rapid fire.

TsNIITOCHmash has developed a family of small arms which should be of great interest to military and police special operations users. With the exception of the bizarre NRS-2 "Special Scout Knife" and the excessively light trigger pull of the Gurza pistol, which could easily be corrected, all of the weapons appear to be well-designed, robust and reliable. These weapons are currently unavailable in the West, but it is possible that export may begin in 1998 with firearms and ammunition available to qualified military and police users.

TULA KBP

Tula KBP is one of the "big three" Russian small arms producers, but like the others, also produces many other items. Tula, for example also produces armored fighting vehicles, while Izhmash makes automobiles and TsNIITOCHmash

makes electroptics. All three companies are quite diverse in their product lines, but our concern is small arms. Tula KBP had a contingent at this years SHOT Show and in their "back room" had information on military small arms that were not on display to the general audience. One of these items was an astonishing new assault rifle, the A-91M.

Tula representatives were reluctant to discuss details of the rifle with the author other than to state that it is not yet in full production. The A-91M, despite its designation, bears little resemblance to the A-91 compact assault rifle also manufactured by Tula KBP. It is not a simply bullpup version of the earlier rifle. Moreover, while the A-91M is similar in appearance to the Kalashnikov family, it is not a Kalashnikov or one of its derivatives with bullpup furniture, as are the Armenian K-3, the Chinese Type 86, The Tula OTs-14 "*Groza,*" and the recently announced South African CR-21.

Despite being manufactured by the same Russian firm that produces the OTs-14, which is truly a Kalashnikov - derived bullpup, the A-91M is apparently quite different. One indication that the A-91M is different is the lack of an obvious ejection port. The sole opening in the upper receiver is a small oval hole just to the right of and beneath the rifle's carrying handle. This small aperture is the ejection port; spent casings are ejected straight forward, not to the

side or downwards as is the case with most other rifles. When the bolt is forward and the magazine inserted, the rifle's receiver is completely closed, thereby minimizing the opportunity for entry of dust and foreign matter into the rifle's operating parts. Even with the bolt to the rear, the ejection port is so small that the receiver of the A-91M is still virtually a closed system as long as a magazine is in place. The gas system of the A-91M appears somewhat different than that of Kalashnikov derived weapons. The gas block itself is completely different, but whether the A-91M uses a Kalashnikov-type bolt carrier and operating rod as do most other Russian designed gas - operated rifles remains to be seen. All furniture is polymer. The nonreciprocating charging handle is located at the left front of the carrying handle and can be pivoted up or down at the shooter's discretion. The barrel of the A-91M appears to be located below the line of recoil forces, which will probably make it highly controllable in fully automatic mode by minimizing muzzle rise. The flash suppressor is a western - style "birdcage, " rather than a typical Russian suppressor. The selector lever is similar in shape and function to that of Kalashnikov weapons, but is in a different location. Since Tula claims that the A-91M is intended to be fully ambidextrous, there is probably a mirror image selector on the

left side of the receiver. The only Kalashnikov component that appears to be shared by the A-91M is the magazine, which may be either steel or polymer.

Although the designation of the A-91M would indicate that it is derived from the A-91 compact assault rifle, this is open to question, given the functioning and overall design of the A-91M, which appears to be significantly different than the A-91. If the A-91M was, indeed, derived from the A-91, it has been extensively modified. The A-91 is a very conventional small, gas-operated assault rifle that ejects to the right from a Kalashnikov-type ejection port. In concept, it is virtually identical to the MA *Vikhr* discussed above, except that the A-91 is available in four different calibers - 5.45x39mm, 5.56x45mm, 7.62x39mm and 9x39mm. (See drawing.)

The A-91M mounts a new 40mm grenade launcher designated the GP-97 above the barrel. The rear mount of the GP-97 mates to a large boss at the base of the front sight post. The grenade launcher's forward mount probably clamps to the barrel at the enlarged portion midway between the forearm and flash suppressor. In available photos, the GP-97 appears to be offset slightly to the right with its trigger located against the forward pistol grip where it can be easily be manipulated by either right or left handed shooters. The GP-97 appears to be essentially an inverted GP-95 grenade launcher with the

trigger mechanism and mounting system relocated for positioning above, rather than beneath, the rifle barrel. The GP-97 fires standard VOG-25 and VOG-25P 40mm grenades to a range of 400 meters. The A-91M also can fire muzzle - launched projected grenades. Whether the flash suppressor is standard NATO configuration is not known, but it appears to be very close dimensionally to the 22mm NATO standard.

Because the A-91M only recently became known in the west and none have been made available for evaluation, technical details of this new rifle are lacking. Why Tula chose to chamber the rifle only in 7.62x39mm is a mystery. The OTs-14 *Groza* for military use is chambered in this caliber rather than 5.45x39mm, so the A-91M may be intended for use by special army units. Nonetheless, any rifle chambered in 7.62x39mm can easily be redesigned to fire 5.45x39mm, 9x39mm, or 5.56x45mm. If Tula is serious about marketing the A-91M outside Russia, they will soon introduce it in alternative calibers. On the whole, from what can be deduced from available photos and the little information provided by Tula KBP, the A-91M appears to be a generally well-designed and executed bullpup rifle. Whether or not it will be viable in the world's highly competitive small arms market remains to be seen.

CHINA

Another new rifle and associated light machine gun has been introduced by the Chinese. These weapons have been under development for some time, but were unknown in the west until China reclaimed Hong Kong in 1997, when Chinese troops arriving there to take over from the British were equipped with them. Despite the fact that their troops were openly shown with these two new weapons, the Chinese military has released little information on them. The Chinese have not announced the model designation of the new weapons, nor has there been an explanation as to why the developers chose to chamber the weapons in 5.8mm, rather than a more common chambering. A partial explanation came from an article in the Chinese press which stated that while the bullet diameter of the 5.8 is greater than that of the military small arms of other nations, the overall cartridge weight is not appreciably greater, so that soldiers can carry the same amounts of ammunition. At the same time, the muzzle velocity of the 5.8 bullet is essentially the same as that of western military cartridges, implying that the ballistic coefficient and sectional density of the new Chinese round is greater than that of western military ammunition. The Chinese have not even publicly announced the cartridge case length, although some sources have stated that the cartridge is 5.8x42mm.

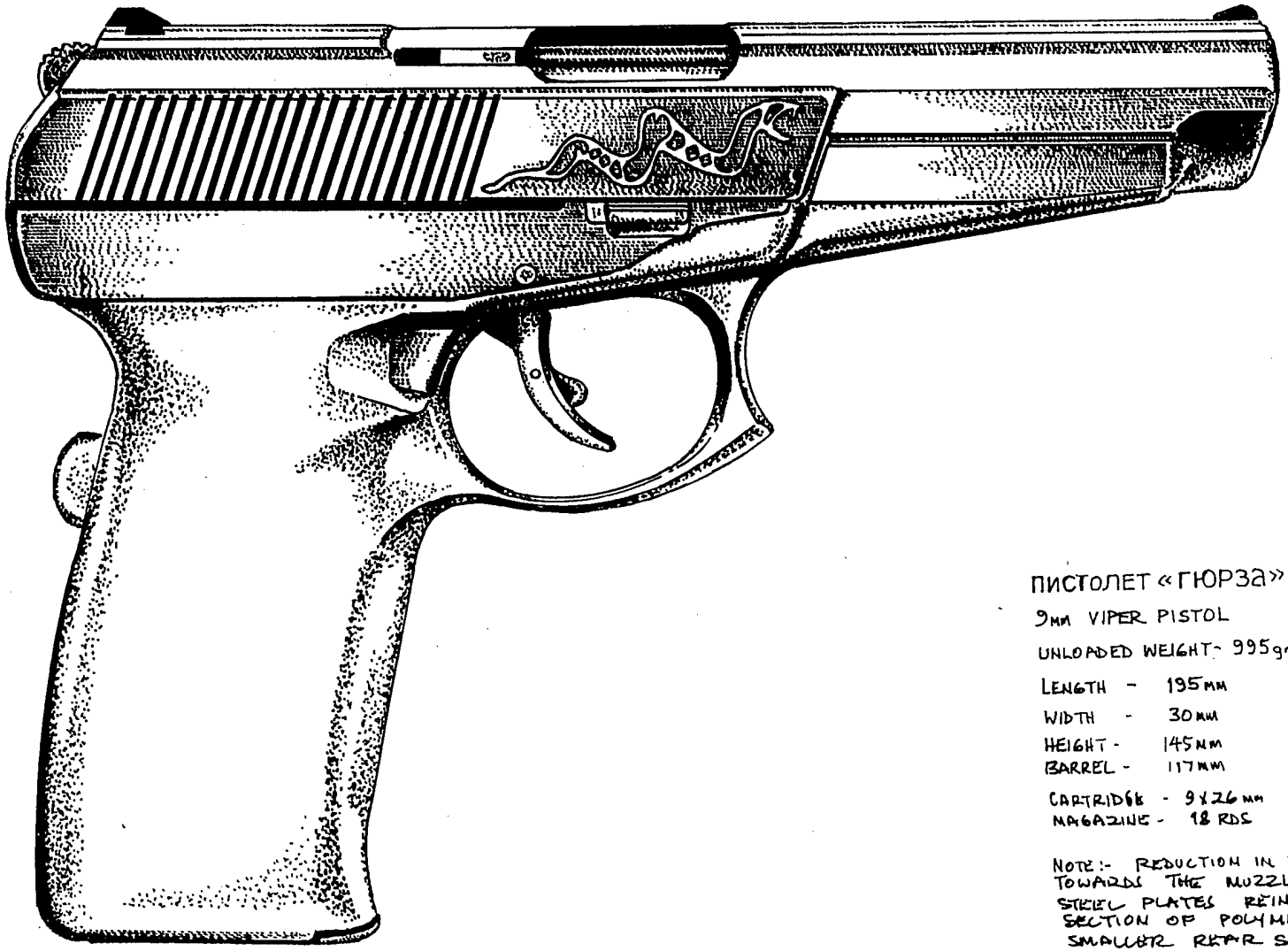
Both weapons are gas-operated, select fire and feed from either a 30 round polymer magazine or 75 round drum. Both apparently fire from the closed bolt. From limited information in the Chinese press, the barrel of the light machine gun is probably not of the quick change type. Iron sights are protected blade front and aperture rear, adjustable for windage and elevation. In addition, there are daylight and low light optical sights for the new weapons, both 3x. The rifle can fire muzzle launched grenades and there is also provision for a underbarrel grenade launcher.

There is a high degree of parts interchangability between the two weapons. In fact, the only significant difference between the two is the heavier barrel of the light machine gun. The weapons appear to be of modern design, making extensive use of state of the art materials such as polymers and lightweight metal stampings and extrusions. According to Chinese press articles, the new Chinese weapons achieve greater reliability than Kalashnikov firearms, but this is unsubstantiated.

Technical Specifications

	Rifle	LMG
Caliber	5.8x42mm (est)	5.8x42mm (est)
Operation	Gas	Gas
Weight	3.25kg (7.15lb)	3.95kg (8.69lb)
Length	746mm (29.3in)	840mm (33in)
Feed	Detachable box Magazine, 30/75 rounds	Detachable box Magazine, 30/75 rounds

The End.



ПИСТОЛЕТ «ГЮРЗА»

9мм VIPER PISTOL

UNLOADED WEIGHT- 995gm

LENGTH - 195mm

WIDTH - 30mm

HEIGHT - 145mm

BARREL - 117mm

CARTRIDGE - 9x26mm

MAGAZINE - 18 RDS

NOTE:- REDUCTION IN PISTOL WIDTH TOWARDS THE MUZZLE
STEEL PLATES REINFORCING TOP SECTION OF POLYMER GRIP
SMALLER REAR SIGHT
VIPER LOGO (IN GOLD ON SLIDE)

From photograph in Russian ОРУЖИЕ mag. (weapon) V.14 NO 15



САМОЗАРЯДНЫЙ ПИСТОЛЕТ ПСС (6-П-28)

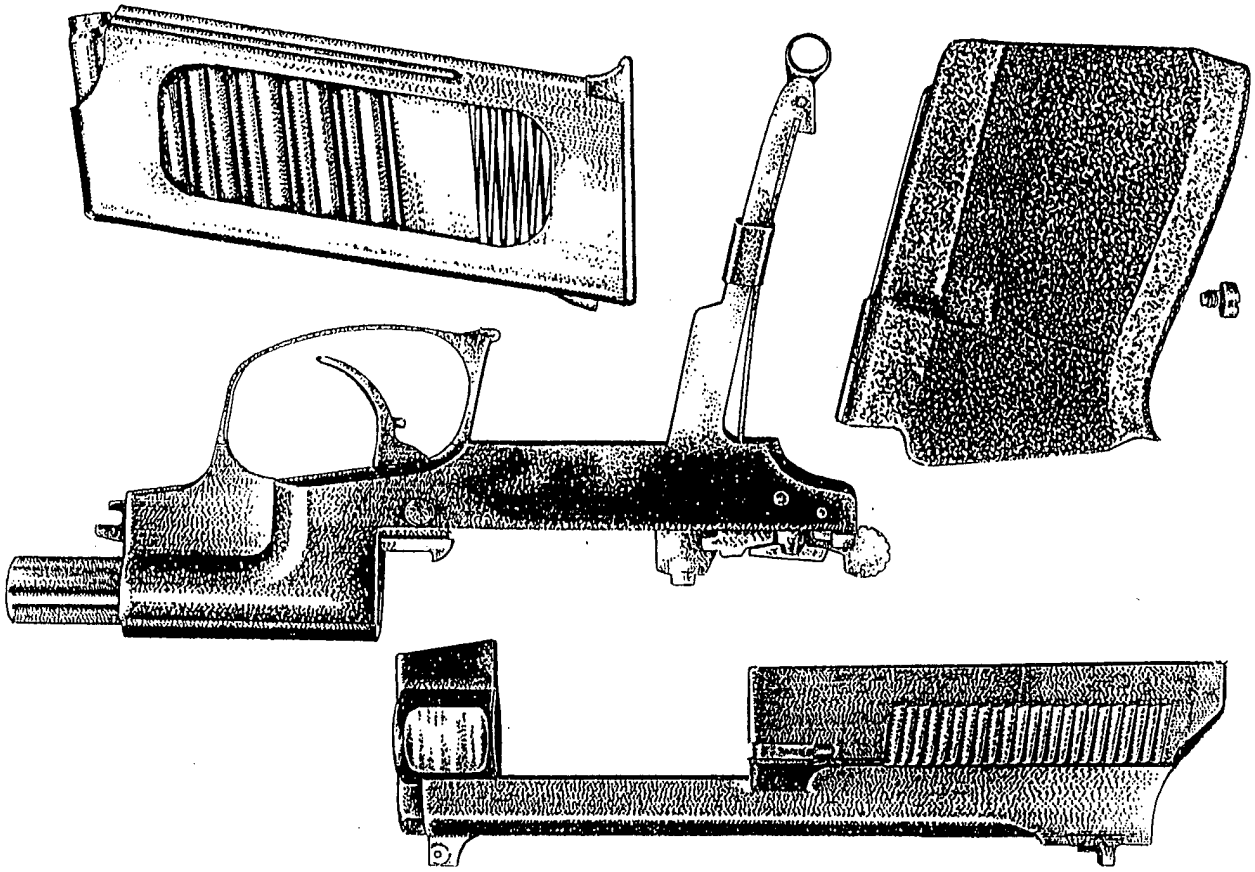
SELF DEFENSE PISTOL PSS (6-P-28)

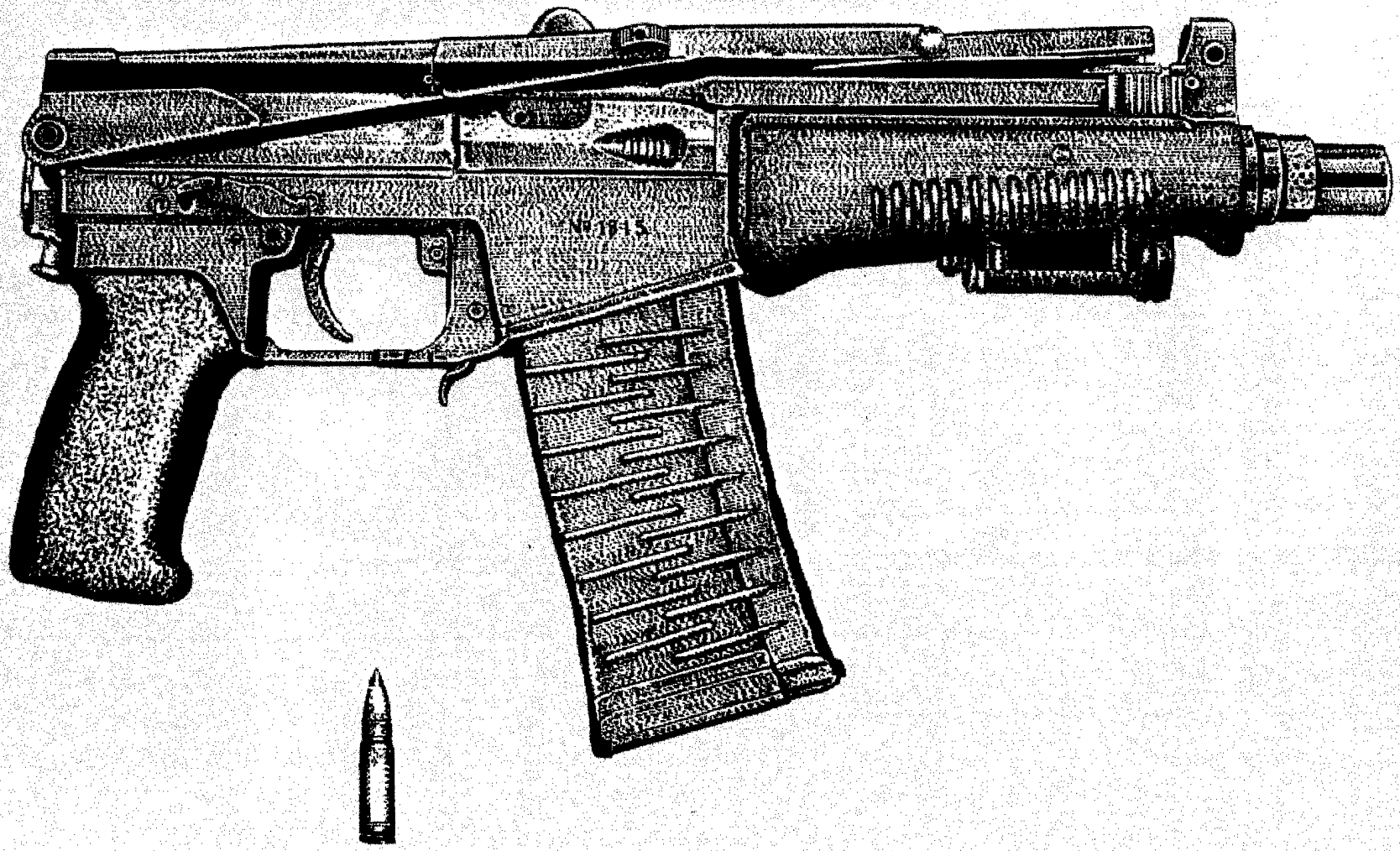
CALIBRE:	7.62мм СП-4 (SP-4)
WEIGHT WITH MAGAZINE:	0.85 kg
LENGTH:	170мм
HEIGHT:	140мм
WIDTH:	26мм
SIGHT RADIUS:	130мм
EFFECTIVE RANGE:	25M
SHOTS PER MINUTE:	6-8
MAGAZINE CAPACITY:	6 ROUNDS

ВУЛ - VUL VOLCANO

Full Size

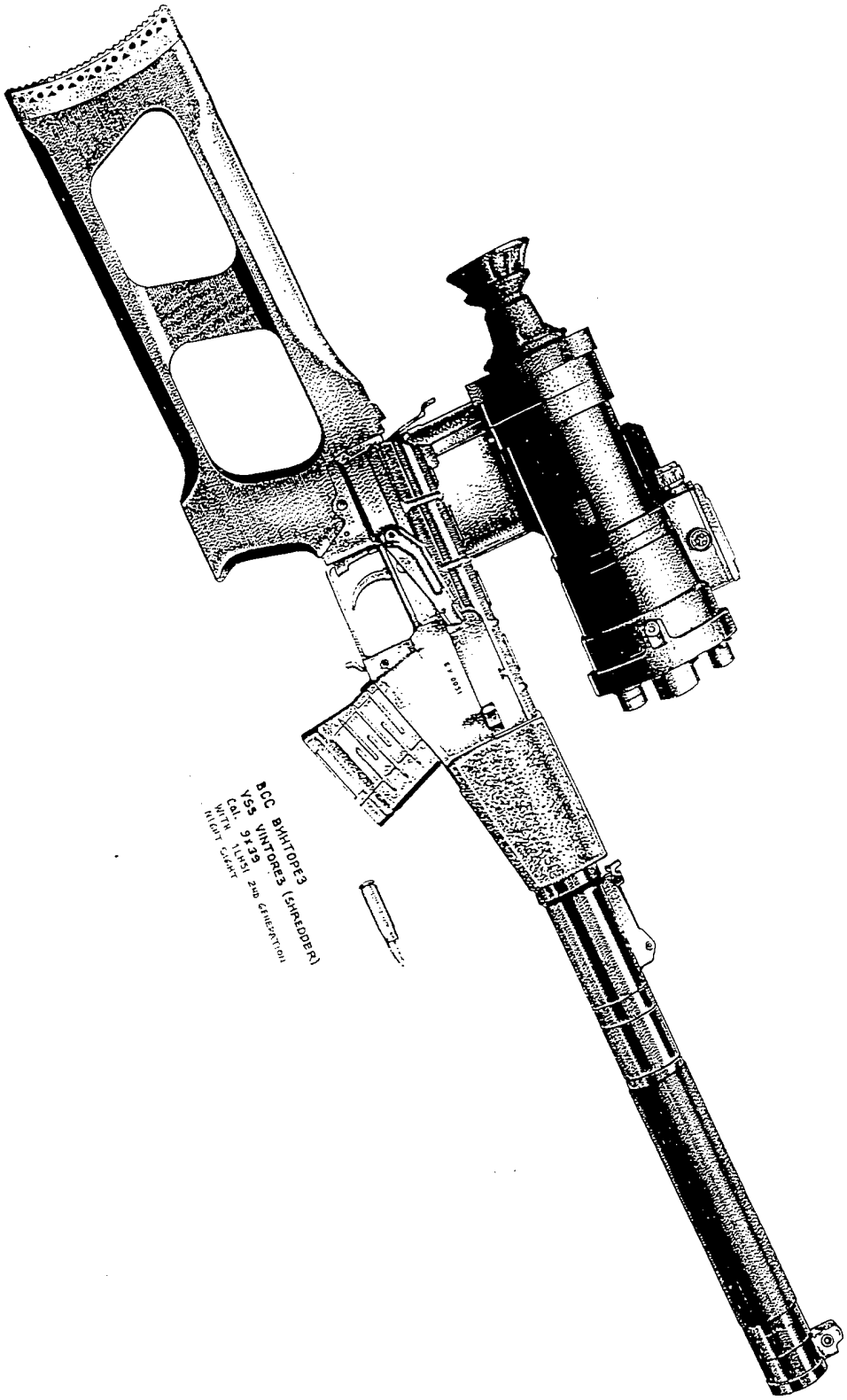
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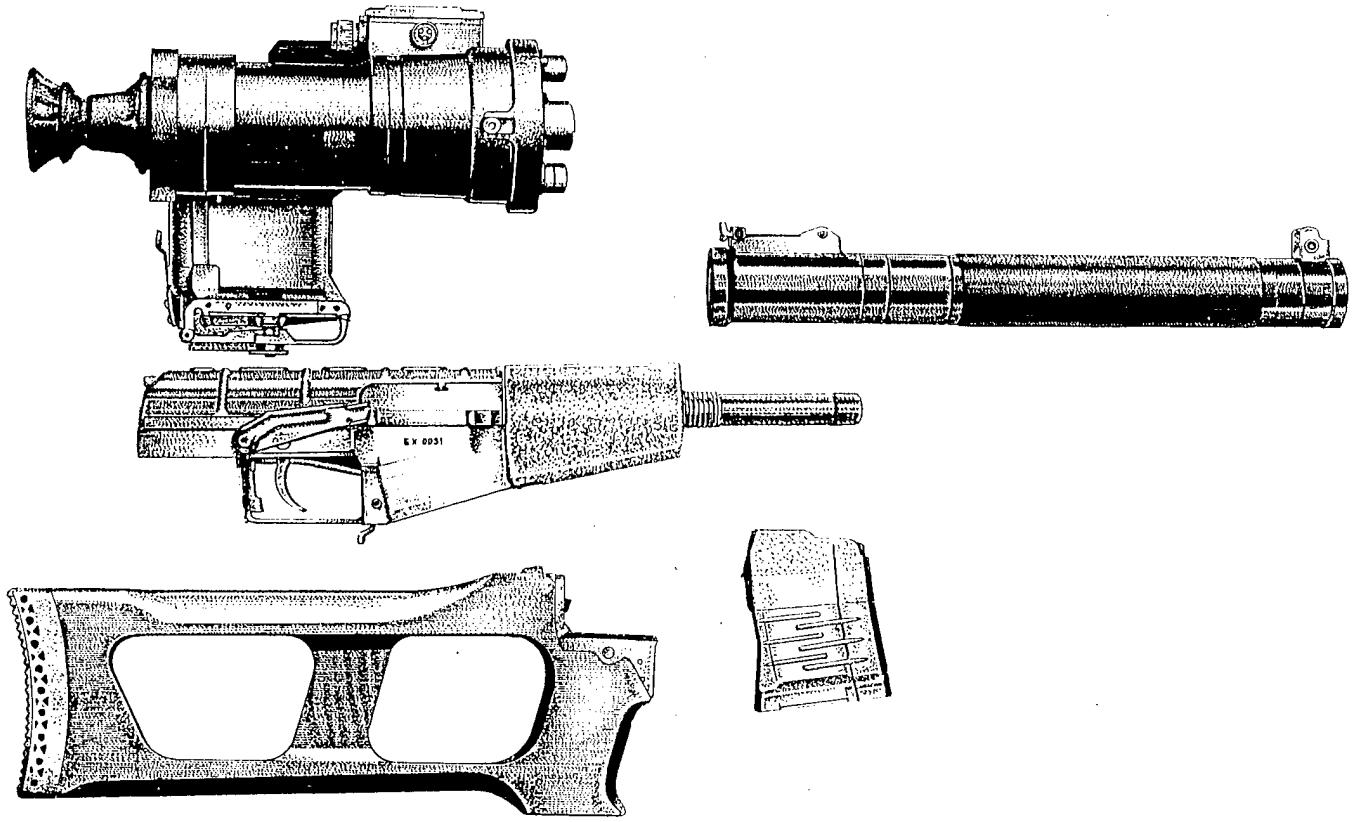


VIKHR MINIATURE ASSAULT RIFLE 9 x 39AS CARTRIDGE

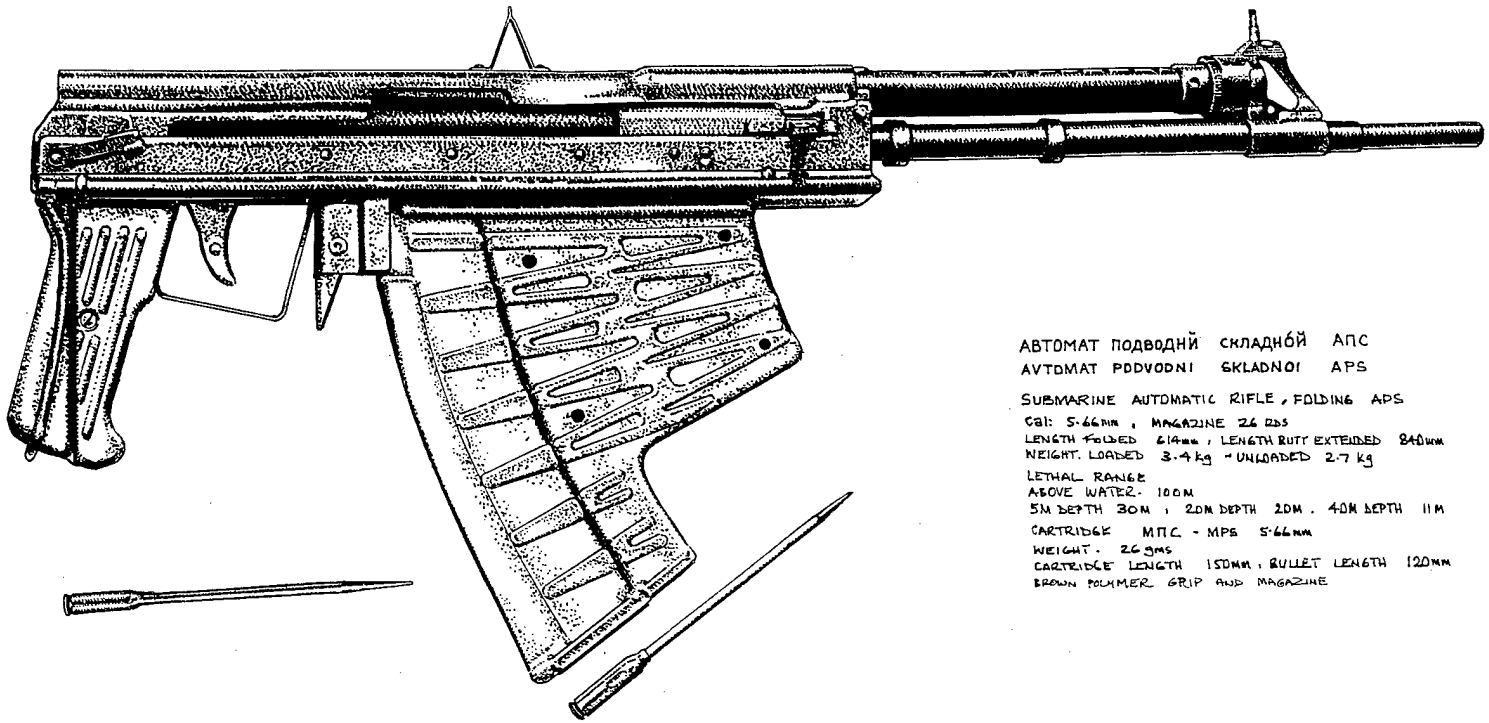
'ВИХРЬ' - WHIRLWIND



BCC BYHITOPE3
VSS VINTOREZ (SHREDDER)
Cal. 9x39
WITH 1LH51 2nd GENERATION
NIGHT SIGHT



V55 TAKEN DOWN FOR DISCRETE TRANSPORT

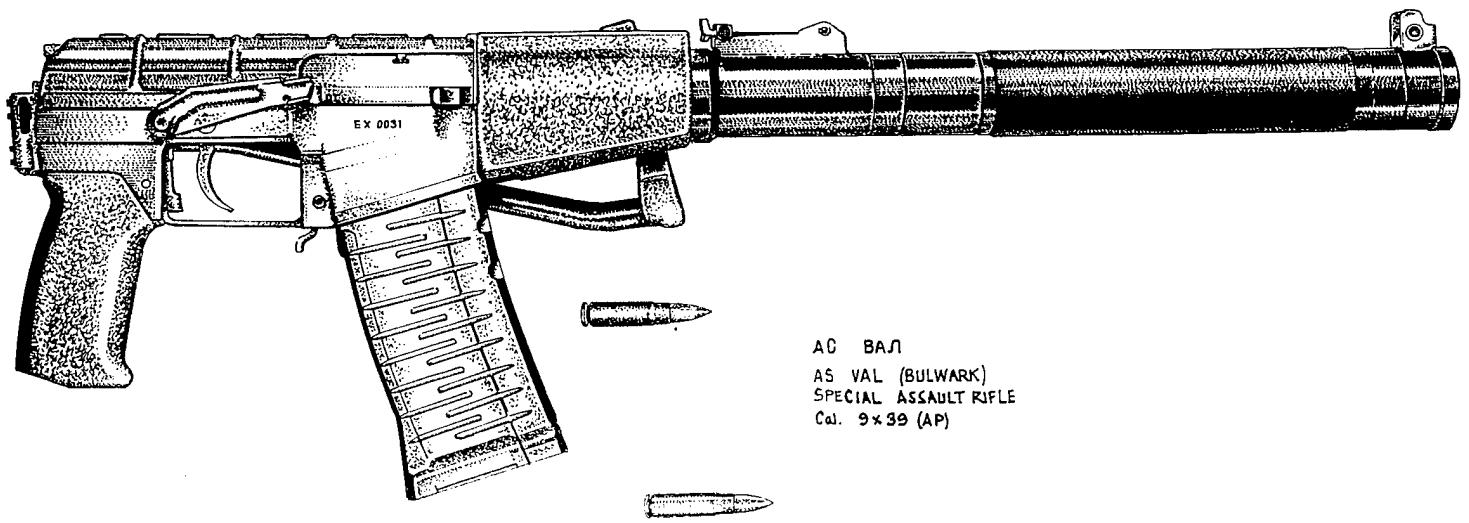


АВТОМАТ ПОДВОДНЙ СКЛАДНÓЙ АПС
AVTOMAT PODVODNI SKLADNOI APS

SUBMARINE AUTOMATIC RIFLE, FOLDING APS

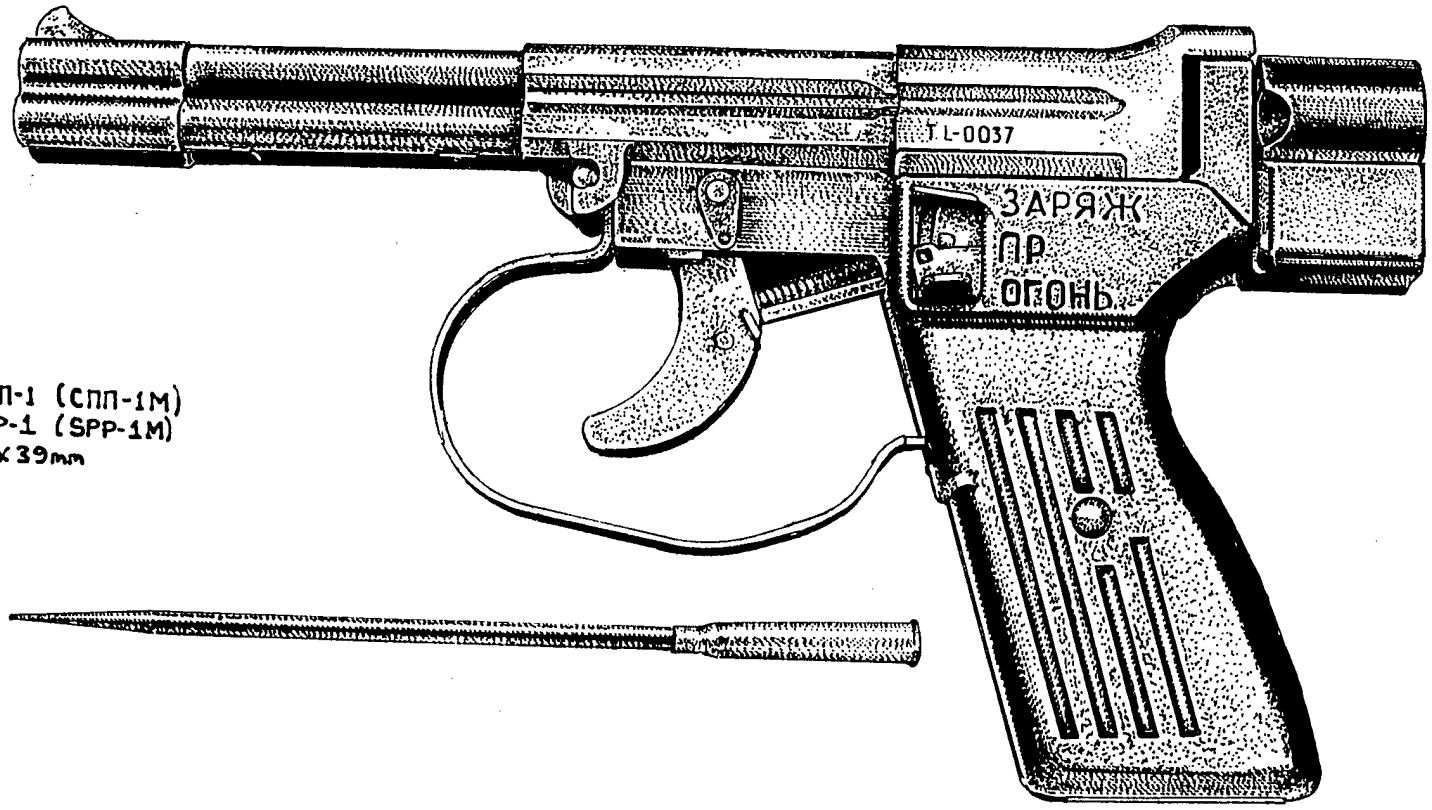
Cal: 5·66mm, MAGAZINE 26 rds
LENGTH FOLDED 614mm, LENGTH BUTT EXTENDED 840mm
WEIGHT. LOADED 3·4 kg - UNLOADED 2·7 kg
LETHAL RANGE
ABOVE WATER. 100M
5M DEPTH 30M, 20M DEPTH 20M. 40M DEPTH 11M
CARTRIDGE МПС - MPS 5·66mm
WEIGHT. 26 gms
CARTRIDGE LENGTH 150mm, BULLET LENGTH 120mm
BROWN POLYMER GRIP AND MAGAZINE

86

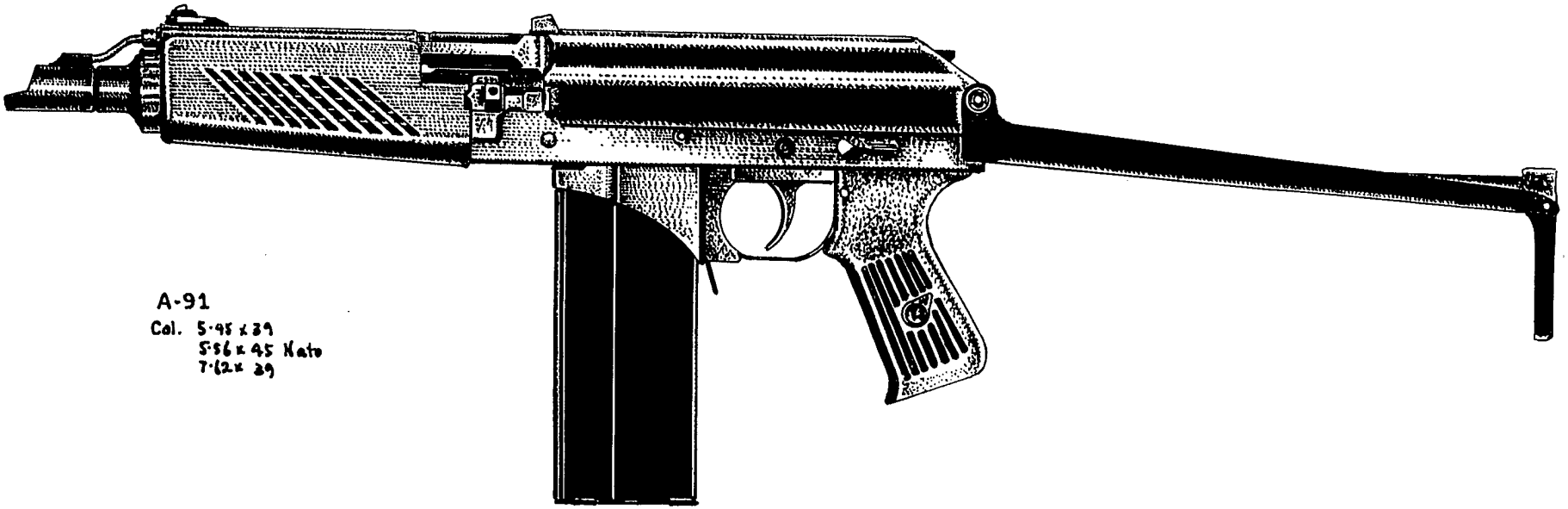


АС ВАЛ
AS VAL (BULWARK)
SPECIAL ASSAULT RIFLE
Cal. 9×39 (AP)

73

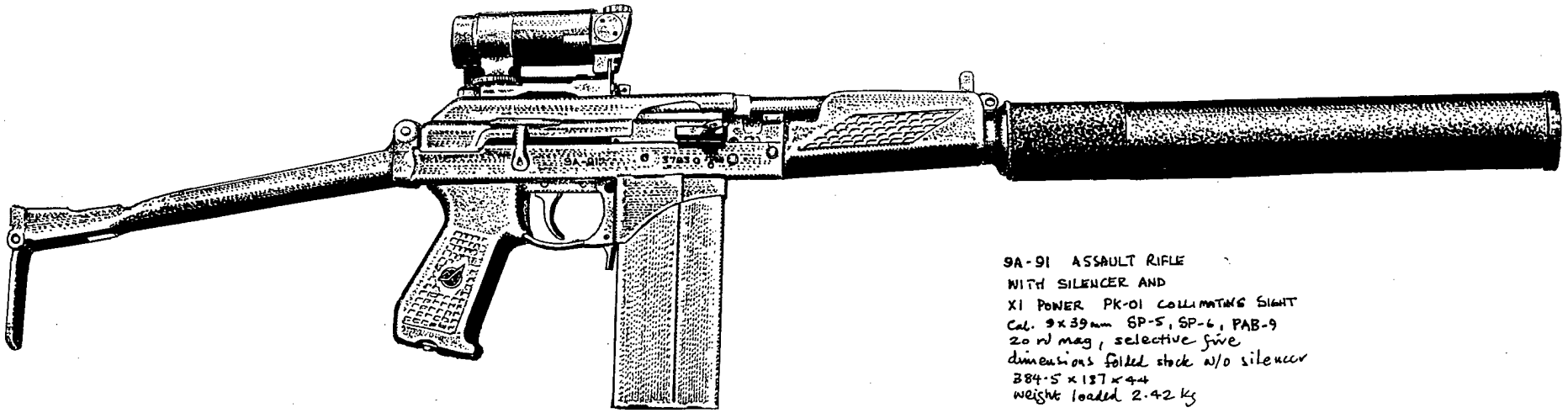


СПС - СПП-1 (СПП-1М)
SPS - SPP-1 (SPP-1M)
Cal: 4.5 x 39mm



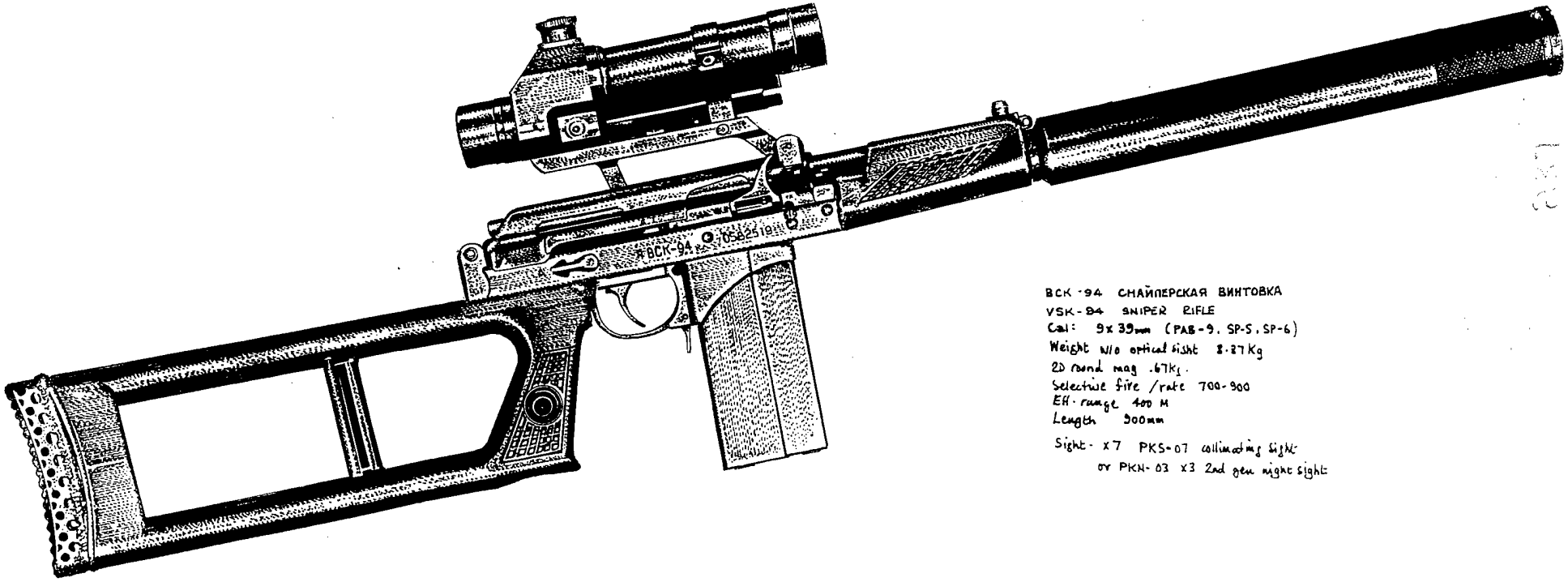
A-91

Cal. 5·45 x 39
5·56 x 45 Nato
7·62 x 39

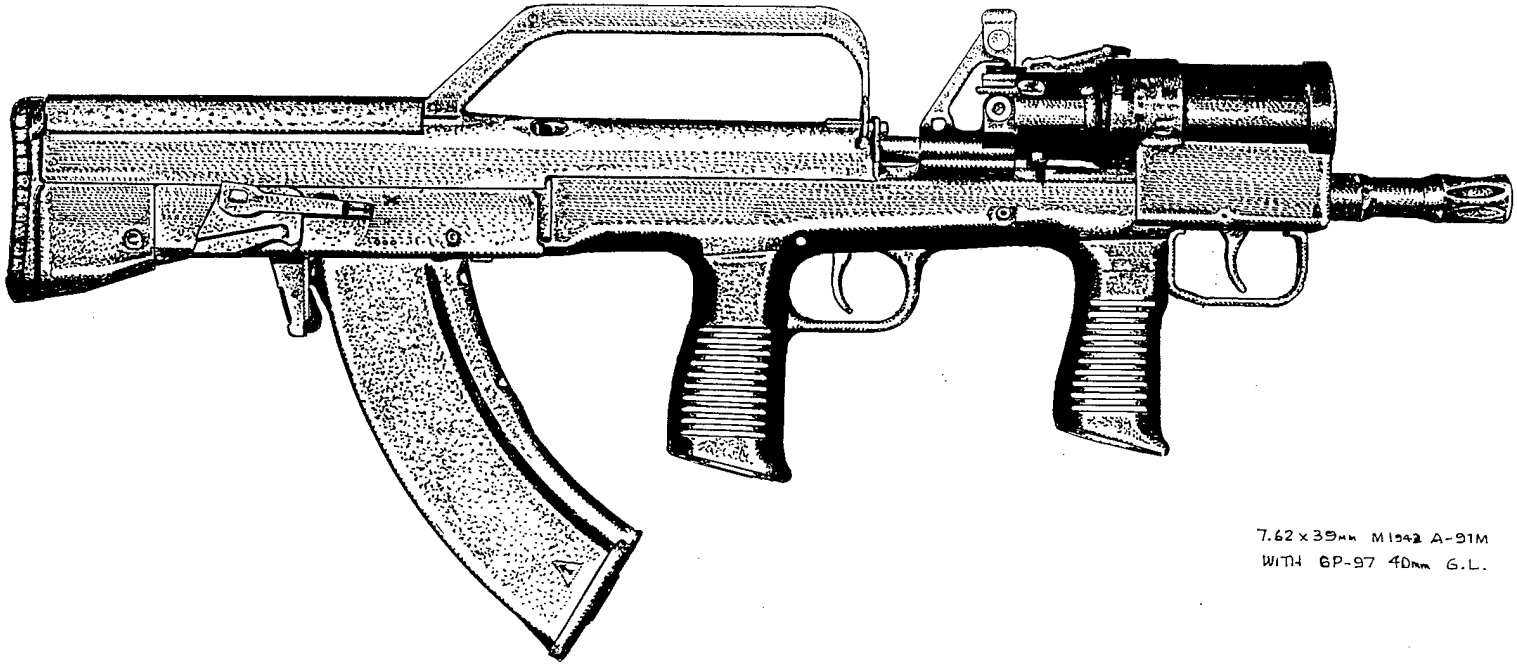


9A-91 ASSAULT RIFLE
WITH SILENCER AND
X1 POWER PK-01 COLLIMATING SIGHT
Cal. 9x39mm SP-5, SP-6, PAB-9
20 rd mag, selective fire
dimensions folded stock w/o silencer
384·5 x 137 x 44
weight loaded 2.42 kg

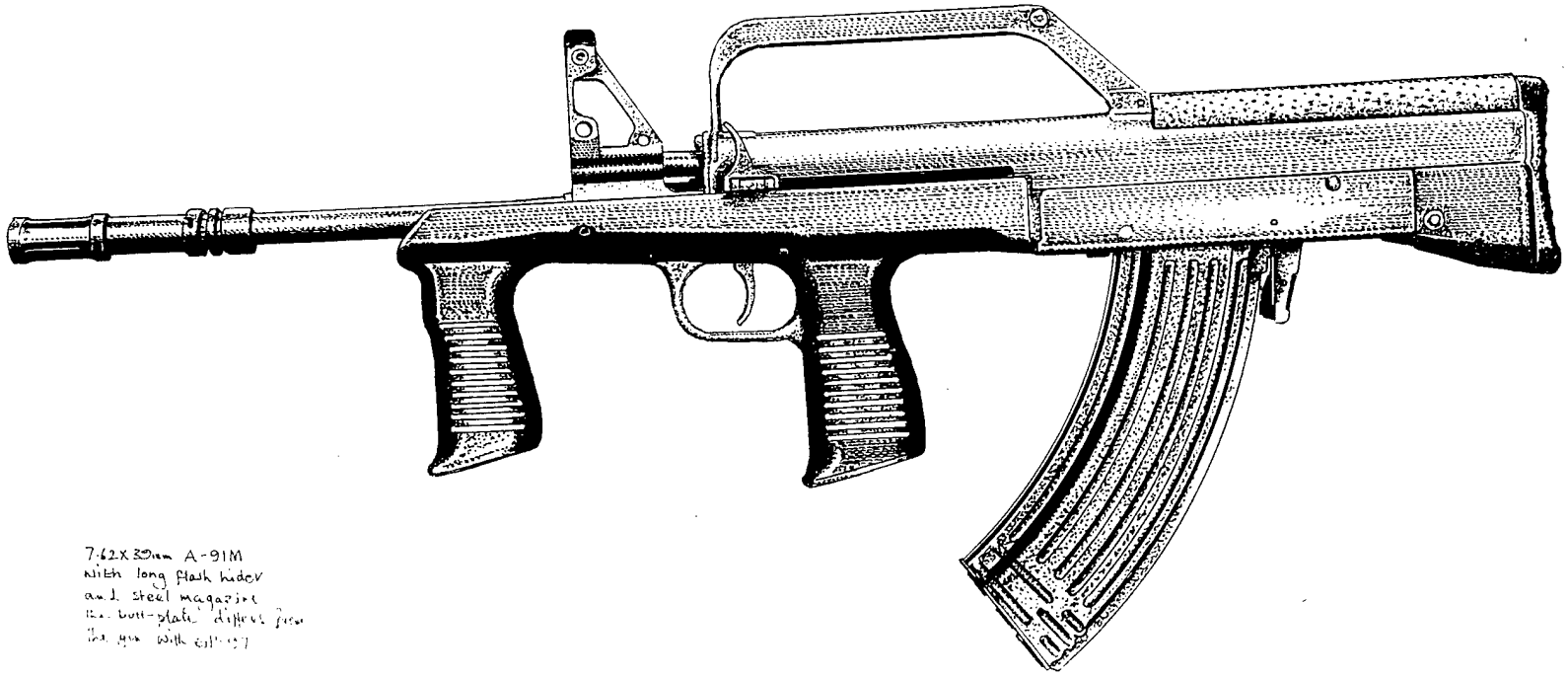
71



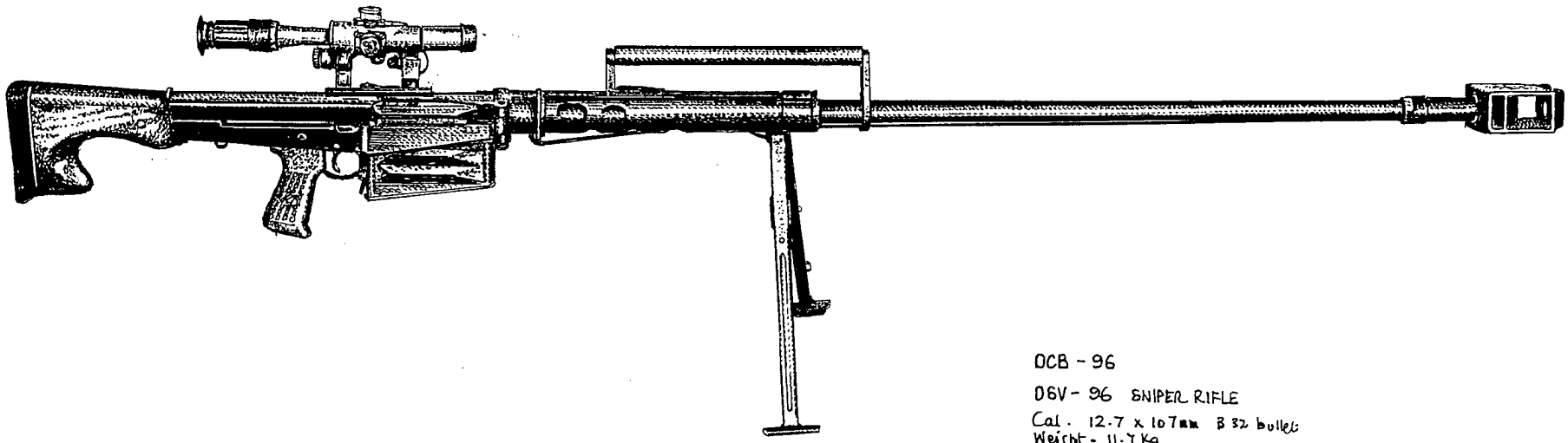
BCK-94 СНАЙПЕРСКАЯ ВИНТОВКА
VSK-94 SNIPER RIFLE
Cal: 9x39mm (PAB-9, SP-5, SP-6)
Weight w/o optical sight 3.27 Kg
20 round mag .67kg.
Selective fire / rate 700-900
Eff. range 400 M
Length 900mm
Sight - x7 PKS-07 collimating sight
or PKN-03 x3 2nd gen night sight



7.62 x 39mm M1942 A-91M
WITH 6P-97 40mm G.L.



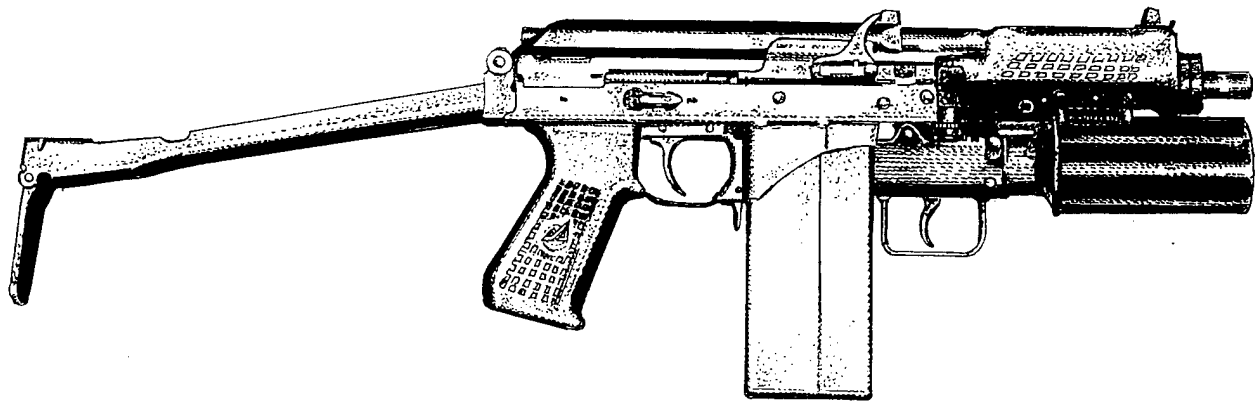
7.62 x 39mm A-91M
with long flash hider
and steel magazine
the butt-plate differs from
the gun with GP-97



ОСВ - 96

ОБУ - 96 SNIPER RIFLE

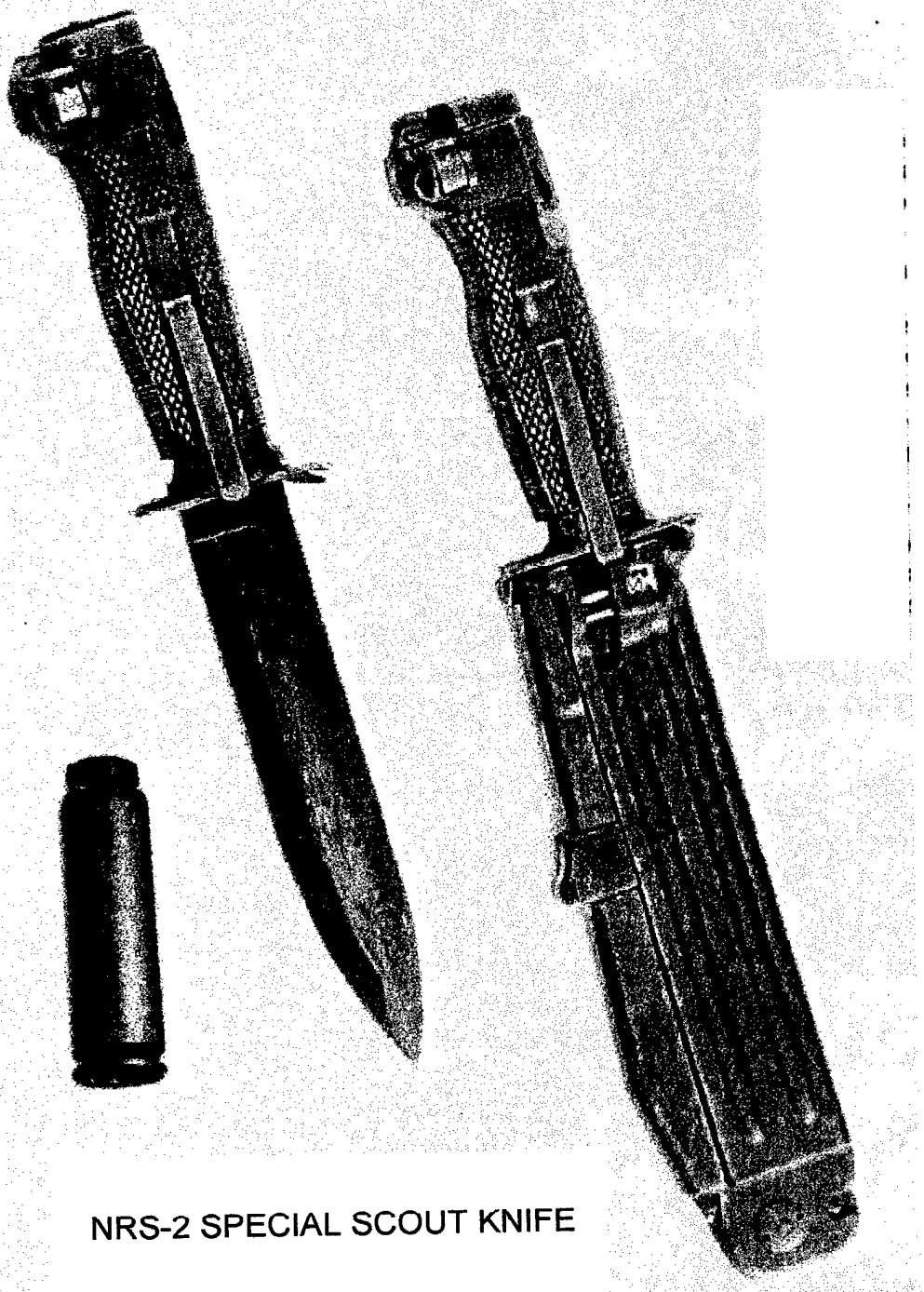
Cal. 12.7 x 107mm B 32 bullet
Weight - 11.7 kg
Length 1700 mm
folded 1100 mm
Pen. 96 % @ 100m @ 20mm armour



ГРАНАТОМЕТ ПОДСТВОЛЬНЫЙ ГП-95

ВР-95 UNDERBARREL GRENADE LAUNCHER FOR 9A-91

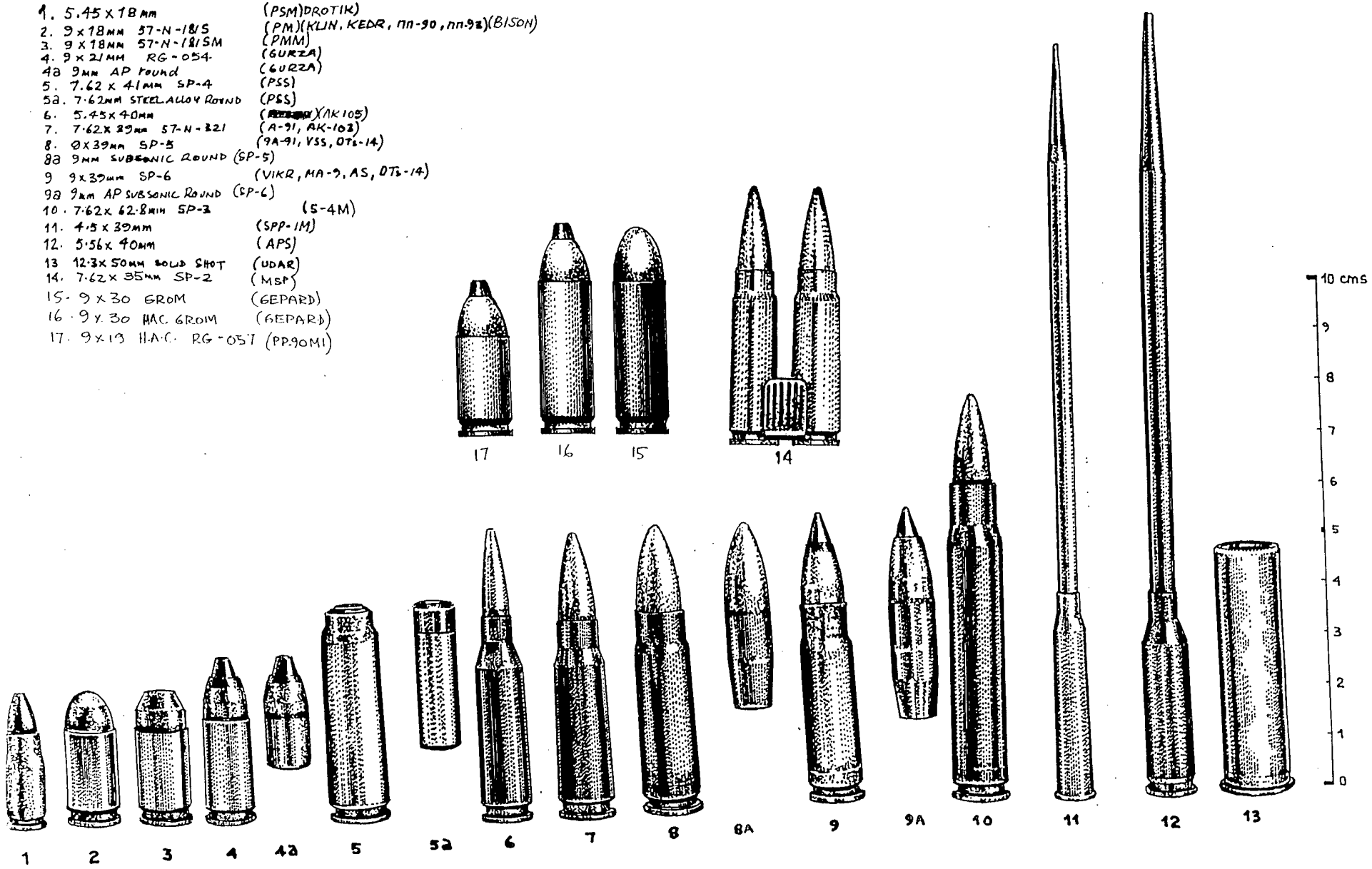
CALIBRE - 40mm
RANGE - 200M
WEIGHT - 1.5 KG
DIMENSIONS - [illegible] mm



NRS-2 SPECIAL SCOUT KNIFE

MODERN RUSSIAN SMALL ARMS AMMUNITION

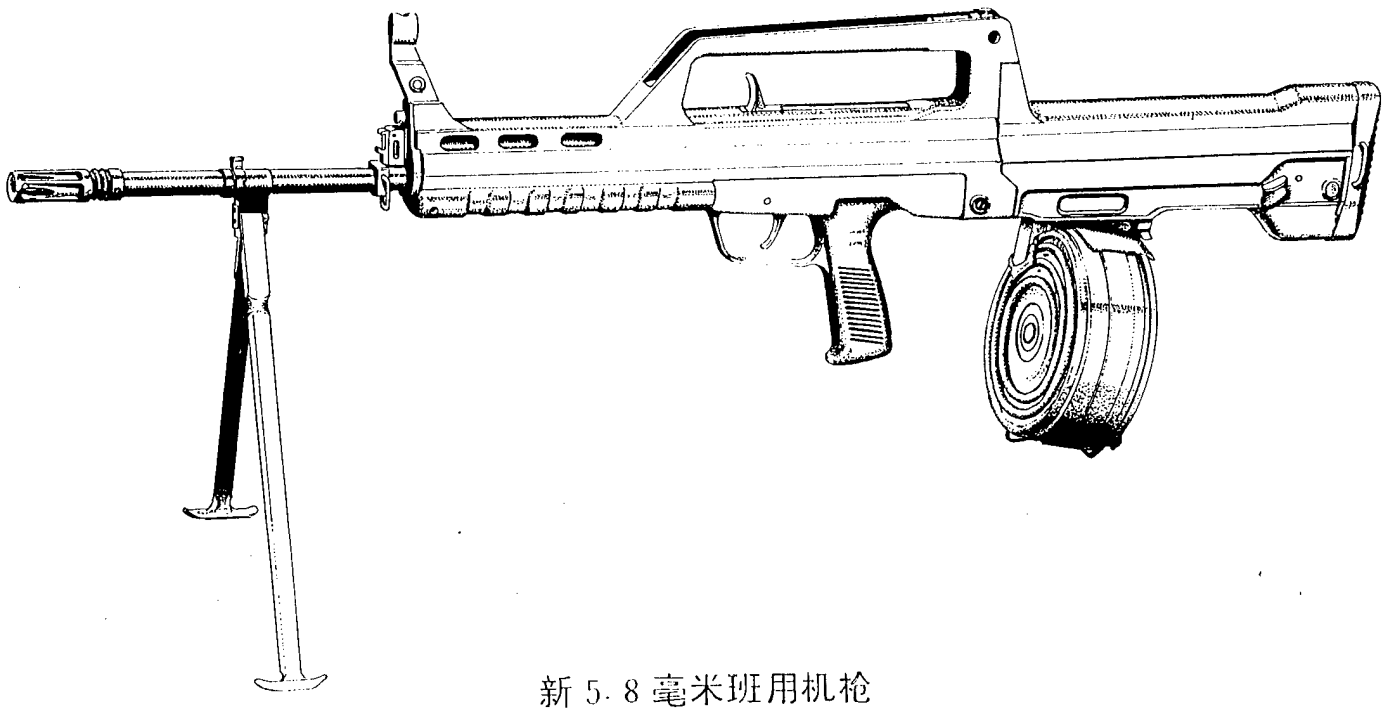
1. 5.45 x 18 mm (PSM) (DROTIK)
2. 9 x 18 mm 57-N-181S (PM) (KLIN, KEDR, ПП-90, ПП-91) (BISON)
3. 9 x 18 mm 57-N-181SM (PMM)
4. 9 x 21 mm RG-054 (GURZA)
4a 9 mm AP round (GURZA)
5. 7.62 x 41 mm SP-4 (PSS)
5a. 7.62 mm STEEL ALLOY ROUND (PSS)
6. 5.45 x 40 mm ([redacted]) (AK 105)
7. 7.62 x 39 mm 57-N-321 (A-91, AK-103)
8. 9 x 39 mm SP-5 (9A-91, VSS, OTs-14)
8a 9 mm SUBSONIC ROUND (SP-5)
9 9 x 39 mm SP-6 (VIKR, MA-9, AS, OTs-14)
9a 9 mm AP SUBSONIC ROUND (SP-6)
10. 7.62 x 62.8 mm SP-3 (S-4M)
11. 4.5 x 39 mm (SPP-1M)
12. 5.56 x 40 mm (APS)
13 12.3 x 50 mm SOLID SHOT (UDAR)
14. 7.62 x 35 mm SP-2 (MSP)
15. 9 x 30 GROM (GEPARD)
16. 9 x 30 HAC GROM (GEPARD)
17. 9 x 19 H.A.C. RG-057 (PP-90M1)





新5.8毫米自动步枪

NEW 5.8mm AUTO/SEMI-AUTO GUN



新 5.8 毫米班用机枪

NEW 5.8mm LIGHT MACHINE GUN AUTO-SEMI AUTO

POLLUTION PREVENTION IN WEAPONS MAINTENANCE CLEANING

Carl Hicks
Inland Technology

P^2 IN WEAPONS MAINTENANCE CLEANING

Agenda

- Introduction
- The Challenge
- Case Study, DPW-E Ft. Lewis
- Authorizations
- Questions

"SERVING THE FORCE"



Inland Technology

Pollution Prevention By Design

TO DATE, THE SCIENTISTS AND ENGINEERS AT INLAND TECHNOLOGY HAVE DEVELOPED SUCCESSFUL SUBSTITUTES FOR THE FOLLOWING PROBLEM SOLVENTS:

TOXIC SOLVENT	USAGE	SUBSTITUTES	COMMENTS
Methylene Chloride	Paint stripping; cold tank soak; resin removal	CITREX™ X-CALIBER™	Both products are biodegradable; CITREX™ is not regulated by RCRA. Both are low VOC.
1,1,1 Trichloroethane	Electronic & electrical cleaning. Also, metal preparation	CITRA-SAFE® TEKSOL EP™	CITRA-SAFE® is biodegradable; TEKSOL EP™ is not regulated by SARA, Title III. Both are low VOC and non-chlorinated
Methyl Ethyl Ketone (MEK)	Surface preparation for painting or welding	SAFETY PREP™ CITRA-SAFE® TEKSOL EP™	SAFETY PREP™, CITRA-SAFE® and TEKSOL EP™ are biodegradable; all are low VOC's
Toluene / Xylene	Surface preparation for painting or welding	SAFETY PREP™ CITRA-SAFE® TEKSOL EP™	SAFETY PREP™, CITRA-SAFE® and TEKSOL EP™ are biodegradable; all are low VOC's
Acetone	Cleaning of fiberglass & epoxy resins	Z-STRIP™ CITREX™	Low VOC's & toxicity; High flash point; CITREX™ is biodegradable
Stoddard Solvent / Mineral Spirits	Parts washing & paint clean up	CITRA-SAFE® TEKSOL EP™ BREAKTHROUGH®	Low VOC's; CITRA-SAFE® is biodegradable; BREAKTHROUGH® is free from most regulations, TEKSOL EP™ is low toxicity
Trichloroethylene	Degreasing & resin removal	CITREX™ TEKSOL EP™ CITRA SAFE®	CITREX™ and CITRA-SAFE® are biodegradable, low VOC. TEKSOL EP™ is non-chlorinated with low toxicity
Perchloroethylene	Degreasing	CITRA-SAFE® ISO-PREP™ BREAKTHROUGH®	Non-halogenated, low VOC's, easier disposal; low toxicity
Methyl Ethyl Ketone (MEK)	Paint Gun Cleanup	EP 921™*	Biodegradable, high flash point, low VOC, not regulated by RCRA or SARA Title III
Freon 113	Vapor Degreasing; Precision Cleaning	CITRA-SAFE® OR SKYSOL® WITH ULTRA FILTRATION	CITRA-SAFE® is biodegradable; SKYSOL® is not regulated by RCRA or SARA Title III, Section 313, both are low VOC's
1,1,1 Trichloroethane	Vapor Degreasing; Precision Cleaning	CITRA-SAFE® OR SKYSOL® WITH ULTRA FILTRATION	CITRA-SAFE® is biodegradable; SKYSOL® is not regulated by RCRA or SARA Title III, Section 313, both are low VOC's

*US Patent #5,449,474

P^2 IN WEAPONS MAINTENANCE CLEANING

- The use of unauthorized chemicals and substances in the process leading to hazards to both service member health and equipment
- Increased waste streams both controlled and uncontrolled
- Significant confusion in the field over what is authorized and what is not (due) to poor coordination between maintenance and environmental staffs during the introduction of the latest fad cleaners
- Dollar-Cost expenditures on the rise due to new rental contracts, increased disposal costs, additional cleaning materials and regulatory compliance

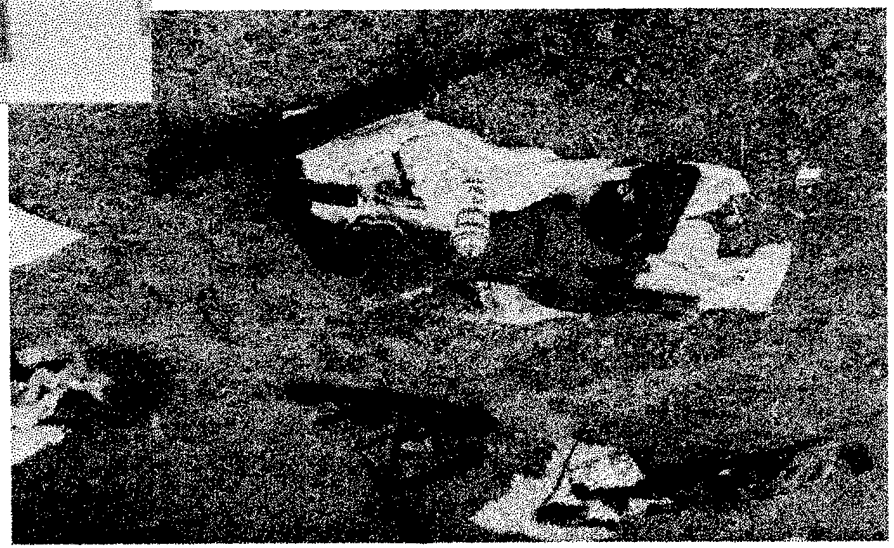
Case Study

- **Client:** US Army, Fort Lewis, Washington
- **Project:** Develop a technology (both cleaner and equipment) to drastically reduce the hazardous waste and emissions being generated by the cleaning of small arms and light crew served weapons
- **POC:** Ms. Cynthia Trout
  Environmental Engineer

Previous Condition:

- Previously Soldiers either cleaned their weapons in the arms room, or at their barracks using individual supplies of Brake Free, CLP, or other chemicals. Some of these chemicals contained ozone depleting substances, and nearly all contained hazardous air pollutants and were considered hazardous waste when spent.





This Created The Following Problems:

- 15,000 lbs. of traceable hazardous waste per year (Source: Fort Lewis DPW-E)
- The use of unauthorized chemicals in weapons maintenance
- Uncontrollable disposal of hazardous waste
- Unreported emissions of hazardous air pollutants and VOCs
- Possible ground contamination

Previous Costs To The Post

- Cleaning materials - $277,250
- Waste management - 42,225
- Regulatory compliance - 8,764
- **Total Annual Cost - $328,239**

(Source: Official U.S. Army Documents)

The Challenge:

- Create a chemistry that contains:
  - ⇨No ozone depleting chemicals
  - ⇨No halogenated chemicals
  - ⇨No hazardous air pollutants
- Create a chemistry that would:
  - ⇨Pass tests for hazardous waste (TCLP etc.)
  - ⇨Be a lower hazard to users
  - ⇨Clean the oils, greases, carbon and other contaminants associated with weaponry as well as the current chemistry

Create

Equipment Technology That Would:

- Provide control over the usage, reporting, and disposal of weapon cleaning materials
- Increase the efficiency of small arms cleaning
- Provide on line cleaning of the solvent to extend its working life and thereby reduce waste generation and costs.

The Solution - Cleaning Fluid:

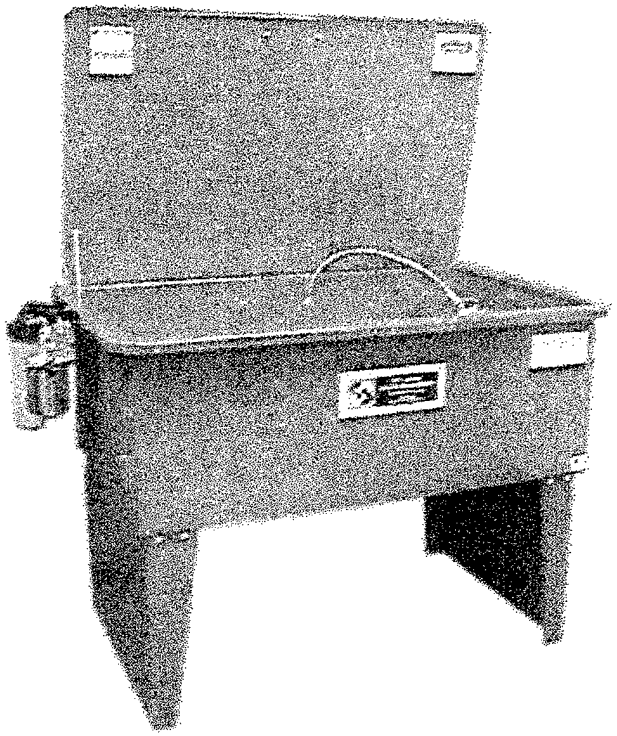
- A cleaning compound called: **BREAKTHROUGH®**
  - It is odorless
  - Passes TCLP tests and other tests for hazardous waste in uncontaminated form, and in well managed systems passes these tests when spent.
  - Is much less hazardous to humans than Mineral Spirits or PD 680
  - Cleans effectively and leaves no residue

Solution:

- The creation of equipment technology identified as **The IT-48WC™ Weapons Cleaning System**:
  - ⇨ Allows 2 soldiers to clean weapons at the same time with total separation of parts and functions.
  - ⇨ Uses the sophisticated **EDGE TEK™ Filtration System** to remove contaminants and allow extended reuse of the cleaning solution
  - ⇨ Uses either **BREAKTHROUGH® or SKYSOL 100 ™ Cleaning Solutions** which are non-hazardous (RCRA), non HAP, non ozone depleting, non EPA 17

Solution:

The IT-48WC™ Weapons Cleaning & Partswashing System





Results:

- After 2 years of testing at Fort Lewis the **IT-48WC™** Weapons Cleaning System using either **BREAKTHROUGH®** or **SKYSOL 100 ®** has demonstrated the ability to:
  - Reduce Hazardous Waste Generation
    - **15,000 lbs. per year to be saved at Ft. Lewis***
  - Save Time
    - Weapons are being cleaned and passing armorer inspections in 1/3 to 1/2 of the normal time

*Source: DPW-E Fort Lewis

Results (Continued):

- Save Money
  - Estimated hard dollar cost savings is over $328,239 per year with the adoption of the **IT-48WC™ System**
- Clean Effectively
  - The two cleaning agents **BREAKTHROUGH ®** and **SKYSOL 100 ®** showed unusual ability to dissolve and remove carbon and other troublesome contaminants without harming sensitive parts, coatings, or elastomers

Comments From Users:

- "...If anybody tried to take this (**IT-48WC™**) out of here, I would ***kill*** them!"

SSG Roberts
1st SFG

Comments From Users:

- "... weapons were cleaned and passed inspection by the unit armorer in half the normal time."
- "... to date, the **IT-48WC™** has been a reliable, safe, and extremely time saving asset to the First Special Forces Group (Airborne)."

Group Support Company,
1st Special Forces Group (Airborne)
Fort Lewis, WA 98433 (04 Jan 1996)

Comments From Users:

- "The results have been outstanding. ."
- ". . .average time to clean a fouled M16A2 was 25 minutes with the solvent and 15 minutes for lubrication. M249 SAWS averaged 20-30 minutes with the solvent and 20 minutes for lubrication and reassembly . . . this was a major improvement over previous methods. ."

Headquarters and Headquarters Company
1st Battalion, 23rd Infantry Regiment (M)
3rd Brigade, 2nd Infantry Division
Fort Lewis WA 98433 (19 June 1995)

DoD Designated Solvent Substitute

- **DoD Selected PD-680 Replacement:**
  - **DLA resourced study conducted by Mobility Technology Center Belvoir (MTCB), Tested 82 Solvents**
  - **After Extensive Field Testing Throughout CONUS Only 5 Were authorized, To include, *BREAKTHROUGH®* NSN 6850-01-378-0666**
  - **Authorized for use In "Maintenance Cleaning Of Weapons, Ground Vehicles And Equipment, and Aviation Materials**
  - **No Other Solvents Have Been Authorized A/O This Time**

***Source:** Technical Advisory Message #92
DIRUSAPC
051530Z Nov 96

FORT HOOD, TX

- DOL Aviation Weapons Maintenance Division
- AH-64 30mm Cannon Phase Service
- 98% decrease in Hazardous waste
- 33% reduction in man-hours required per service!

FORT CAMPBELL, KY

"Using the (IT-48WC) is the highlight of my tour here at Fort Campbell!"

SSG Simpson
HHC, 3-502 IN
17 SEP 97

"Until such time as this message is rescinded, aqueous-based cleaners are not authorized."

TACOM-ACALA Maintenance Advisory Message 97-17

Director, TACOM-ACALA Rock Island Arsenal

INDEPENDENT LABORATORY TESTS OF **BREAKTHROUGH®** FOR MATERIAL COMPATIBILITY AND PERFORMANCE

Tests Conducted By Scientific Material International Inc., An Internationally recognized Aerospace Testing Laboratory

TEST PERFORMED	RESULTS
CHLORINE CONTENT	Pass
NON-VOLATILE RESIDUE	Pass
STOCK LOSS CORROSION	SAE ARP 1755
2024-T3 Aluminum (Bare)	Pass
4375 Magnesium	Pass
4507 Copper	Pass
4911 Titanium	Pass
5040 Carbon Steel	Pass
5536 Nickel (Hastalloy X)	Pass
2024-T3 Anodized	Pass
410 Stainless Steel Cad Plated	Pass
IMMERSION CORROSION	ASTM F 483
4037 Aluminum	Pass
4377 Magnesium	Pass
4911 Titanium	Pass
5050 Carbon Steel	Pass
5040 Carbon Steel Cad Plated	Pass
SANDWICH CORROSION	ASTM F 1110
2024-T3 Anodized	Pass
2024-T3 Alclad	Pass
7075-T6 Anodized	Pass
7075-T6 Alcad	Pass
TITANIIUM STRESS CORROSION	ASTM F 945
AMS 4911	Pass
AMS 4916	Pass
HYDROGEN EMBRITTLEMENT	ASTM F 519
	Pass
COATING ADHESION	PESD-STD 141 TEST METHOD No. 6301
	Pass
EFFECT ON PAINTED SURFACES	
Epoxy Topcoat	Pass
Polyurethane	Pass
Enamel	Pass
STRESS CRAZING OF ACRYLIC PLASTIC (Mil-P-5425 and Mil-P-25690)	Pass
STRESS CRAZING OF POLYCARBONATE PLASTIC (Mil-P-83310)	Pass
EFFECT ON POLYSULFIDE SEALANTS	Pass
RUBBER COMPATIBILITY	Pass
EFFECT ON POLYIMIDE INSULATED WIRE	Pass

CONCLUSIONS

- *Documented waste reduction*
- *Dramatic time savings*
- *Authorized technology*

Powder Metallurgy Replacements for Lead in Small Caliber Bullets

Norm Vaughn and Rick Lowden
Oak Ridge National Laboratory
Oak Ridge, Tennessee

NDIA 1998 Small Arms Systems Section Annual Conference
Columbus, Georgia
June 16, 1998



"Green and Mean"

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ORNL Non-lead Bullet Efforts Have Focused on Perfecting a One-to-one Replacement for Lead

- A sinterless fabrication technique that takes advantage of the processes of mechanical interlocking and cold welding has been used to produce non-lead composite simulants.
- Powder metal mixtures have been selected based upon ES&H and performance criteria.
- Materials specifications and processing parameters have been determined.
- Pistol and rifle bullets, and buckshot have been fabricated, characterized and tested.
- Tin-tungsten composites yield the best results; however, the impact behavior of zinc-tungsten combinations is interesting.
- The powder metallurgy approach allows for significant flexibility in the design, fabrication, and performance of small caliber bullets.



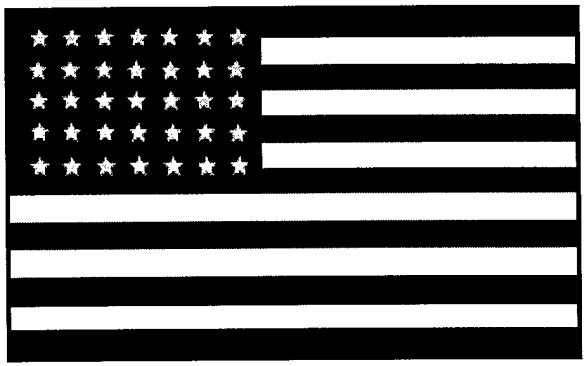
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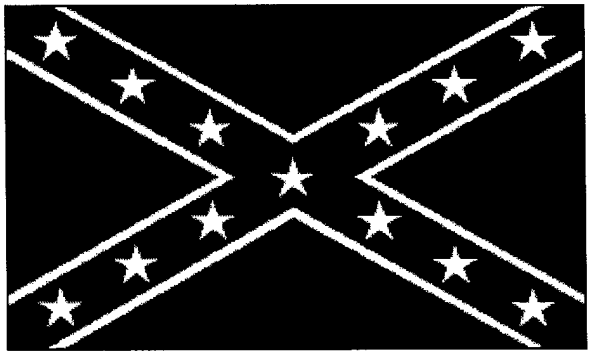
Lead is a four letter word!

- Contamination of soil, sediments, and surface and groundwater
- Ingestion by wildlife
- Hazardous exposure during shooting and handling of weapons
- Hazardous waste from shooting and cleaning of weapons
- Billions of rounds fired each year



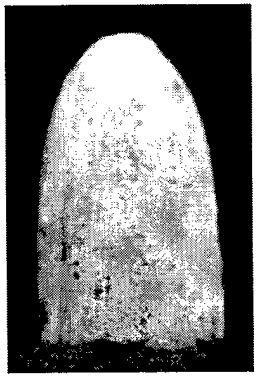
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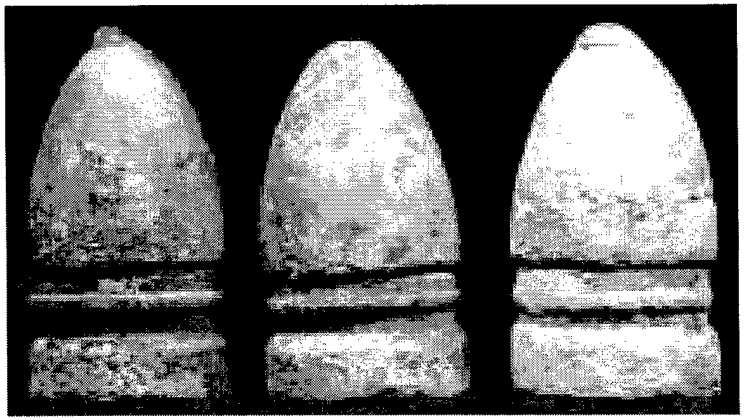


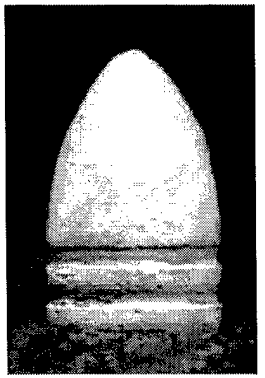




....But Bullets From the Civil War Are Found Intact....







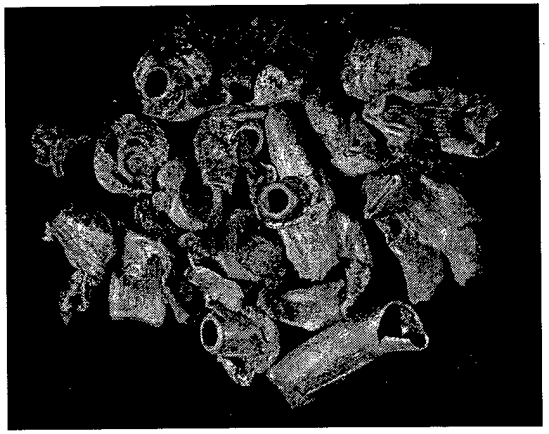


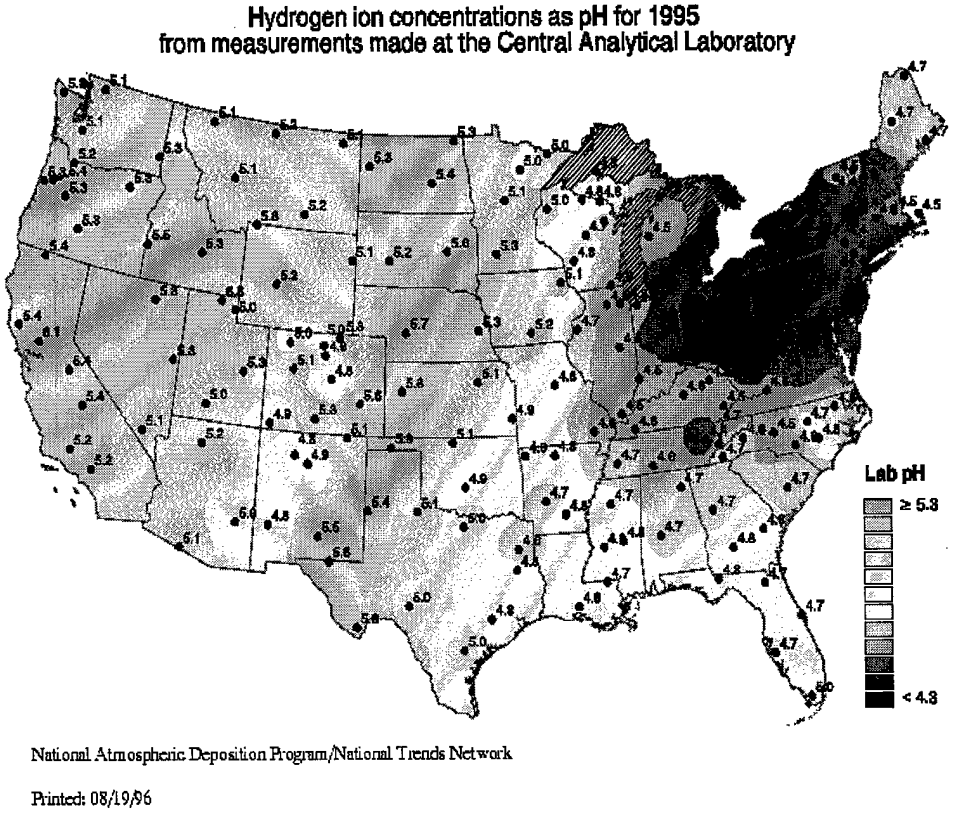


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Modern Bullets Fragment,







And Acid Rain Dissolves the Lead



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The Search for a Lead Replacement Is Not a New Endeavor

After WWI, the lead supply was diminished, thus replacements for lead were explored.

Tungsten powder mixed with lead or other soft metals to produce materials for weights (Rodriguez, 1923).

After WWII and the Korean conflict, non-lead projectiles were of interest for practice ammunition

Lead-bakelite, iron-bakelite, and iron projectiles were investigated with varying success.

The quest for reduced toxicity shot has been well publicized.

Steel, bismuth, sintered tungsten, tin, polymer-tungsten composites

"Practice ammunition" has been studied and is used by the military.

Powdered iron, same with different binders, metal powders in polymer matrices



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More Recently, the Danger of Lead in ALL Ammunition Has Been Realized

Manufacturer/Bullet	Composition
CCI ZNT Lawman	Cast zinc in copper jacket
Delta Frangible	Pressed copper powder
Federal CQT	Zinc wire in copper jacket
Longbow NTF	Copper powder in a nylon matrix
Remington Disintigrator	Copper plated pressed powdered iron
Powell River Laboratories	Tungsten in a tin matrix, plated or jacketed
Simunition	Copper/bronze powder in a nylon matrix
Winchester Ranger	Tungsten and copper powders in a nylon matrix
Winchester NT	Tin-cored bullets



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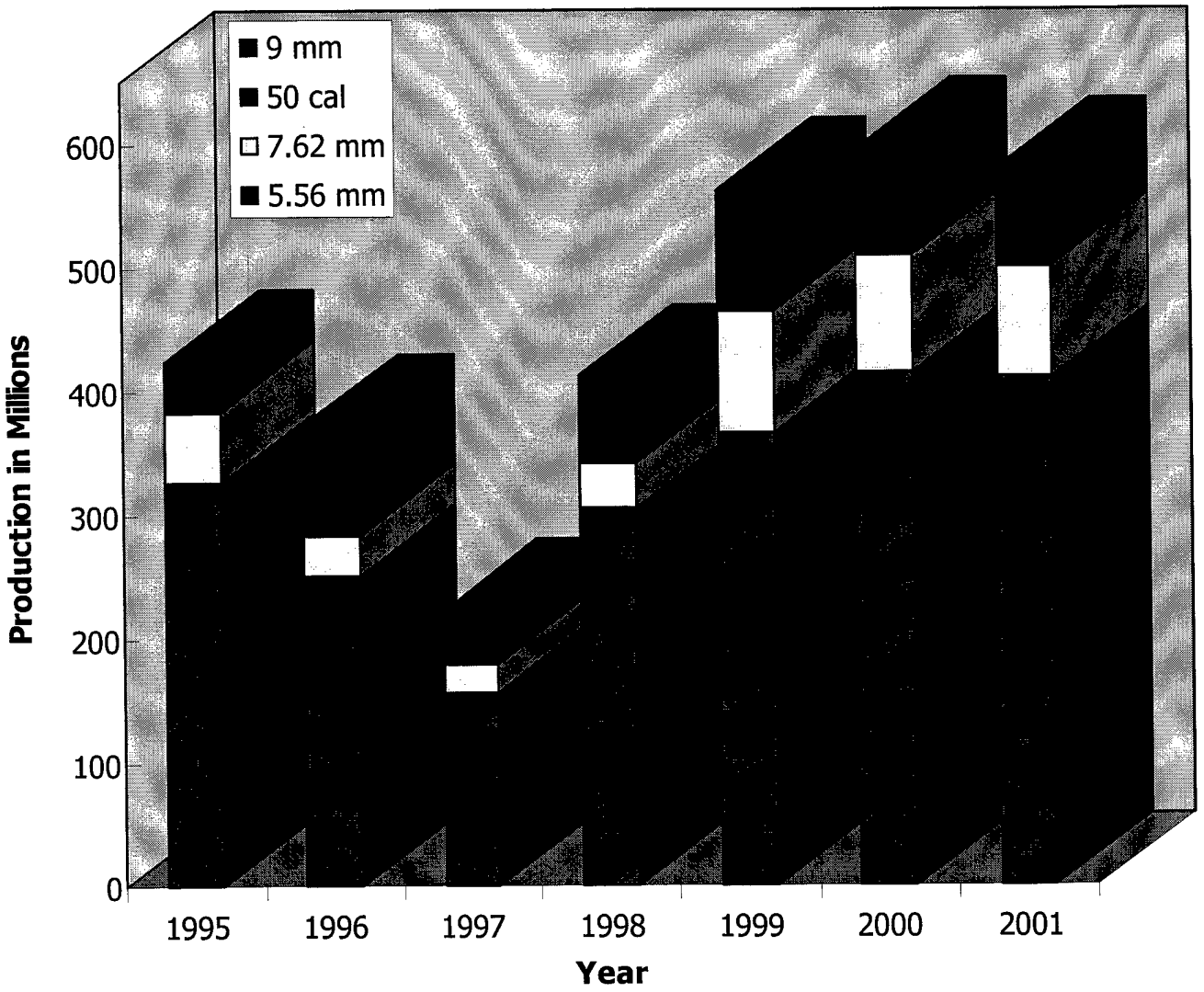
It has been estimated that HUNDREDS OF TONS OF LEAD PER DAY are used in the production of small arms ammunition

- > 500 million rounds per year are produced for military use.
- DOE fires > 10 million rounds in training each year.
- 3 - 4 billion rounds of 22 rimfire are consumed each year.
- There are 2 million active skeet shooters.
- Law enforcement and security forces



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Yearly Military Production Numbers for Small Caliber Ammunition Are In the Hundreds of Millions

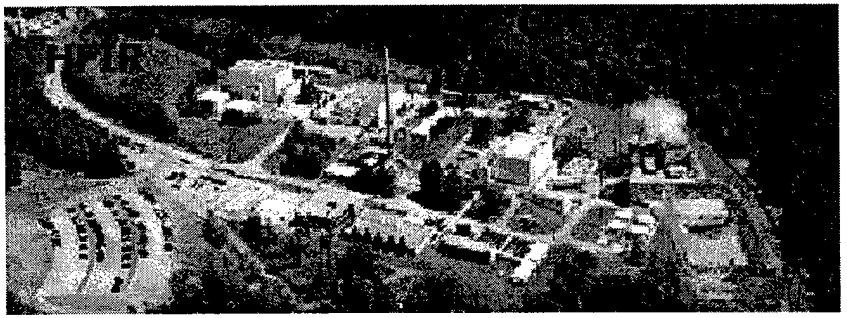


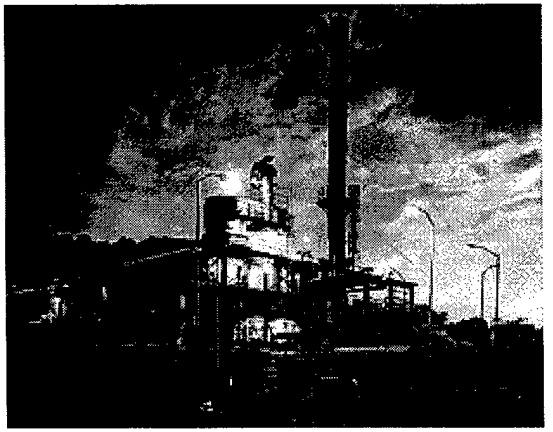


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Why is the Department of Energy interested in non-lead, frangible ammunition?

- DOE is the steward of the US nuclear materials stockpile
- > 10 million rounds fired annually in training producing ~300,000 pounds of waste lead and copper
- Special requirements involving the RAD and HAZMAT areas
- One bullet for training and service use - without loss of performance or function as compared to current products

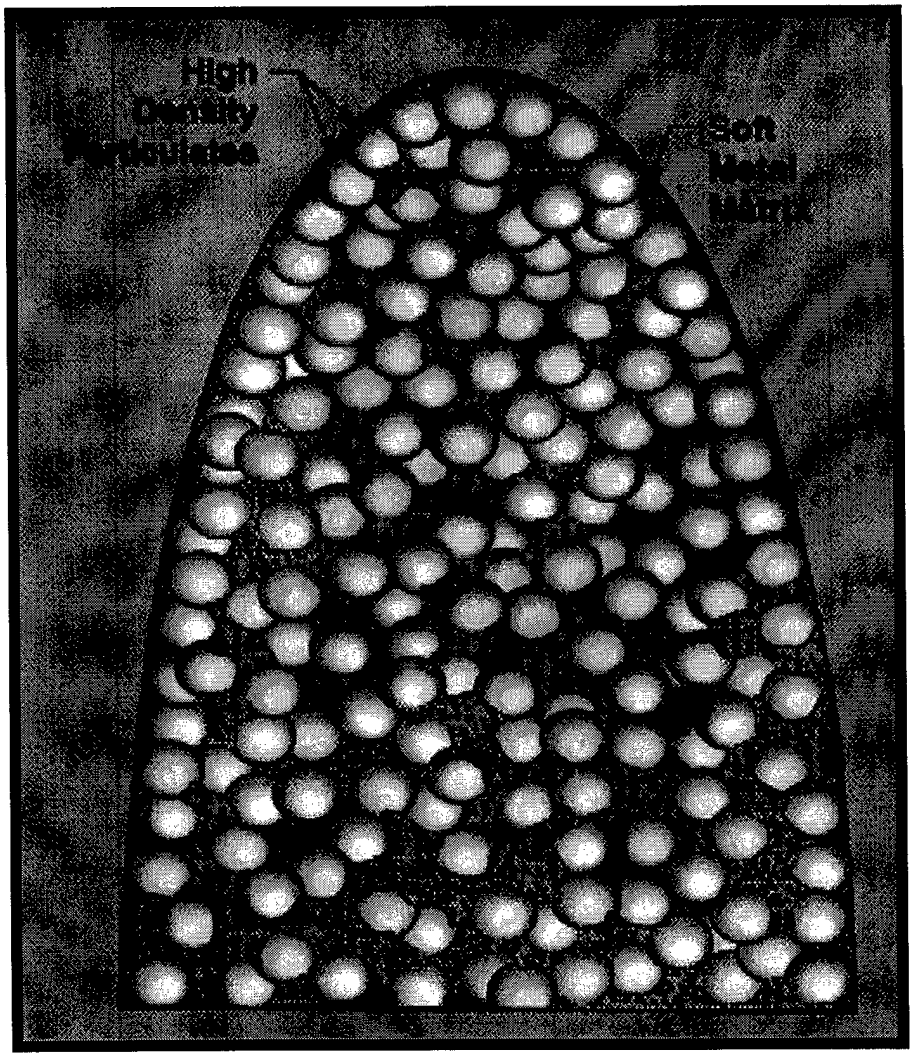






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Powdered Metals Can Be Combined to Produce Composite "Simulants" for Lead





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Our Efforts Have Focused on Tungsten Powder With Tin and Zinc As Binders

Tin - Sn

Elemental tin and its insoluble inorganic compounds are not toxic. In soils, tin is typically present as insoluble compounds.

Zinc - Zn

Elemental zinc and its insoluble inorganic compounds are not toxic to humans. There are no reports of adverse ecological impacts for zinc.

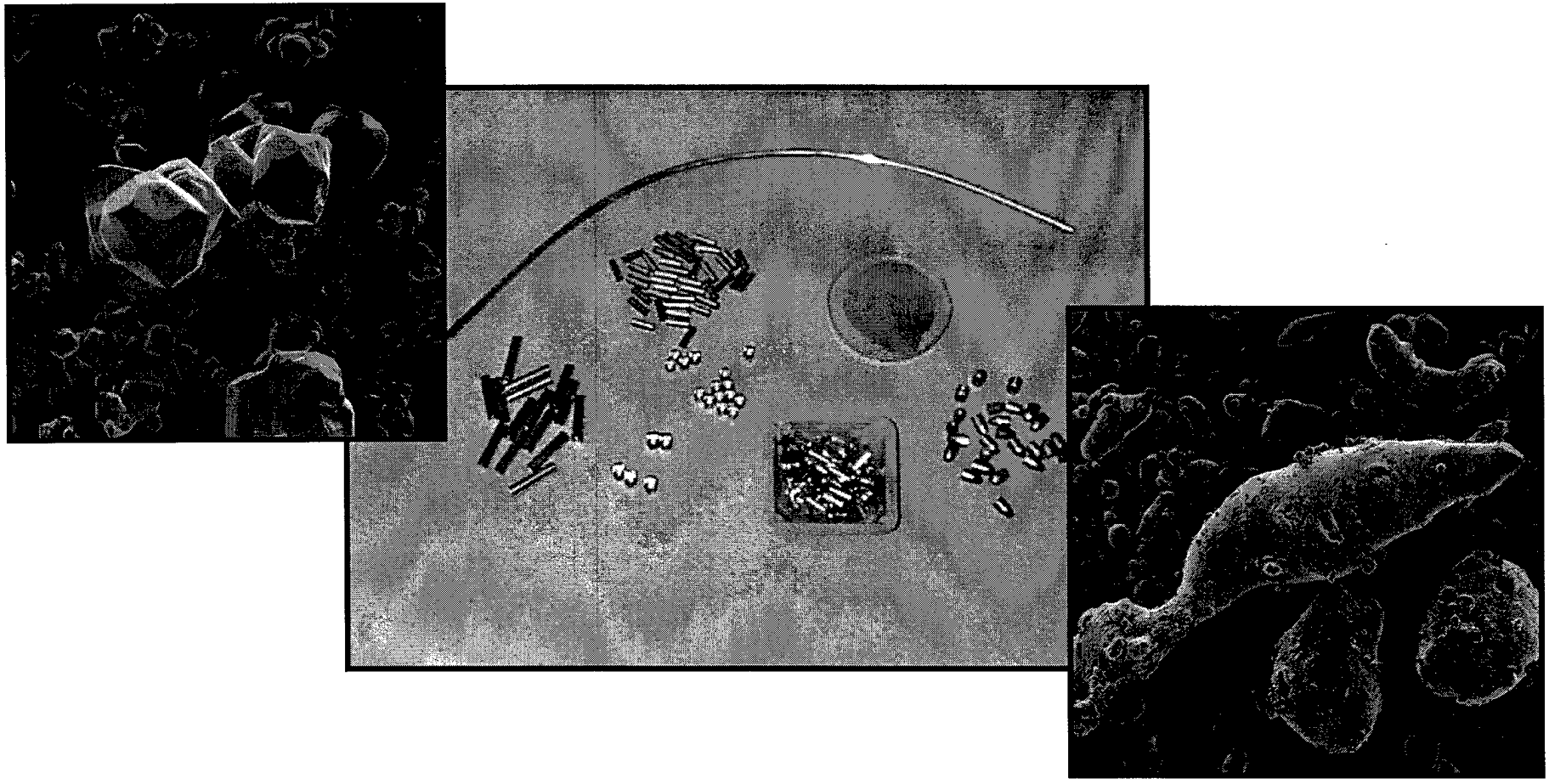
Tungsten - W

Tungsten metal dust is heavy, inert, and relatively safe up to the OSHA exposure limits. Tungsten becomes tungsten oxide and tungstic acid in the environment, both of which are insoluble.

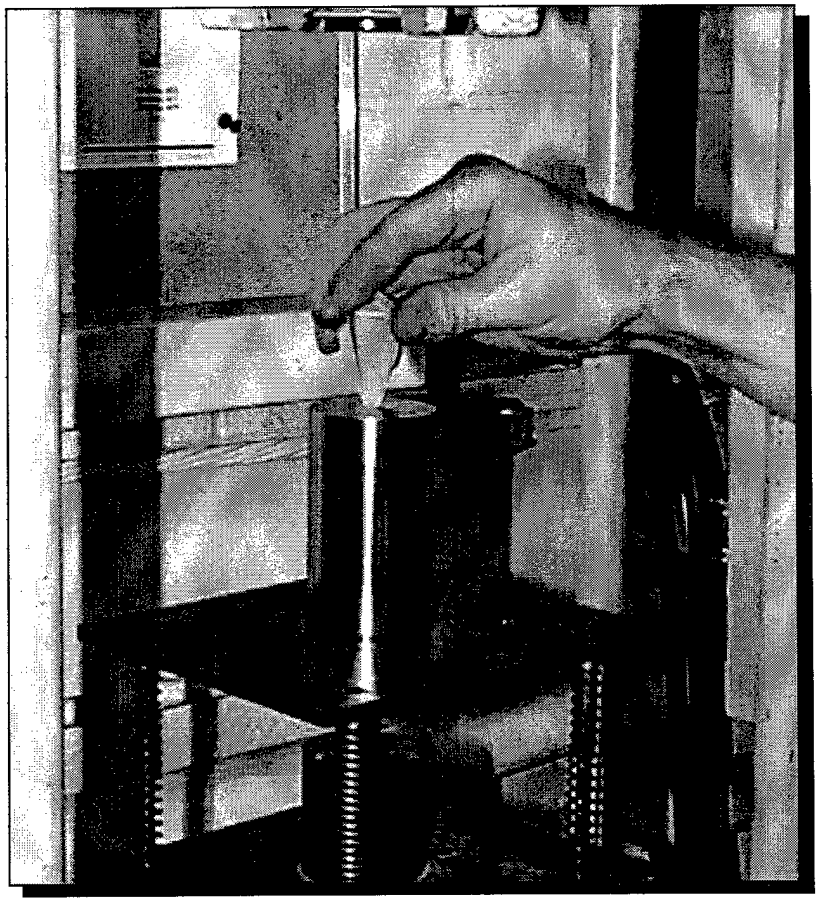


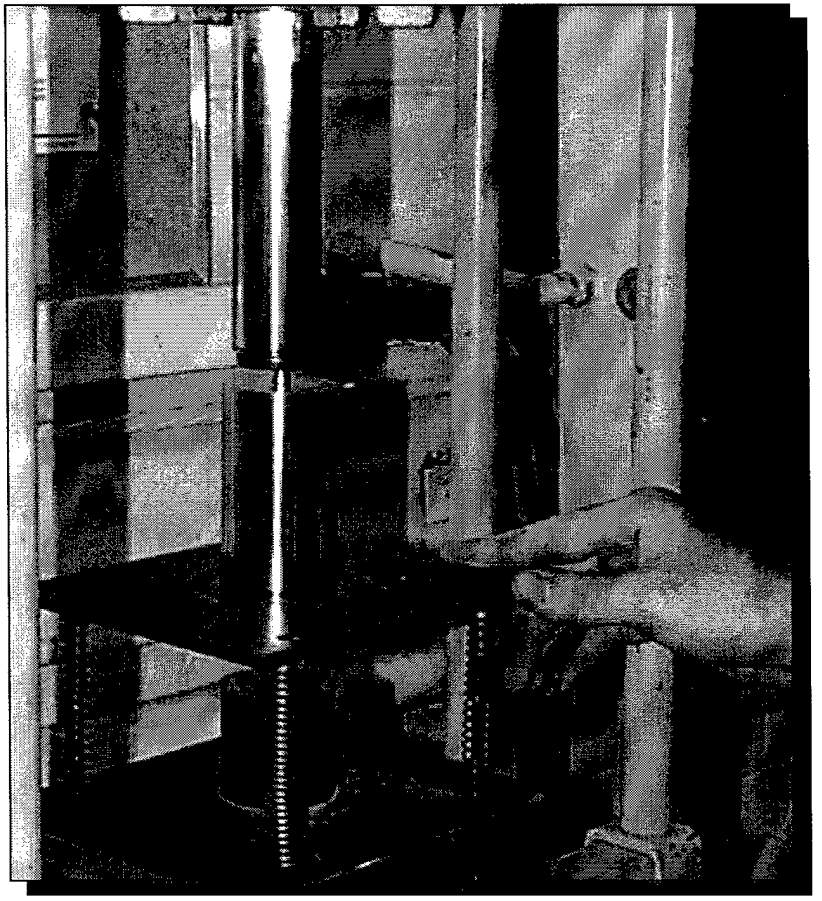
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Powdered Metals Are the Primary Raw Materials Used in the Fabrication of the Non-Lead Bullets



Blended Powdered Metals Are Simply Compressed at Room Temperature

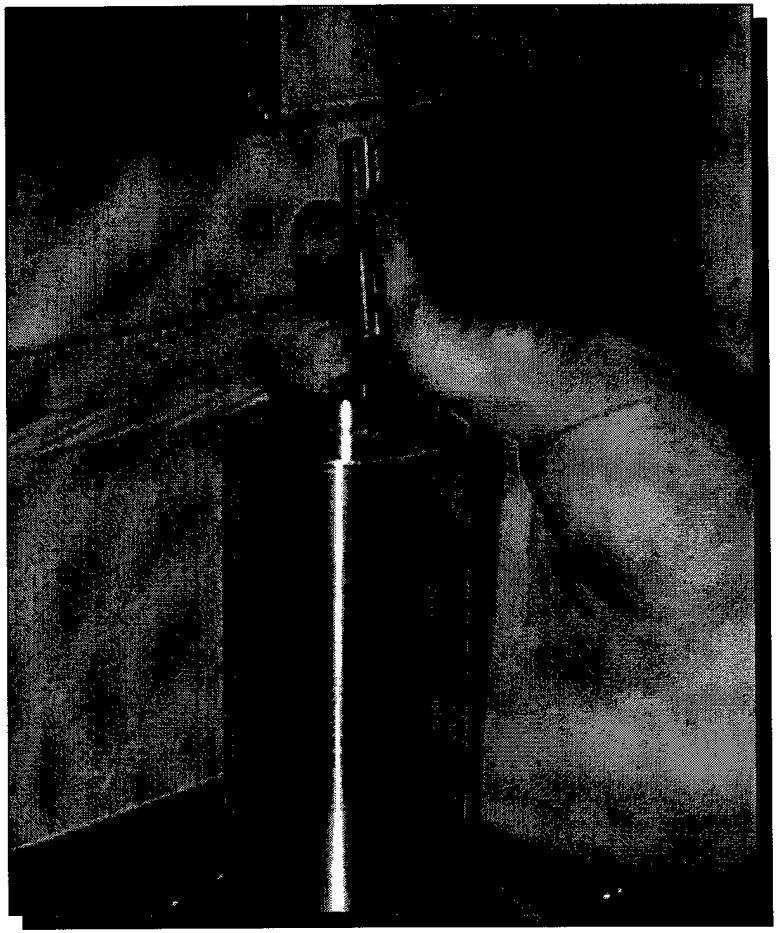


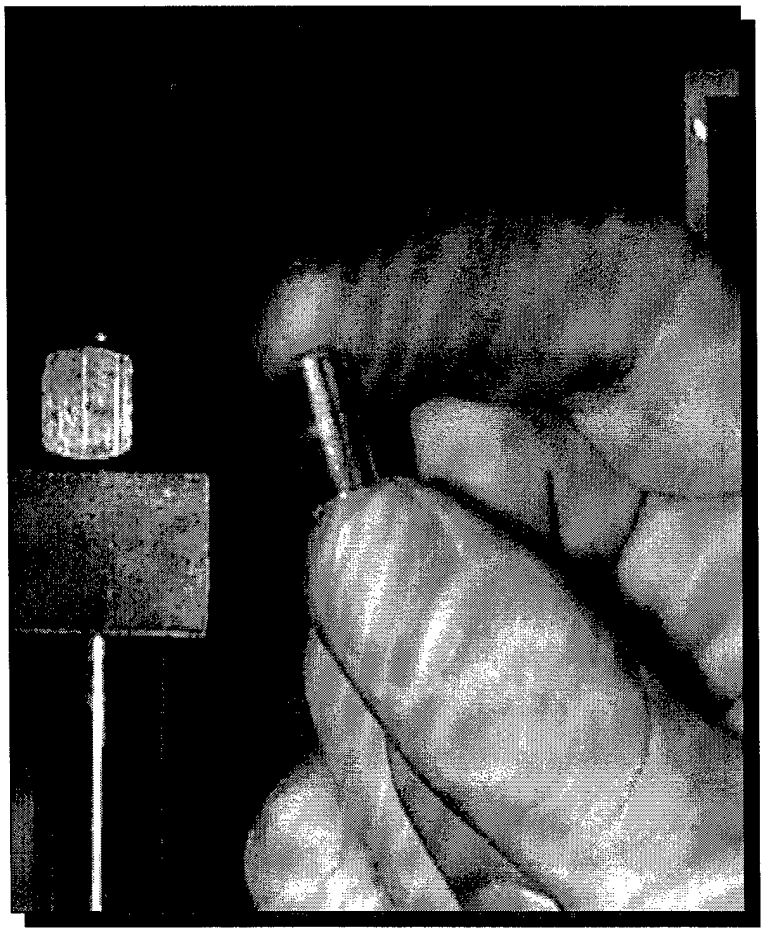




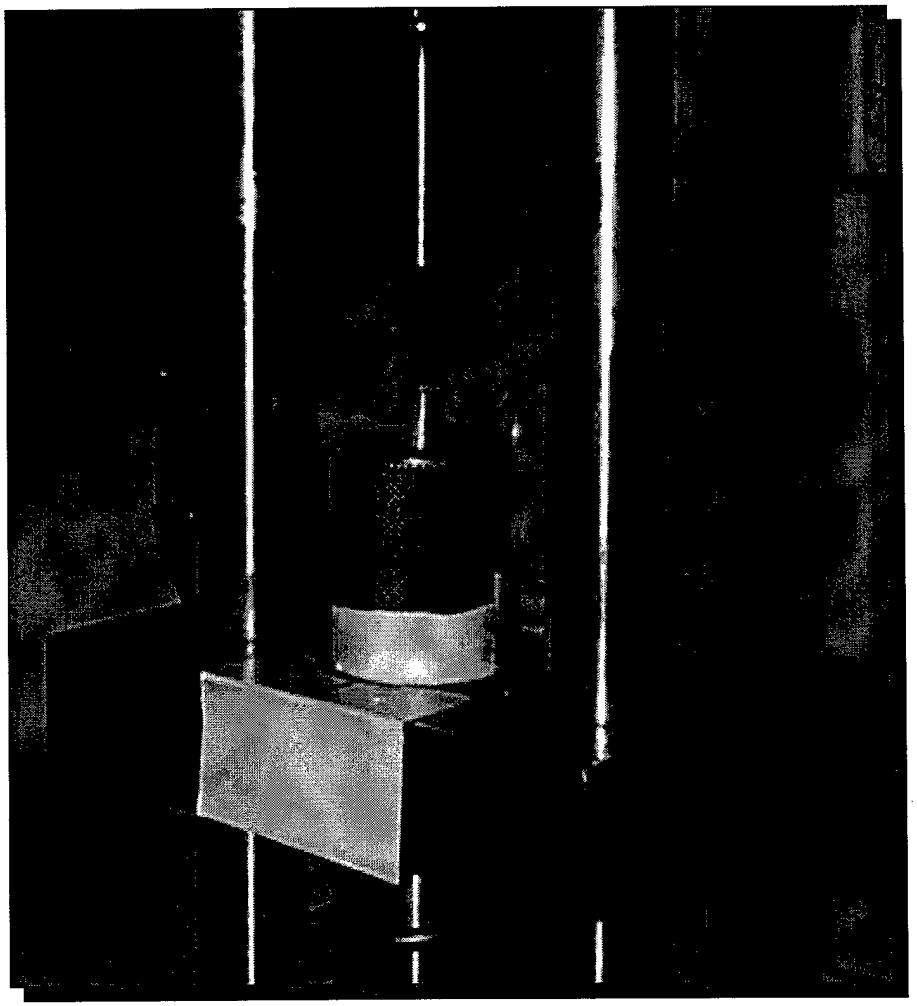
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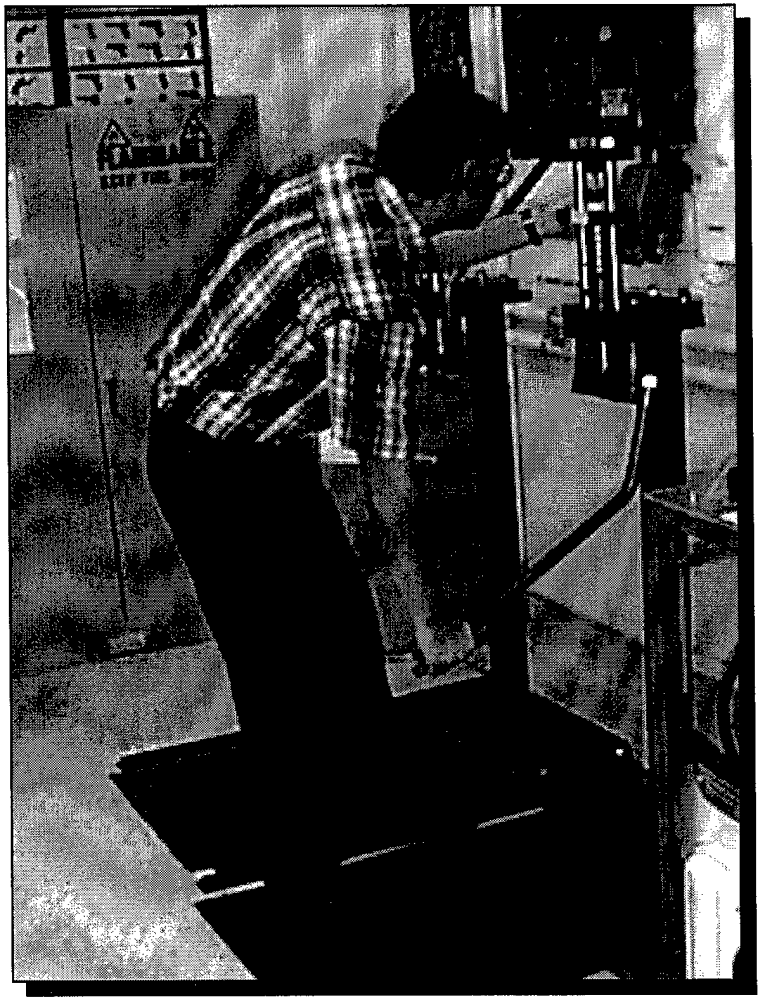
Compaction Produces a Dense Part That Is Bonded Together by the Processes of Mechanical Interlocking and Cold Welding





The "Slug" Can Be Swaged to Shape or Jacketed in the Same Manner As a Lead Bullet

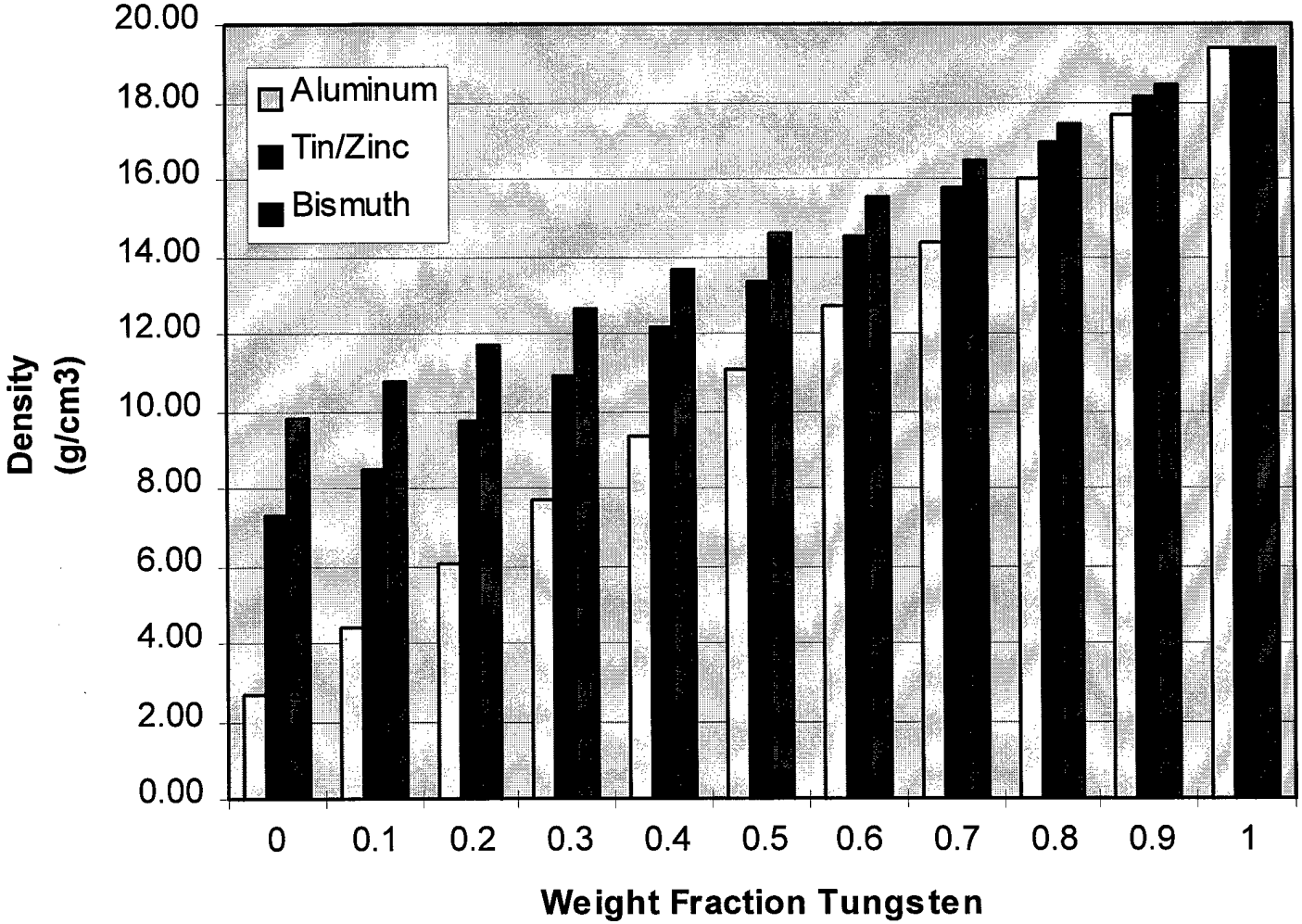






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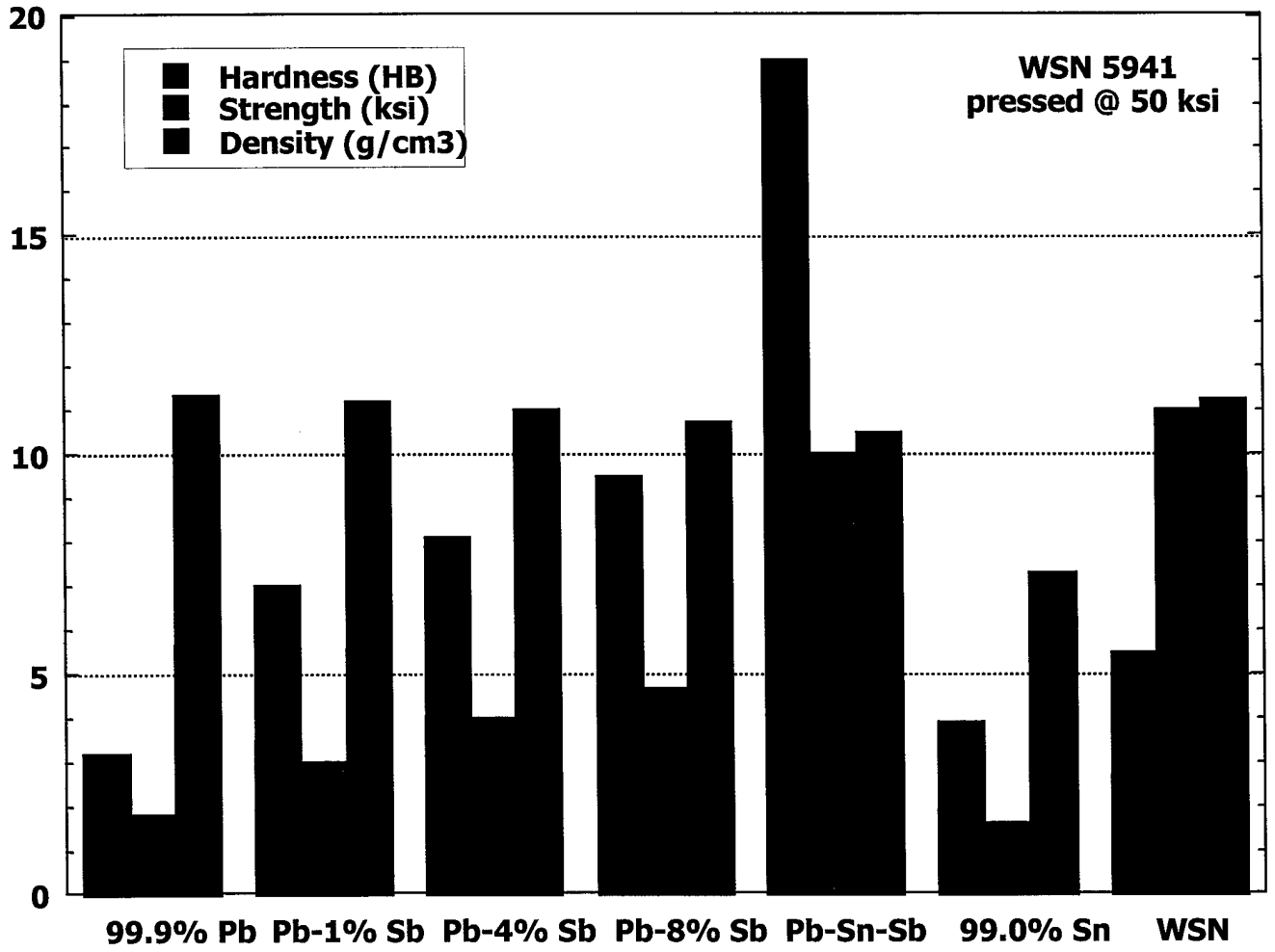
The Properties of the Composite Are Determined by the "Rule of Mixtures"



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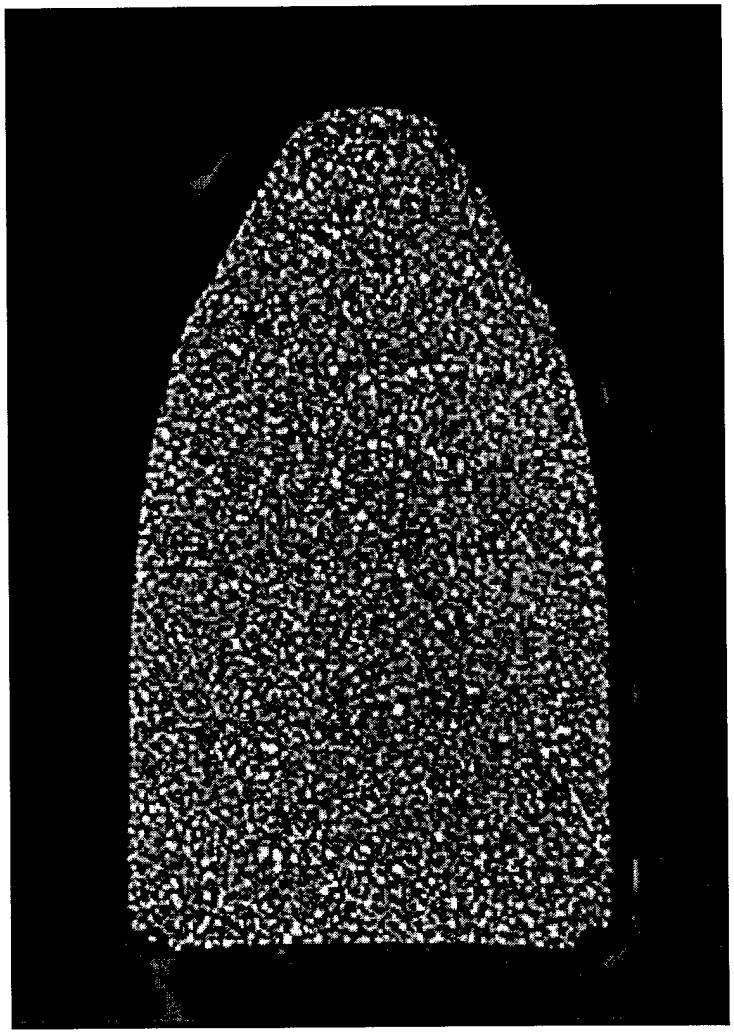
The Properties Of The Composite Simulant Can Be Controlled To Match Those Of Lead Or Lead Alloys



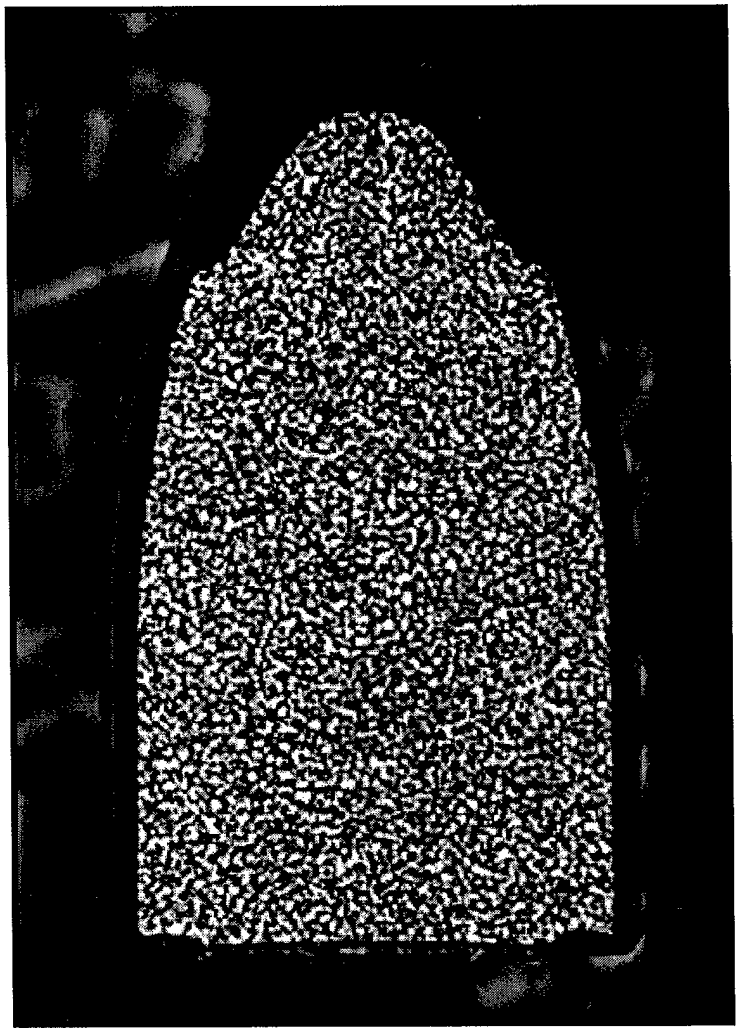


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The Only Difference in the Bullets Is the Composition of the Core



9 mm W-Sn

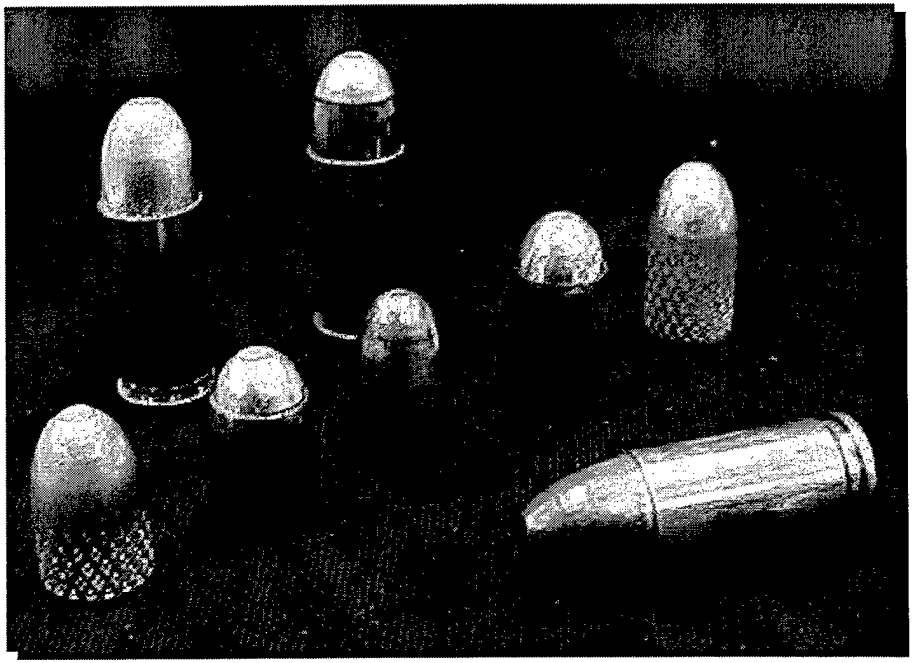


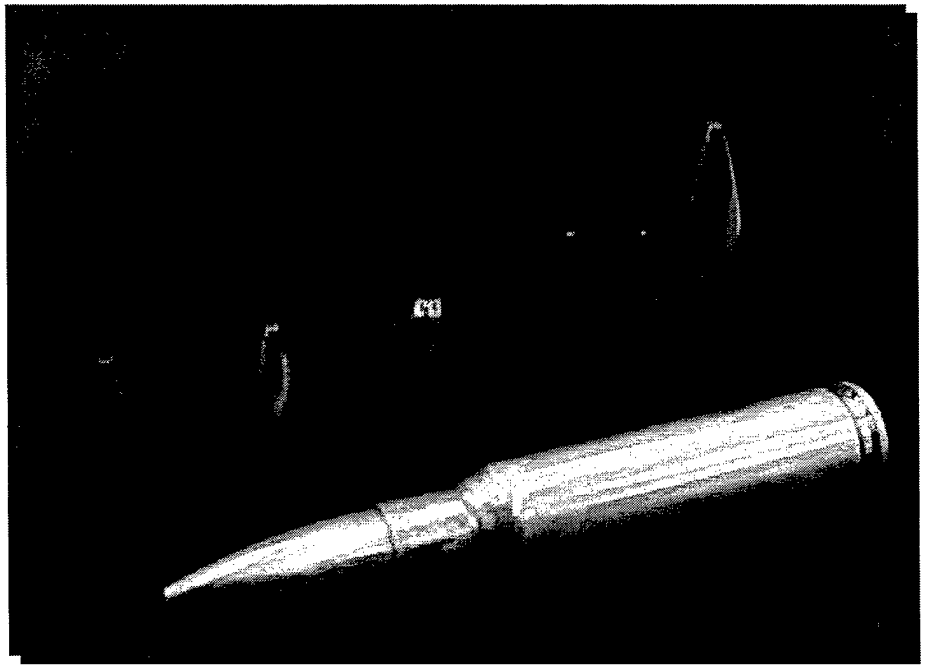
9 mm W-Zn

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Any Bullet Design Can Be Fabricated Employing the Non-lead Composite Materials







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WSN Bullets Proved to Be True 1-to-1 Replacements for Their Lead Analogs

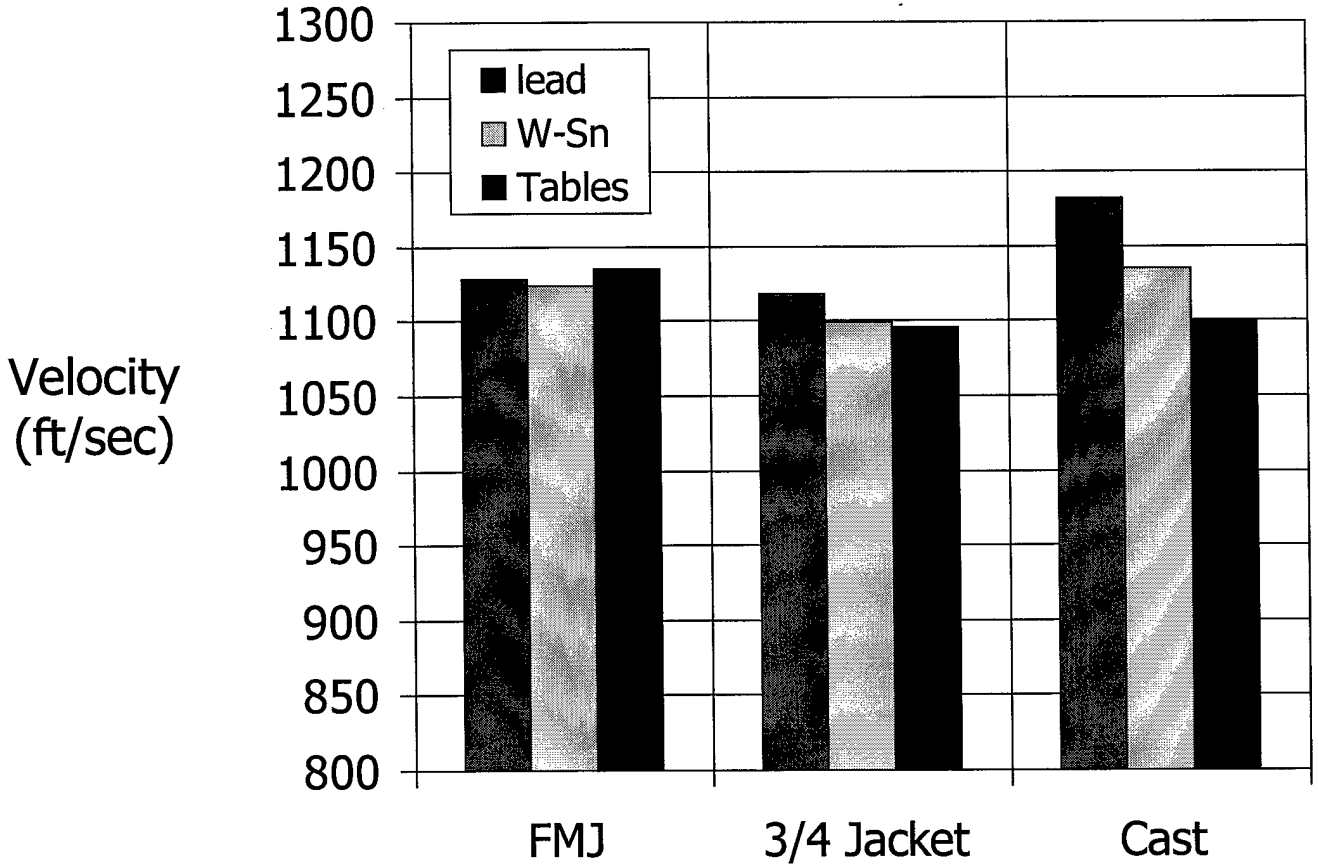
Bullet Caliber	Weight (grains)	Bullet Style	Chamber Pressure (ksi)	Velocity (ft/sec)	Group @ 25 yards (in, w x h)
9 mm	124	ball	38.4	1205	4.1 x 2.4 [7.0 x 3.8]
9 mm	124	Frangible	28.2	1052	0.8 x 1.8
9 mm	124	FMJ	not measured	not measured	not measured
9 mm	124	SP	37.8	1192	1.9 x 2.2 [4.1 x 6.6]
9 mm	115	FMJ	35.5	1125	2.1 x 2.9 [5.3 x 3.5]
5.56 mm	57	OT FB	53.5	3028	4.0 x 3.9* [8.5 x 7.9]

(work conducted in cooperation with Delta Defense Inc.)



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Load-velocity Relationships Are Similar to Those for Lead

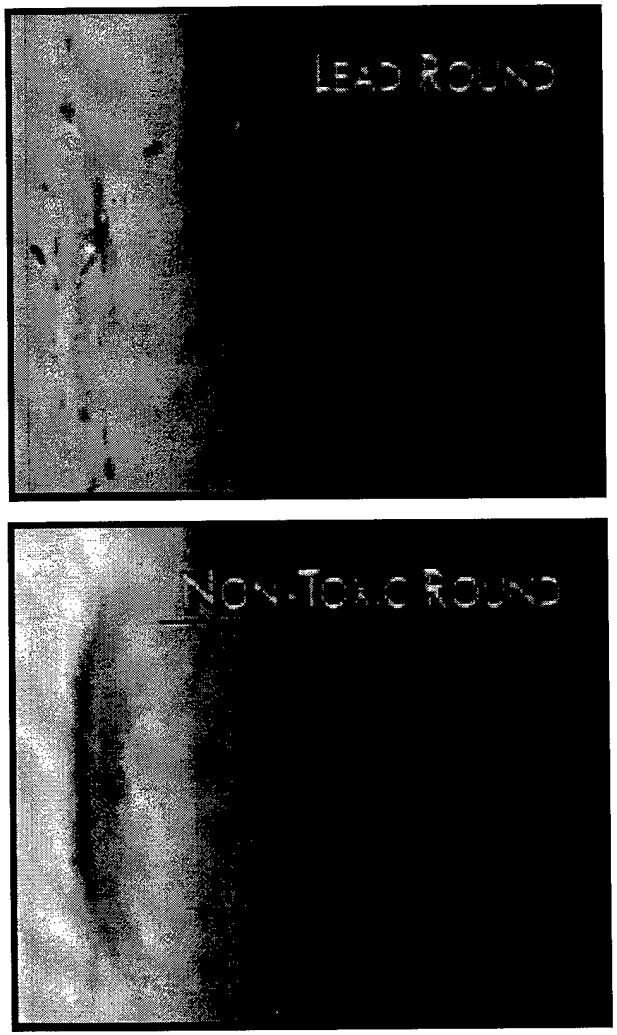


124 grain 9 mm bullet loaded with 5.0 grains W231

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The Impact Properties of the Composite Bullets Can Be Altered



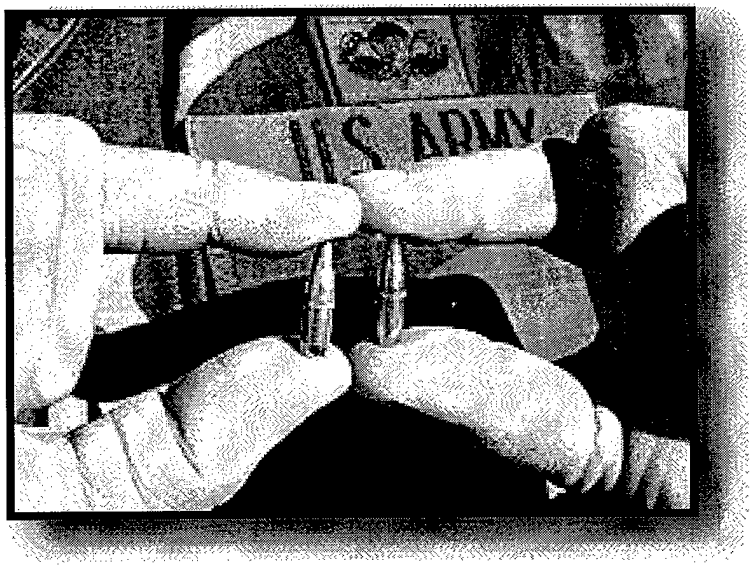
"Frangibility" is a positive attribute!

- Reduced collateral damage
- Minimized ricochet & back splatter
- Close-quarters training
- Urban terrain

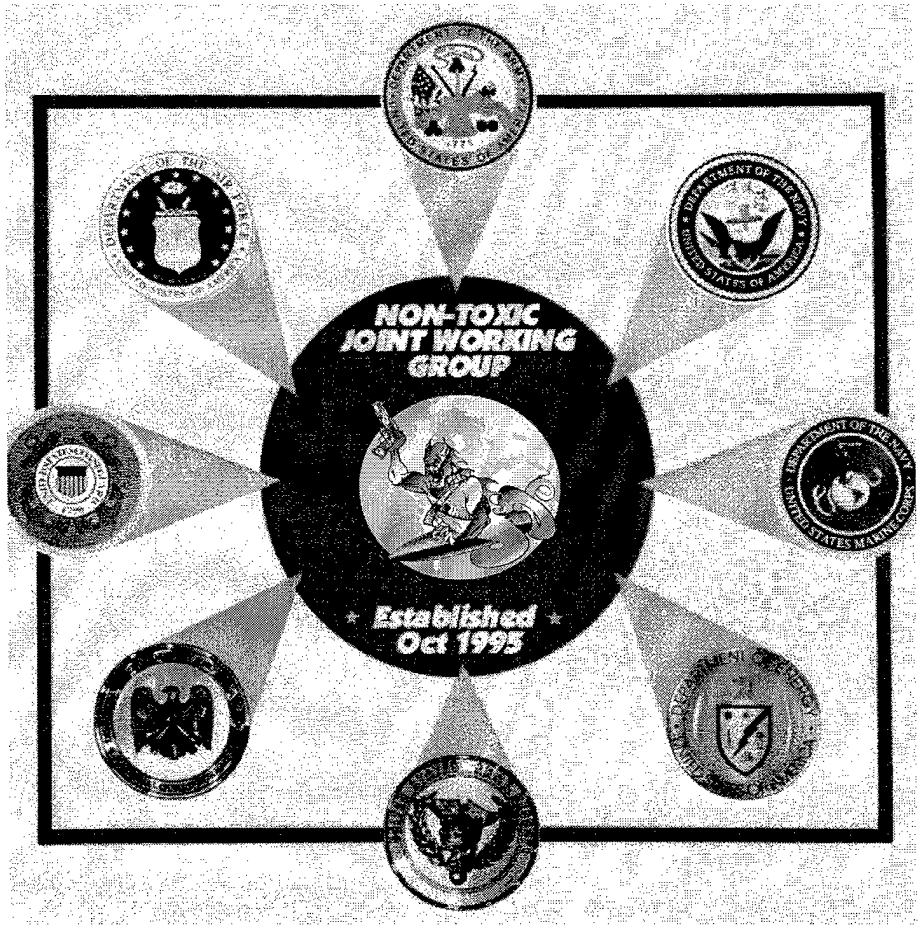


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ORNL Is Part of the Non-Toxic Ammunition Joint Working Group



The Green Bullet Team is working across government lines to more rapidly develop and implement non-lead ammunition.



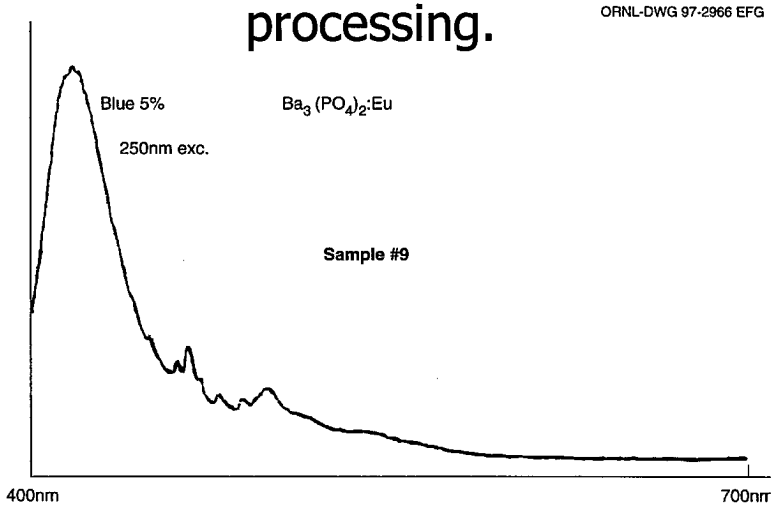


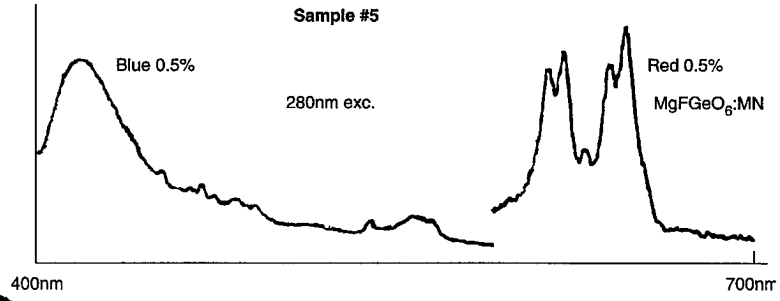
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Powder Metal Bullets Can Be "Tagged" for Easy Identification

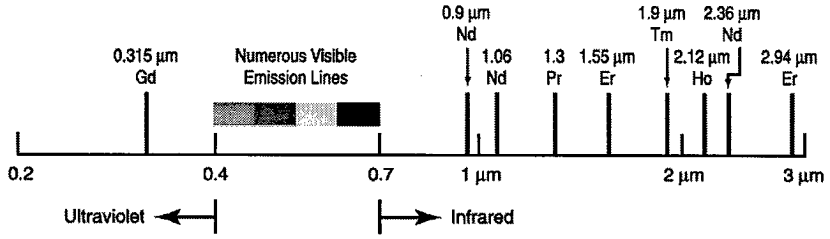
Phosphors can be added during processing.

ORNL-DWG 97-2966 EFG

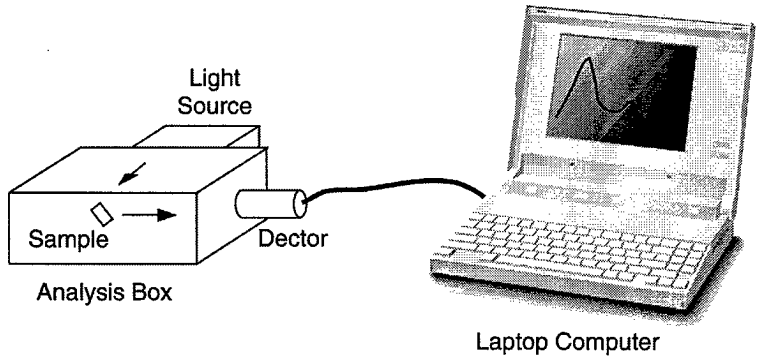




Emittance can be tailored.



ORNL-DWG 97-2968 EFG

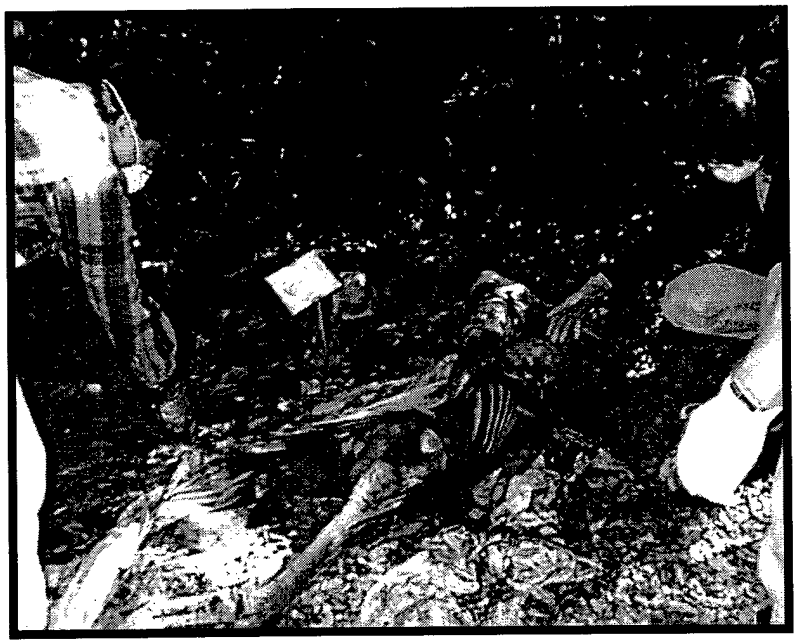


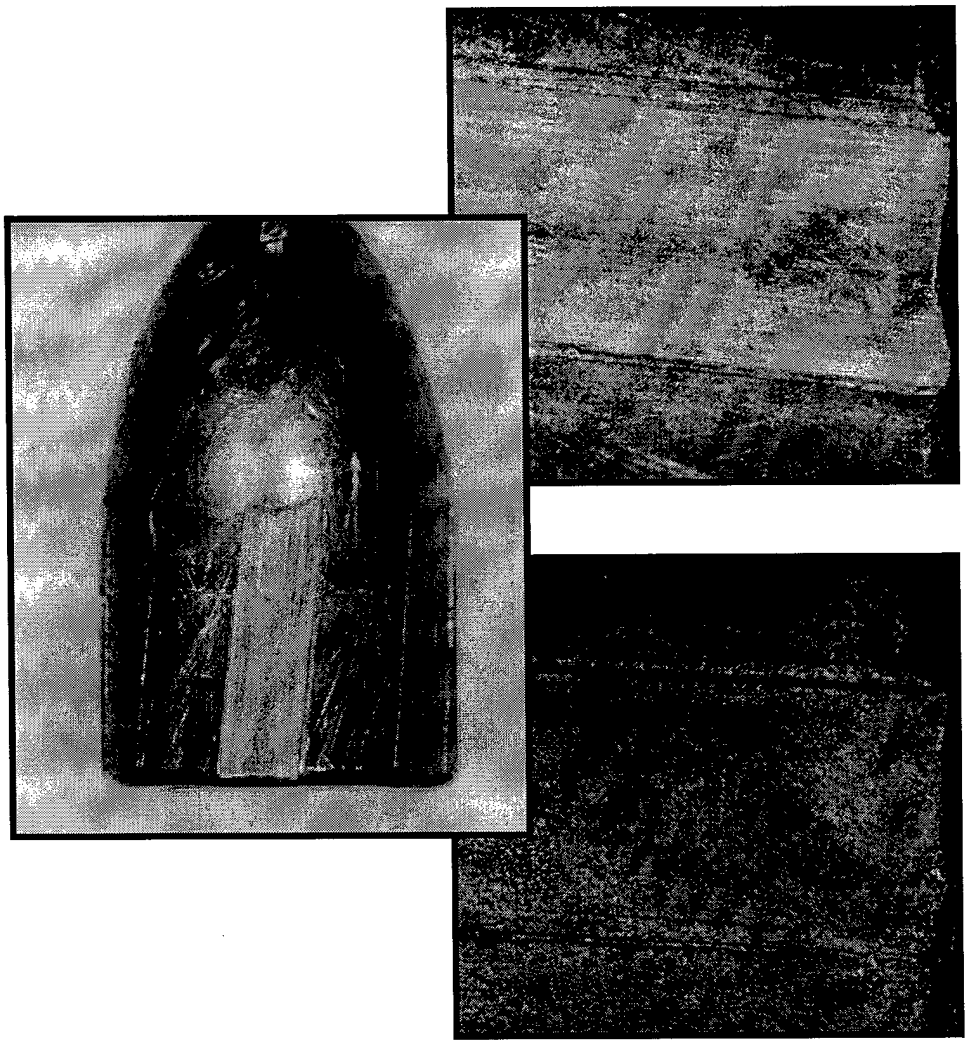
Portable Analysis System

LEAD

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Corrosion of a Bullet Could Be Slowed or Eliminated by Altering the Composition of the Core Material



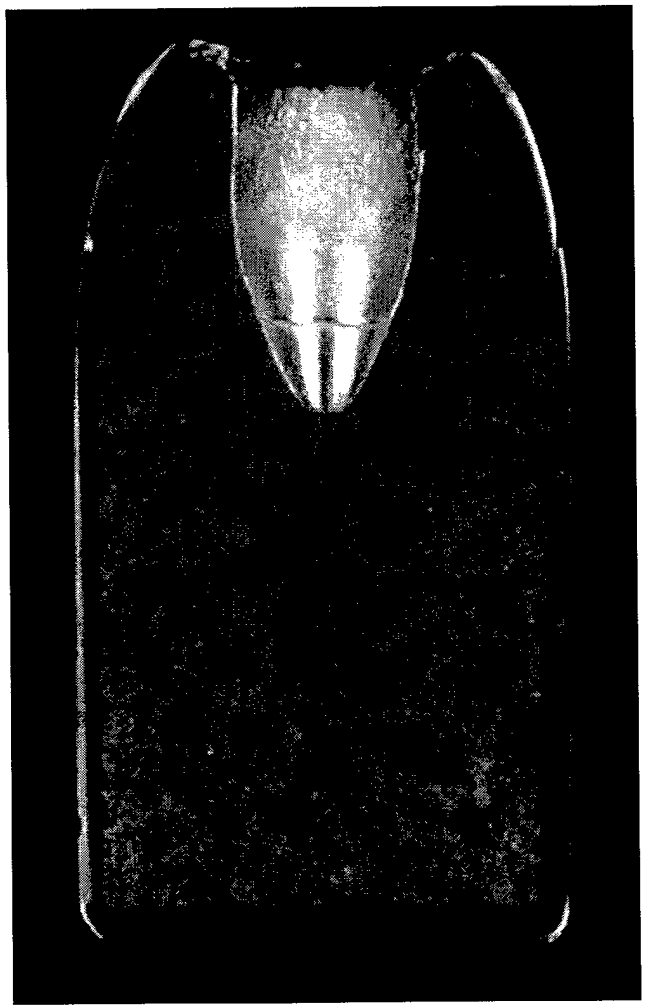


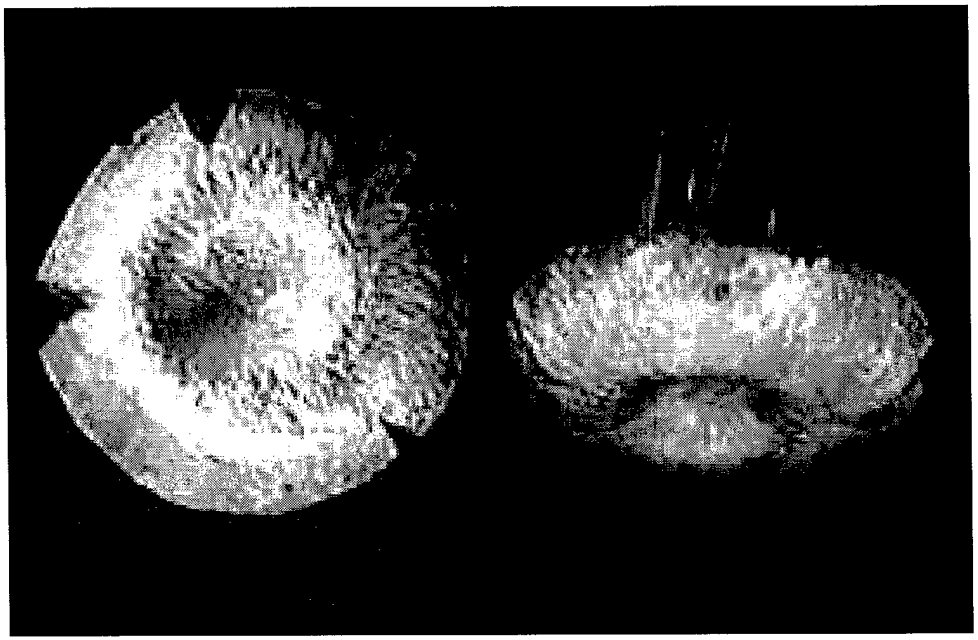
Captured bullets have been implanted into decaying human bodies to examine the effects of decomposition on bullet identification.

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High-Density, Non-Lead Bullets With Controlled Expansion Have Been Produced and Tested



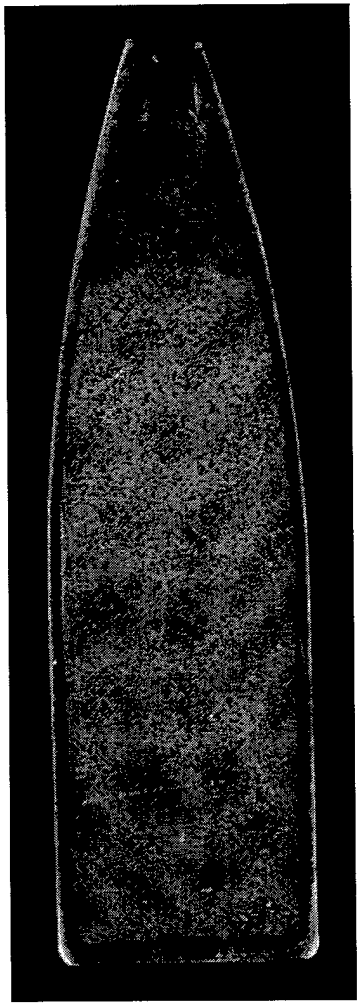


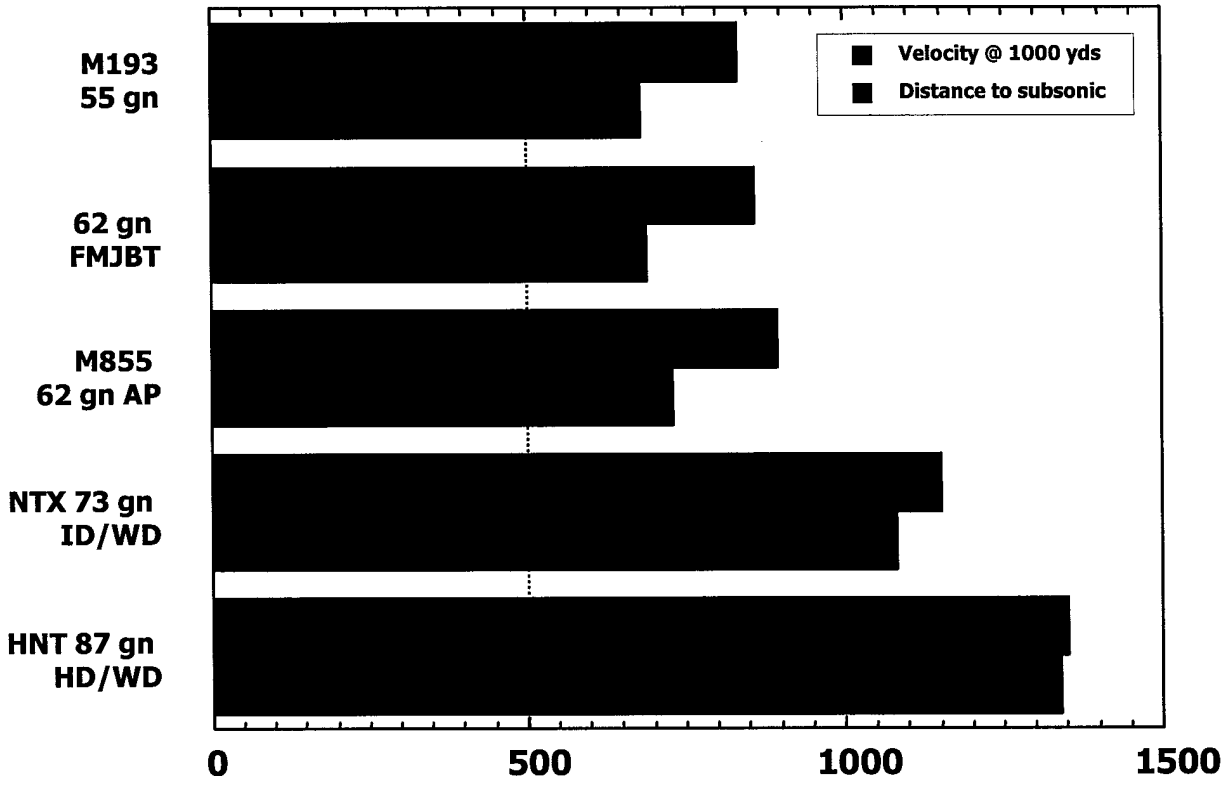
140 grain 357 magnum non-lead HP recovered from ballistic gelatin

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Density and Weight Distribution Can Be Controlled to Enhance Performance



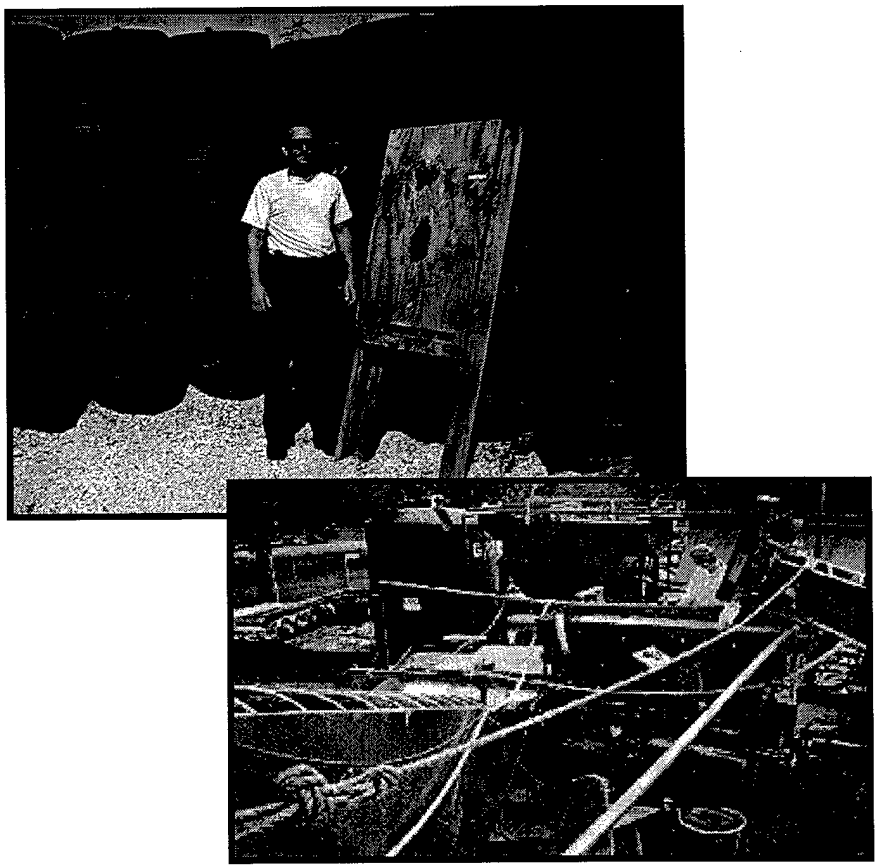


Effective range and accuracy can be extended.

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The Benefits of Using Non-lead Ammunition Are Astounding



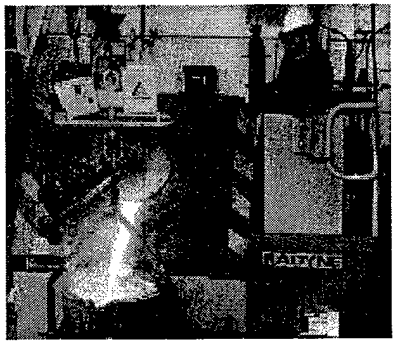
Annual Cost Comparison for the DOE ORR Central Training Facility Live-Fire Range				
			Slug Composition	
			Lead	Tungsten-Tin
Ammunition			$2,500	$7,500
Maintenance & Cleanup			$48,000	$2,500
Total			$50,500	$10,000

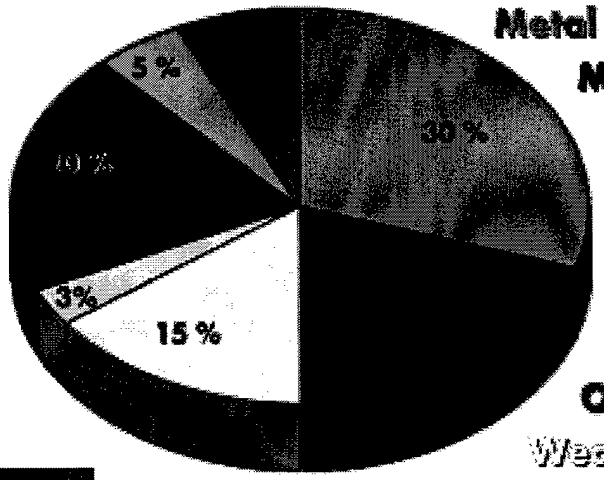
Note: Ammunition cost is based on 10,000 rounds of 9mm per year at $0.25 each. "Cleanup" refers to periodic activities such as the recovery of fragmented bullet material from the traps.

LEAD

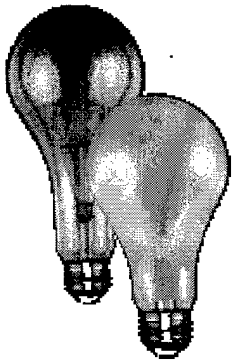
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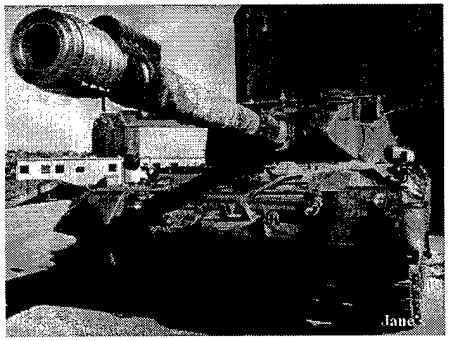
Tungsten Has Many Commercial and Military Uses

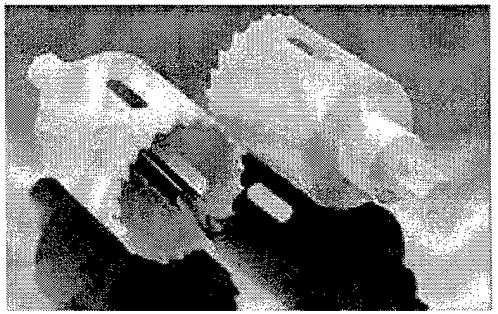


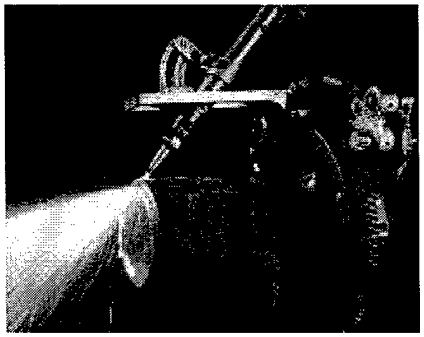


Metal Cutting Machinery
Mining Tools
Chemicals / Catalysts
High Speed Tool Steels
Military Ordnance
Other Markets
Wear Resistant Parts









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The Use of Tungsten in Bullets Will Result in the Dispersion of the Metal Throughout the Environment







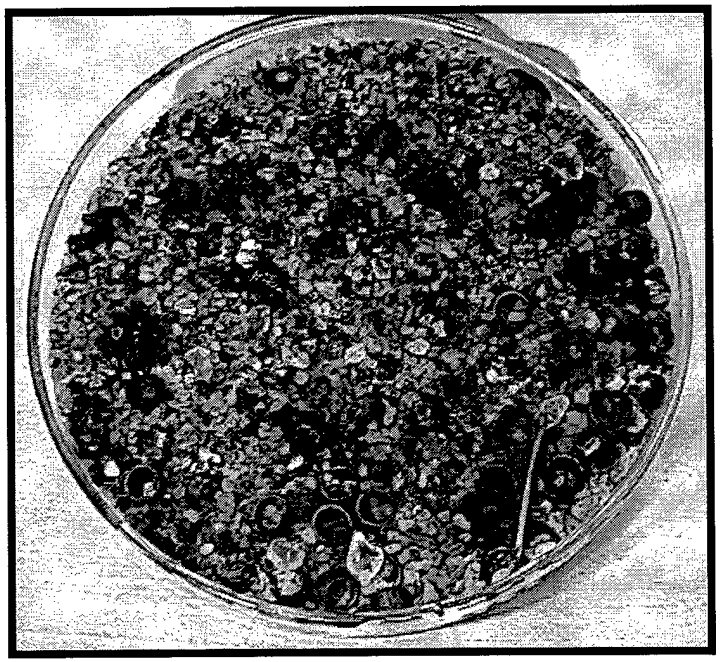




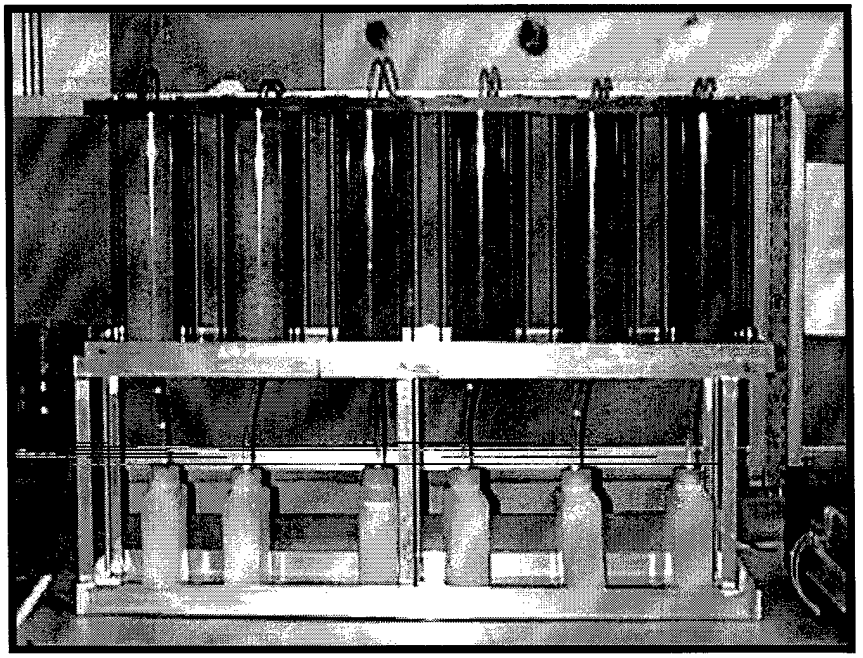


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The Environmental Behavior of the Tungsten-Containing Lead Replacements Is Being Examined



Accelerated corrosion experiments are being conducted.



Mobility in the environment is being investigated.

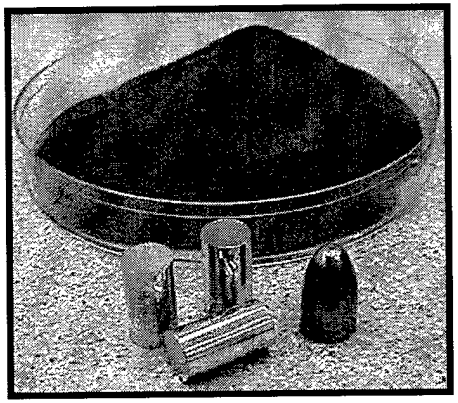


DoD EPA DOE SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

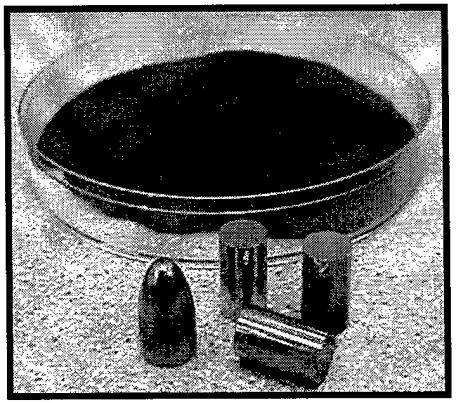
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Recycling of Materials, Specifically Tungsten, is of Great Importance to Lowering Cost

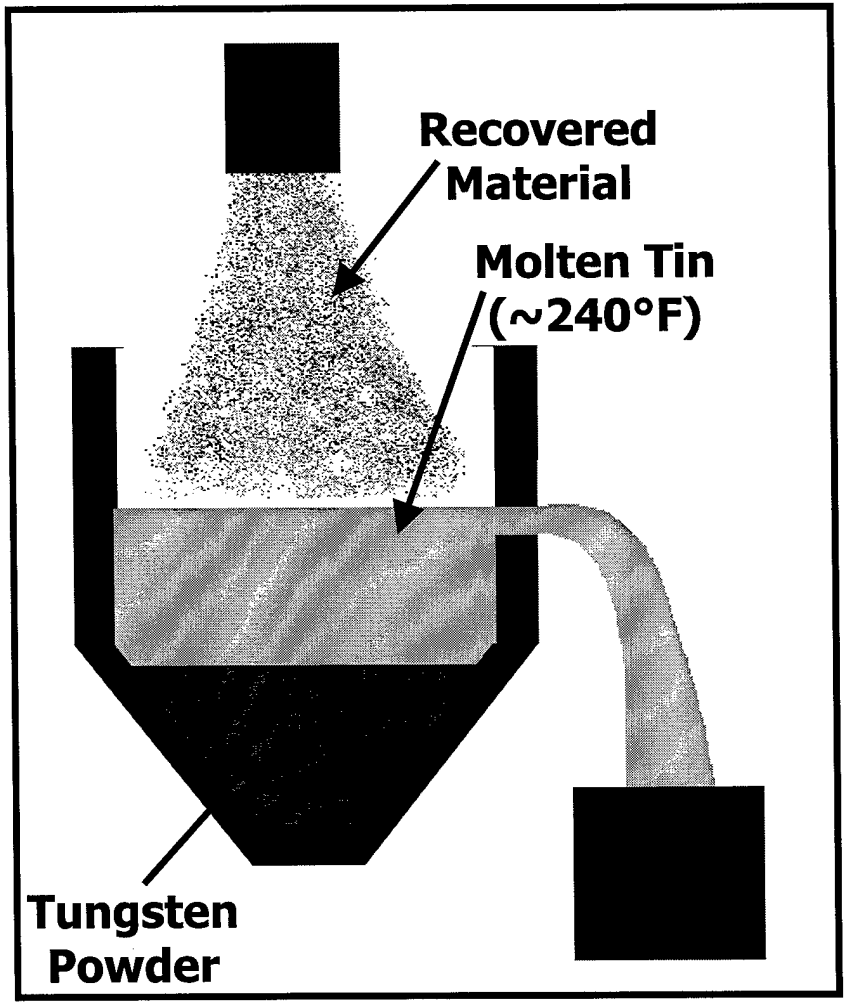
As-Purchased Tungsten



Recycled Tungsten



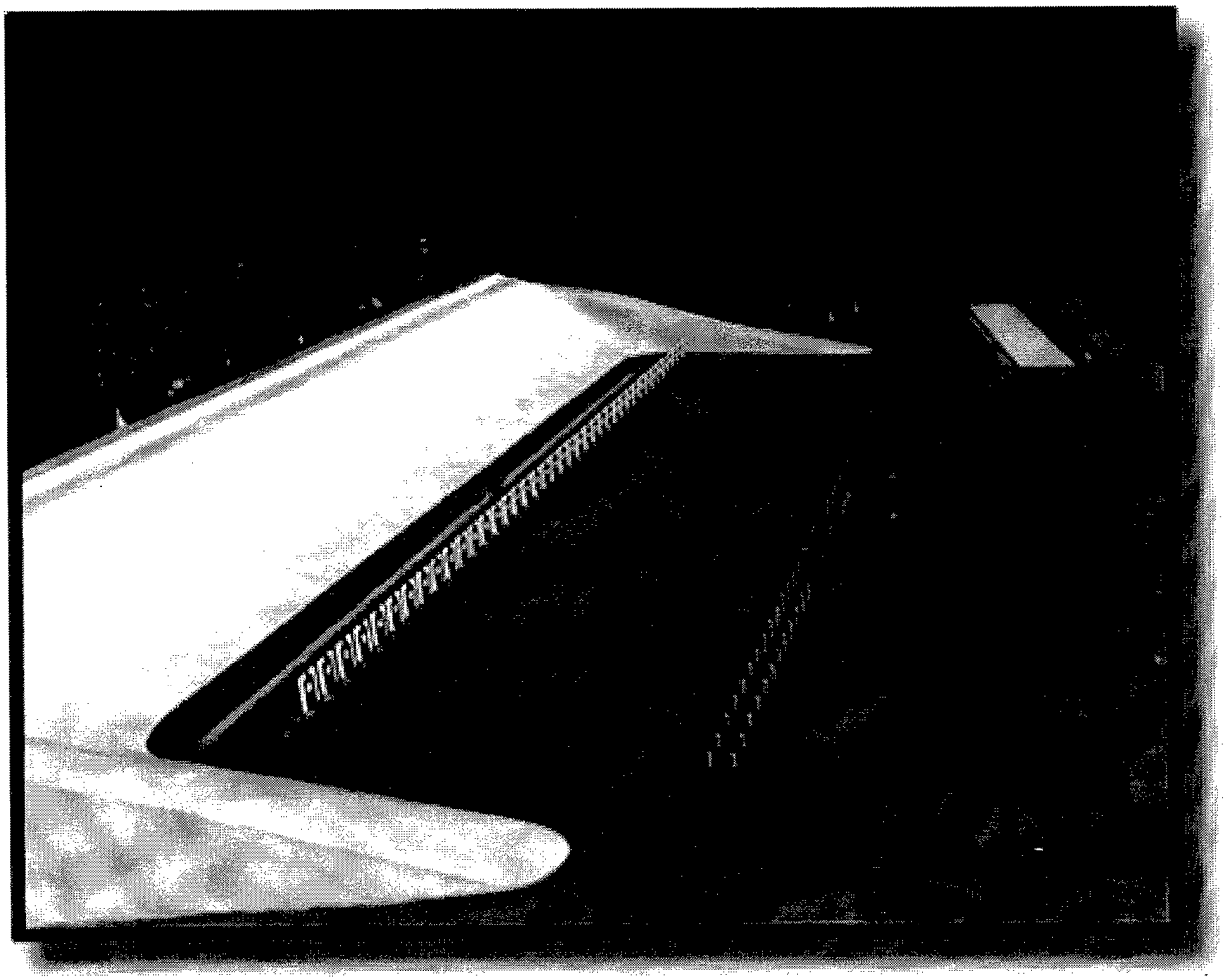
Density Comparison			
Tunsten	**Mix**	**Density**	**% Theoretical**
Raw	5941	11.32	100%
Recycled	5941	10.41	92%



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Ranges Must Also Be Designed to Maximize Capture and Minimize Release of Bullets





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The Impact Of This Technology On The Future Of Small Arms Ammunition Is Being Realized

"It is perhaps the most exciting development in rifle accuracy in the last one hundred years"

A. Chalmers, *Precision Shooting*, August 1996

"This is the most significant advancement in small arms ammunition since the introduction of the jacketed bullet."

J. Knight, SOCOM, *Non-Toxic Ammunition Demonstration*, Ft. Belvoir, VA, September 1996

The bullets are not just green, but are technologically superior to lead.



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SUMMARY

- Powder metallurgy is a viable approach for the fabrication of one-to-one replacements for lead-containing bullets.
- Good results have been achieved using metal matrix composites composed of tungsten bonded with softer, lighter metals including tin and zinc.
- Terminal properties can be controlled through materials selection, composition, and processing.
- The performance of pistol and rifle bullets can be vastly improved using this technology.
- The impact of the technology on the future of small arms ammunition is significant.
- Cost will be reduced through maximizing capture of the bullets, and through recycling of the tungsten and the other metals.



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9MM NON-TOXIC FRANGIBLE TRAINING AMMUNITION



ANDREW ROSE

ABERDEEN TEST CENTER (ATC)

ABERDEEN PROVING GROUNDS

ABERDEEN, MD

(410) 278-8653

****

LILIANA McSHEA

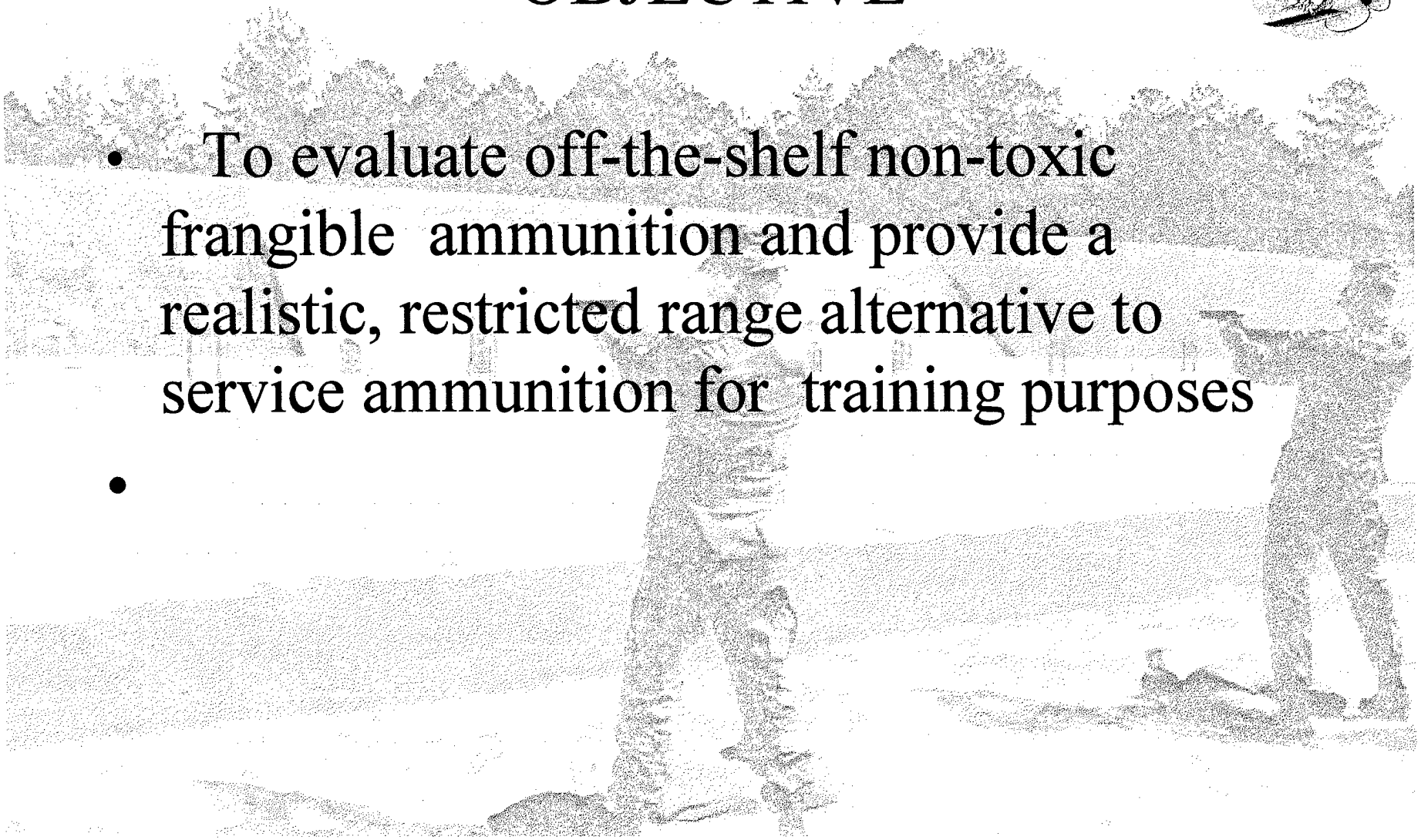
U.S ARMY RESEARCH DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

CLOSE COMBAT ARMAMENT CENTER

PICATINNY ARSENAL, NJ

(973) 724-6089

OBJECTIVE



- To evaluate off-the-shelf non-toxic frangible ammunition and provide a realistic, restricted range alternative to service ammunition for training purposes
-



BENEFITS

- Improve quality of life for instructors and users during training exercises
- Reduction of hazardous waste through the use of non-toxic materials
- Reduce operating costs through efficient local training area utilization
-



BACKGROUND

- The Joint Service Small Arms Program (JSSAP) funded the program
- Industry survey was conducted and three potential sources were evaluated
- two sources were selected for safety release testing
- TECOM granted a safety release on 9 March 98

TEAM EFFORT



- AIR FORCE SECURITY POLICE AGENCY
- ARDEC
  - * JSSAP
  - * Engineering (Small Caliber Green Ammo Team)
  - * Aeroballistics
- Aberdeen Test Center (ATC)
- SNC Technologies
- Delta-Winchester
- Longbow Inc.
-



REQUIREMENTS

• Weapon Systems:	• M9, M11, MP5
• Function:	• No devices or weapon mods.
• Trajectory:	• Match M882 to 50 meters
• Maximum range:	• Less than M882
• Operating environment:	• -20 to 140°F
• Nontoxic cartridge:	• Bullet and primer heavy metal free
•	
• Terminal Ballistics	• Complete breakup upon 1/2" mild steel
•	
• Affect on Weapon	• No decrease in parts life expectancy including barrel



Test Findings

- Chamber and Port Pressures below M882 Ball Cartridge.
- Accuracy and dispersion equivalent to M882.
- Functioned in all weapons with slight degradation in reliability (when compared to M882).
- Completely disintegrates upon impact with 1/2" mild steel target at 35 meters.
- Ballistic match to 50 meters; maximum range less than 1200 meters.
- Produce impulse noise levels requiring single hearing protection.
- Capable of withstanding the effects of rough handling; safe to handle transport, fire and dispose.
-



Test Findings (Con't)

- No adverse effects due to Temperature/Humidity and Thermal Shock.
- No adverse effects due to exposure to common chemicals.
- Produce no lead when fired under controlled conditions; toxic gas levels comparable to standard M882 ammunition.
- Salt fog caused corrosion on case preventing feeding.
- Safe to fire from -20°F to 140°F.
- Can be packaged in the M2A1 shipping and storage container.
-



CONCERNS

- There were no safety incidents; however the ammunition could break during feeding and become lodged in-bore.
- Need to conduct the following tests:
  - Barrel erosion.
  - Primer sensitivity.
  - Terminal ballistics at ranges closer than 35 meters.
-



CONCLUSIONS

- There were no safety incidents.
- Additional tests need to be conducted.
- Lead-free components.
- Operational environment -20°F - 140°F.
- Disintegrates upon impact with required target.
- Can be packaged to current M882 requirements.

SNC INDUSTRIAL TECHNOLOGIES INC.

SIMUNITION
Division of SNC Industrial Technologies Inc.

LEAD FREE, SHORT RANGE, FRANGIBLE AND TRACER SMALL ARMS TRAINING AMMUNITION:

A QUANTUM ADVANCE IN TECHNOLOGY

Presented by:

SNC INDUSTRIAL TECHNOLOGIES INC. (SNC IT)

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NDIA, 1998 SMALL ARMS ANNUAL CONFERENCE

June 17, 1998

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1. ACKNOWLEDGEMENT

Thanks to my colleagues
for their contribution to this program, particularly:

♦ Ms Louise Guindon

Technical Director, Small Arms Ammunition,
responsible for the supervision of the R&D work.

♦ Ms Danielle Tremblay

Responsible for adopting the pencil tracer technology
to the frangible projectile compound.

♦ Mr. Patrick Lizotte

Responsible for optimizing the frangible compound
for both ball and tracer projectiles.

2. GENERAL CHARACTERISTICS

- The technology described in this paper has been developed for 7.62mm ammunition. However, it can well be applied to other small arms ammunition.

- Development works are underway to scale down the technology to 5.56mm caliber.

- The product, known under the trade name Short-Stop® ammunition, is based on a new projectile design with forward fins. A schematic representation of the product is shown in Figure 1.

- The fins introduce "reverse" spin to the rotation caused by the rifling, and thus, the resulting "reverse" spin causes the projectile to become unstable very quickly.

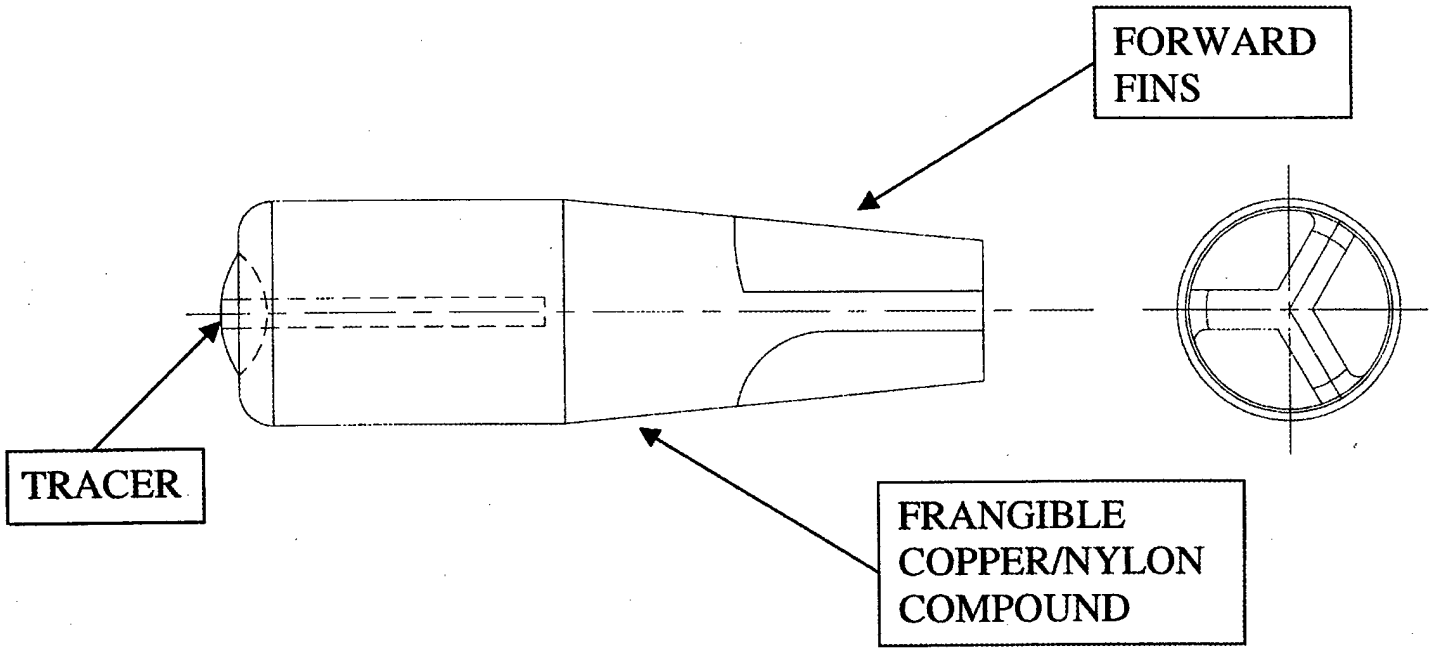


FIGURE 1 – Schematic representation of a 7.62mm SRTA-T projectile

3. MAIN OBJECTIVES

The objectives of the R&D program conducted at SNC IT were as follows:

- To develop a short range training ammunition (SRTA), having a maximum range of about 400-500 meters compared to the maximum range of standard 7.62mm ball ammunition which is about 4,000 meters.

- To develop "green" and frangible ammunition.

- To adopt the pencil tracer technology to frangible compound.

- To match the accuracy of service rounds to 100 meters.

4. STATUS ON THE 7.62MM SRTA PROGRAM

- Generic qualification tests were conducted at ARDEC a few years ago following NATO 7.62mm D150 test procedures.

- An initial type qualification test was conducted by ARDEC and APG in early 1998.

- A full type qualification test should be conducted before the end of FY98.

- The product should be used for training purposes to support, for example, the MOUT program.

- Fielding of the product should take place in FY99 or FY00.

5. INTENDED MISSION AND FUNCTION

The 7.62mm SRTA ammunition solves many problems related to the safety template area within urban environments where there are few places and opportunities to train.

- Realistic training for various training scenarios can be achieved:
  - Reactive steel targets,
  - Shooting houses,
  - Outdoor ranges to reduce danger zones imposed by zoning laws and environmental restrictions,
  - Indoor ranges to reduce environmental maintenance costs,
  - Improvised training facilities with portable backstops,
  - Sniper initiated assault training at facilities using improvised or portable bullet traps.

6. PHYSICAL CHARACTERISTICS

- Cartridge case:
  - Brass (copper alloy 70/30)
- Primers:
  - Lead free primers available
  - Heavy metal free primers available
- Propellant:
  - Double base propellant
- Projectile:
  - Molded copper and nylon compound; the concentration in volume and weight being optimized to minimize projectile break-up.
  - Patented by SNC IT
- Tracer:
  - A pyrotechnic column formed of zirconium powder, potassium perchlorate and a suitable binder.
  - Patented by LSI / USA

7. THE "PENCIL" TRACER TECHNOLOGY: A NEW CLASS OF LIGHT EMITTING PROJECTILE

- Fabrication of the tracer cord:
  - An elongated hole in a cord of soft metal is made,
  - The hole is filled with a pyrotechnic composition,
  - The diameter of the cord is reduced by extrusion to the desired size.
- Introduction of the tracer cord into the projectile body:
  - The cord is cut to the required length (slugs),
  - The slugs are inserted into the interior cavity of shaped projectiles,
  - The slugs are compacted into the projectile body and they are hold in place by mechanical or chemical means.

8. CHARACTERISTICS OF THE TRACER TECHNOLOGY

➢ Advantages of "pencil tracer" technology have been identified. They are:

- Full luminosity and viewing under ***DAY*** and ***NIGHT*** conditions,
- High reliability and simplicity of design,
- Large reduction in caloric output. The "cool light" transmits less than $1/50^{th}$ of the heat to the outside atmosphere as compared to standard tracer ammunition,
- Enhanced safety,
- The heat loss to the walls controls the linear burning rate.

9. BALLISTIC CHARACTERISTICS

a) Maximum range

- Measured and calculated values: less than 550 meters for a quadrant elevation of 30°
- Methods of evaluation: radar tracking and calculations or recovery of projectiles on a suitable runway space.

b) Precision:

- 7.5cm (3in) mean radius at 100 meters

c) Trajectory:

- The 7.62mm SRTA/SRTA-T projectiles match the trajectory of ball round (M80) up to a range of 100 meters; ± 1 mils at 100 meters.

9. BALLISTIC CHARACTERISTICS ... cont'd

d) Function and Casualty:

Temperature	Cycling rate: rounds / min	Weapon
70°F	532 – 560	M60
125°F	543 – 585	M60
- 4°F	538 – 555	M60
The rounds function the weapons without any stoppage at all temperatures.		

e) Noise Level

- Test conducted in accordance with TOP-1-2-608
- Noise level between M80 and the SRTA was found to be less than 1dB difference at each weapon position namely:
- 5 meters rear of muzzle: 138 dB
- 5 meters right of muzzle: 152 dB

9. BALLISTIC CHARACTERISTICS ... / cont'd

f) EPVAT

	SRTA Ammunition	Reference ammunition
Chamber pressure	185 Mpa	365 Mpa
Velocity at 24m	800 m/s	838 m/s

g) Waterproofness

- Submerged rounds into water were subjected to a 50 Kpa vacuum for 30 seconds.
- Results show that the SRTA design with or without waterproofing sealant compound were 100% waterproof.

9. BALLISTIC CHARACTERISTICS ... / cont'd

h) Ricochet

- No significant fragments were recovered after impacting steel targets placed 5 meters from the muzzle of M60 machine guns at 0° and 30° obliquity.

i) Recoil

- Less than or equivalent to that obtained with service ammunition.

10. GUIDELINES FOR SAFETY AND USE

- No specialized procedures, techniques, tools as test equipment are required to train with Short-Stop® ammunition.

- This ammunition can be lethal.

- It is not recommended to stand 5 yards to the side of a target since metallic dust from impact of the projectile could cause an injury.

- Following sustained fire, the chamber should be emptied if there is a long delay until the next firing takes place.

- A minimum backstop plate of 1/4 inch armoured steel is recommended.

11. CONCLUSION

- The new Short-Stop® lead free, short range, frangible and tracer 7.62mm ammunition represents a quantum advance in the small arms ammunition technology.
- The same technology could be applied to other small arms weapon / ammunition systems.
- The initial and the final development phases are completed.
- The SRTA ball ammunition has already been industrialized.
- The product is safe to use and meets or exceeds environmental regulations.
- More detailed technical information can be obtained upon request.
- A firing demonstration will be done during the last session of this conference.

Fifty Caliber Match Ammunition
By
Dr. Eric L. Williams & Buddy G. Clifton

Introduction

In 1985 a small group of shooters, enthusiastic about sporting uses for the fifty Browning Machine Gun cartridge, formed the Fifty Caliber Shooter's Association (FCSA). Instrumental in the formation of the association was Marty Liggins - at that time a ballistician for Accurate Powder Co. Within a year, Marty had organized the first national shooting competition held in Lodi, WI in which six shooters competed.

In that first match, a 9 5/16" five-shot group at 1000 yards had been fired. This first benchmark gave notice of the long-range potential of the .50 BMG cartridge as fired from a portable, shoulder fired weapon. Within the realm of small-arms, the .50 BMG cartridge possesses the greatest effective range potential. This range potential comes from fifty caliber projectiles possessing a greater transonic range and lower wind deflection than smaller caliber projectiles. These attributes are fundamentally due to the higher ballistic coefficients attainable from .50 caliber projectiles compared with smaller caliber projectiles. The high ballistic coefficient coupled with the variety of projectile types available, gives the .50 caliber its unrivaled long-range capability for a small arm.

An aspect of the FCSA which brought about significant accuracy developments was the quality of people who made up the association. A survey of the membership indicated that 77% of members were educated beyond high school, and 65% were business owners or salaried professionals. Inventive people coupled with the passion that competition brings, has improved the 1000 yard, five-shot group record to 3.2395 inches. Consistent sub-minute-of-angle groups are evident from the six-target aggregate record of 7.4271 inches.

What will be described in the remainder of this paper are the various loading components that make up the precise fifty caliber match round.

Figure 1 - A History of FCSA Records

Single Target / 5-Shots / 1000 yards

1986 - 9.3125" Eric Williams, MO
1991 - 8.75" Bruce Seiler, MD
1991 - 7.1875" Art Guidi, MA
1991 - 6.8125" Dennis Chapman, TX
1991 - 4.25" Skip Talbot, NV
1992 - 4.034" Skip Talbot, NV
1995 - 3.2395" Craig Taylor, WA

Six-Target Average / 1000 yards

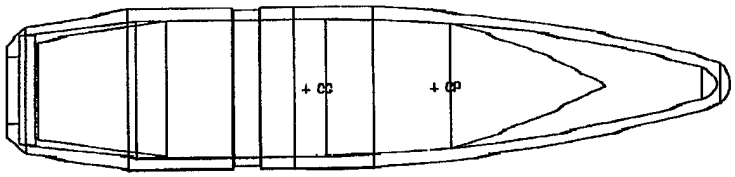
1996 - 8.0417" Buddy Clifton, CA
1997 - 7.4271" Scott Nye, IL

Projectiles

Over the 13 years members of the FCSA have been competing, the most significant advances in technology have come in ammunition. Sorting out the various components in a fifty caliber round, the most effective improvements have come in projectile technology.

As a basis for comparison, Figure 2 shows a drawing of a military API fifty caliber projectile. In order to have a standard model for making fair comparisons, we have analyzed a variety of projectiles using PRODAS - a projectile computer modeling program licensed by Arrow Tech Associates. The calculated properties were derived by first entering the physical dimensions and densities of the bullet components. The bullets were then modeled at a velocity typical as fired from a match rifle. The transonic range represents a maximum effective range. The accuracy potential can be roughly gauged by a combination of the wind deflection numbers (at 1000 yds.) and the dispersion sensitivity. The dispersion sensitivity (lower numbers are better) is dependent on design features of the bullet - most importantly, the placement of the center of gravity. Bullet length is also shown in the tables. This must be considered if the ammunition is to be used in a magazine fed weapon. Only rounds less than ~5.5 inches will feed through magazine fed weapons.

Figure 2 - M-8 API 650 Grain Projectile

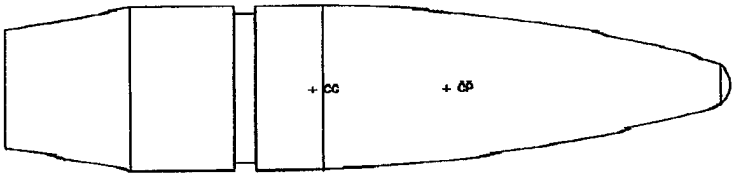


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.69	**2800**	**1593**	**58.5**	**0.016**	**2.31**

When the association began competition, the only projectile available besides military offerings was the Thunderbird Cartridge Co., Inc. 750 grain solid (Figure 3). This bullet essentially copies the external dimensions of the military API projectile shown above. Being a homogenous brass solid, this bullet is much more consistent than the four-piece military projectile. Due to its greater mass, it has a higher ballistic coefficient than the military projectile giving it better range potential. Although it has a larger dispersion sensitivity than the military projectile, its construction simplicity more than makes up for this deficit. It held all the FCSA records prior to mid-1991, and can easily deliver sub-MOA groups at 1000 yards. A downside to this bullet is its tendency to foul barrels.

Figure 3 - Thunderbird 750 Grain Projectile

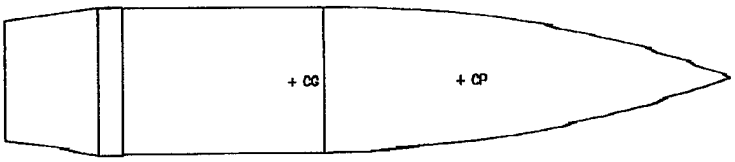


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.84	2750	1914	47.0	0.020	2.32

In 1991 a small tool company in California (Zero Index) began manufacturing a solid projectile made from a soft steel alloy (Figure 4). The noteworthy attribute of this projectile was its high degree of dimensional precision as a result of being finished by centerless grinding. It also featured a driving band which was added to reduce both fouling and bore wear relative to a fully engraved projectile. This projectile established new records of 4.25 and 4.034 inches in 1991 and 1992 in spite of the fact that its ballistic coefficient was no better than military offerings.

Figure 4 - Zero Index 700 Grain Projectile

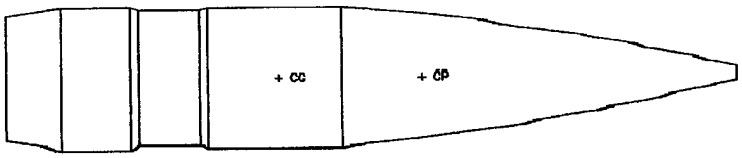


PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.70	2800	1686	57.5	0.015	2.50

The current world record holding projectile is the Barnes 800 grain, bronze solid (Figure 5). This bullet's highly efficient secant ogive coupled with its heavy weight results in a high ballistic coefficient. Even though its heavy weight limits its muzzle velocity, the high ballistic coefficient results in a 29% extension of transonic range over military projectiles. As with the Zero Index bullet, the Barnes offering utilizes a driving band and a bourrelet. This design feature significantly reduces bore wear and fouling. A similar design is also available from Barnes in a 750 grain weight. Both of the Barnes bullets are dimensionally very consistent.

Figure 5 - Barnes 800 Grain Projectile



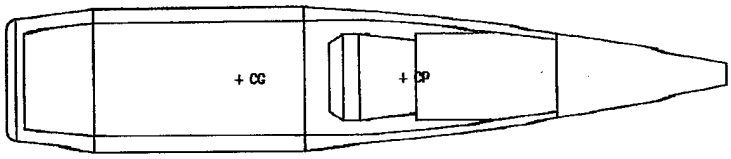
PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.98	2700	2054	40.1	0.018	2.65

A recent and innovative addition to the selection of fifty caliber match projectiles is the Hornady A-Max design. This bullet is partly a traditional lead-cored, copper jacketed bullet. The innovation in this bullet is a sizable aluminum insert placed in the nose. This insert serves two purposes. First, it shifts the bullet's center of gravity rearward resulting in the relatively low dispersion sensitivity; and second, it forms a large part of the efficient ogive. Without the insert, a lead filled design with these dimensions would weigh approximately 900 grains; and could not be fired at desirable velocities.

Although the Hornady bullet has not yet been used in match competition to the degree of the Barnes bullet, it has shown that it is capable of 0.5 MOA groups.

Figure 6 - Hornady A-Max 750 Grain Projectile



PRODAS Calculated Properties

BC (G1)	Velocity (ft/sec)	Transonic Range (yds)	Wind Defl. (in/10MPH)	Dispersion (mils/rad/sec)	Length (in)
0.96	2750	2073	40.0	0.011	2.56

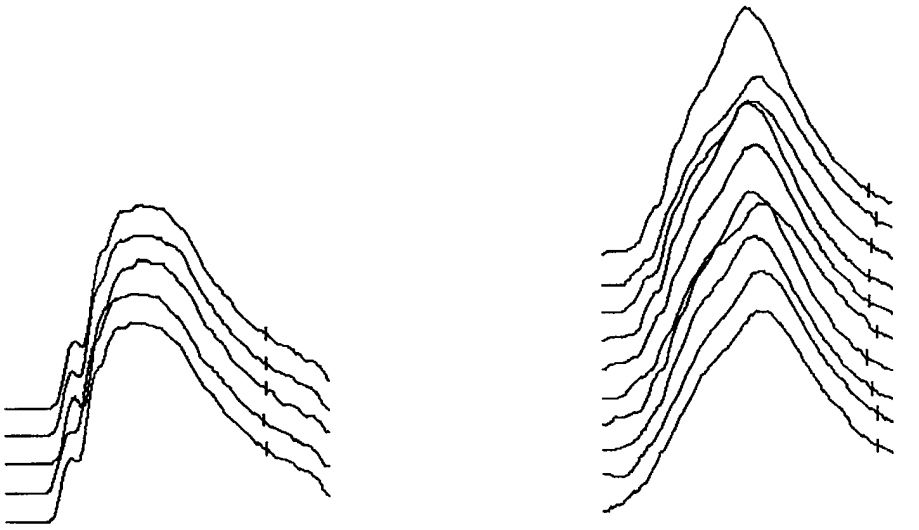
These bullets represent the trendsetters in the sport, but are not the only designs available to shooters. Numerous other small volume producers can be found in the FCSA Suppliers List.

Propellants

Up until the last four years fifty caliber match shooters relied on the supply of surplus military, fifty caliber propellants. These propellants include WC870, WC860, WC872, IMR5010 and T5070 (a renamed spherical propellant of unknown origin). Most of these were quite well matched in burning speed to the fifty caliber case when firing a 650 grain military projectile. However, when used with heavier 750 and 800 grain projectiles these propellants are too fast in burning speed. Because of the poor match between projectile weight and propellant speed, lower than desired loading densities resulted.

Shown below in Figure 7 is a comparison of pressure/time curves between a military load and a load with a poorer loading density. The shot-to-shot consistency can be seen by looking at the overlay of the curves. The military load with the lighter bullet is more consistent than the lower density load.

Figure 7 - P-T Curves of a Military Load and a Low Density Match Load



WC 860 Military
650 gn M33 Ball
55,400 psi (ave.)

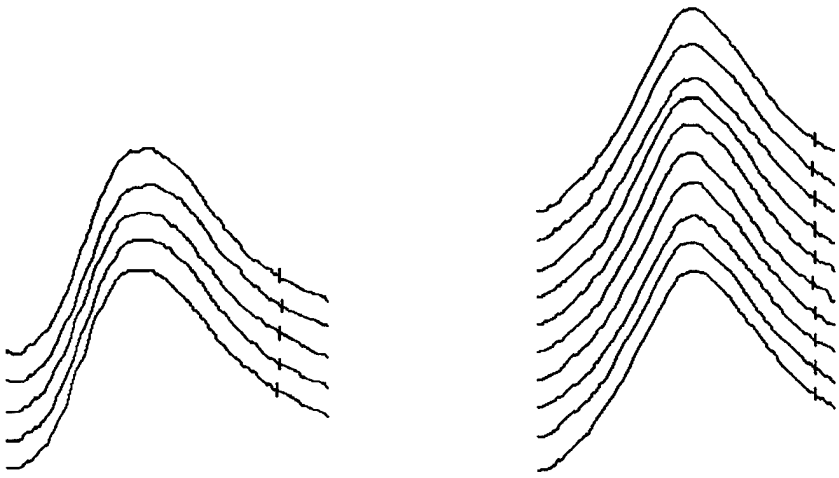
230 gn. T 5070
750 gn TCCI
59,200 psi (ave.)

In 1994 Kaltron-Pettibone began the importation of a 20MM cannon propellant from the Finnish company Vihtavuori Oy. Fifty caliber shooters quickly found that this propellant was well suited to the .50 BMG case when loaded with heavy match bullets. This propellant is the favorite of match shooters, and holds the current world records.

Recently, some samples of Primex's WC886 (a 25MM propellant) were tested in some fifty caliber loads with heavy bullets. This propellant is slower burning, higher in energy and features a more advanced formulation than the older generation fifty caliber Ball® propellants.

Figure 8 shows some pressure/time curves for these two newer propellants. In both cases, the loading density is high and the curves are highly consistent.

Figure 8 - P-T Curves for VV 20N29 and Primex WC886 Propellants With Heavy Match Bullets



250 gn WC 886
750 gn AMAX
55,500 psi (ave.)

250 gn VV 20N29
800 gn solid
56,000 psi (ave.)

Primers

Match reloaders have had, until very recently, only two brands of primers available; namely, the RWS#8212 and the CCI#35. The RWS primer is the 2:1 favorite of match shooters. It is characterized by a soft cup and a lower brisance flame. In contrast, the CCI primer has a hard cup and is higher in brisance.

Very recently, IMI primers have become available. These primers appear to be similar in some characteristics to the CCI primers.

Cartridge Brass

Match ammunition almost exclusively starts with new cartridge brass. For the reloader new brass has been available from Israel Military Industries. This brass, with some preparation steps, is consistent enough to produce good quality match ammunition. The IMI brass was used in all the current FCSA world records.

Another brand, from SNC Industrial Technologies (Quebec), has recently become available to reloaders. In terms of dimensional consistency, this brass is the best available; and will likely become the match shooters' favorite.

US military brass is sometimes used by match shooters. Its major drawback is that it is only available to shooters as machine gun fired. Machine gun fired brass can be highly stretched in the web due to the lack of headspace control in machine guns. Brass which has stretched in the web will not withstand multiple reloads.

Aberdeen Test Center Capabilities Demonstration

In 1997 co-author Buddy Clifton conducted a long-range capability test at Aberdeen Proving Grounds. Buddy fired his light match rifle using his favorite match load at 1200, 1500 and 1900 meters. He also fired a Barrett M82A1 with military Mk211 ammo at the same ranges for comparison. The load Buddy used and the results are shown in the table below.

Projectile - **Barnes 800 gn solid**
Case - **IMI**
Primer - **RWS 8212**
Powder - **258 gn VV20N29**
Velocity - **2690 fps (34" barrel)**

Rifle / Ammo	1200 M ES inches	1500 M ES inches	1900 M ES inches
M82A1 / Mk211	50.9	87.2	151.3
Clifton Match	11.9	31.7	44.9

The data is the average extreme spread for three, three-shot groups. The groups for the match ammunition are one-third to one-quarter the size of the military ammunition demonstrating the superiority of match over mass produced military ammunition.

Summary

Significant advances in fifty caliber ammunition precision have been made by competitive shooters of the Fifty Caliber Shooters' Association over the last 13 years. Commercial bullet makers have made possible the greatest advances in long-range ammunition technology with the manufacture of precision, low drag bullets. These bullets offer a 29% advantage in transonic range when compared to standard military bullets.

Match grade bullets are available as homogeneous solids or as jacketed designs. The solids are more consistent dimensionally, but can be sensitive to varying bore dimensions. The jacketed designs, such as the Hornady, are more tolerant of varying bore dimensions due to their ability to swage or obturate to fit the bore.

The most consistent ammo is produced using slower burning propellants than what is normally used in fifty caliber ammunition. Propellants suitable for 20MM and 25MM cartridges work best in the .50BMG when firing heavy match projectiles.

Currently, the best components available (based on match results and physical measurements) are the Barnes 800 grain solid, Canadian IVI headstamped cartridge brass, RWS primers and Vihtavuori propellant.

Acknowledgments

The authors thank Jim Frigiola of VTS Inc. for his coaching and for serving as a bridge between the FCSA and the NDIA. We also thank Arrow Tech Associates for the use of PRODAS. Randy Brooks of Barnes Bullets and Dave Emary of Hornady have provided the necessary modeling data for their bullets which has been greatly appreciated. We thank Steve Faintich of Primex for propellant samples and consultations.

We welcome all to visit the Fifty Caliber Shooters' Association's web page at "www.fcsa.org" for more information on the association and the sport.

The AK-based Russian "SAIGA-12" combat shotguns

The 1970s are considered to be Golden Age of Soviet Defense Industry. The number of personnel in the defense sector of the national economy was estimated as many as 4,800,000 people to compare to 3,350,000 in the U.S.A., 700,000 in UK and 290,000 in the Federal Republic of Germany. Izhmash's* military sector operated at full steam and turned out more than 500,000 "Kalashnikov" assault rifles of various types per annum.
The early 1980-s saw a precarious economic imbalance between the civilian and military sectors, with the scales heavily tilted toward military production. In Izhevsk** alone, about 80 percent of industries had defense orientation.
In the late 1980s, however, due to the ongoing liberalization and democratization of Russian society, the "military industrial machine" began to reveal its first symptoms of malady.
The first really serious blow on the defense industry came in 1988 when the Soviet Government declared its decision to cut the defense budget by 14 percent and military production by 19.5 percent during the years 1989 and 1990. Further developments that took place in the International arena only aggravated the situation.
After the collapse of the Soviet Union in 1992, and as a result of disintegration of the Warsaw Pact, Izhmash faced a serious problem in small arms sales.
Izhmash's leading specialists in cooperation with the Arms Design Center outlined the principles of conversion - the strategy of transferring a part of the company's military production potential into civilian.
In fact, Izhmash's model of conversion was based, for the main part, on preserving the existing productional potential and adapting it to manufacture of para-military and sporterized firearms, to be developed on the basis of AK and SVD.

In 1993 the factory developed the SAIGA rifle chambered for the 7.62 x 39 mm round. It turned out a promising experiment. This encouraged IZHMASH to create novel smooth-bored auto-loading shotguns. Company's gun specialists decided to develop a shotgun which would require the least number of changes: in gauge .410. Frankly speaking, we did not expect that this weapon would become so popular. Statistically, the guns in this specific gauge make only 5 to 7 percent of the world's firearms market share. However, the SAIGA-410 short version with the folding stock sold very well, the main market segment being various security agencies (banks, offices, etc.)
What was important, people at IZHMASH were able to understand, the way out of the situation was found! We moved in two directions: more new rifles and more new shotguns. IZHMASH made improved rifles chambered for the 5.6x39 and .308 cartridges and a shotgun in ga. 20.
Then there was the war: in the Central Asia, the North Caucasus and

Moldavia.

(*) The IZHMASH Open Joint Stock Co. is Russia's largest arsenal home of the AK family of small arms. Founded in 1807.
(**) Izhevsk, the city with population of 730,000 people, is located in Western Urals 1,200 kilometers east of Moscow.
Numerous attacks of terrorists on the civilian population made us realize, the SPECOPS may need a shotgun to be used in the changing type of tactical operations:
(a) short/close ranges, mobile actions in cities with high concentration of human population;
(b) mobile patrols for the purpose of creating a screen around such places where surgical/policing operations were under way.
Application of issue army automatic weapons (AKMS or AKS74U, for example) resulted in numerous and unwanted "side effects" - casualties among citizens.
The facts were telling us, a combat shotgun based on the AK system would be just perfect. Why the AK system? The considerations were as follows:

1. The degree of parts commonality would make maintenance and repairs easier from the point of view of the stock of spare parts.
2. Training of shooters who are familiar with the AK weapons was easier and more effective thanks to constructional similarity.

One of such weapons is a smooth-bored shotgun in gauge 12 and designated the "Saiga-12". The shotgun is available in three main configurations:
(1) "Standard" - with the 580 mm long barrel and a non-folding buttstock;
(2) "Standard Folding" with the barrel 580 mm long and a folding stock;
(3) "Short" with the barrel 430 mm long, with the folding buttstock derived from the AK74M.
To special orders, the factory makes barrels 330 and 680 mm long.
Barrels of the "Saiga-12" are made either cylindrical or with the full choke of 1.0 mm.
Cylindrical barrels may be optionally equipped with various muzzle devises, such as: "paradox", half-choke or full choke. The gun accepts all brands and types of ammunition in ga. 12.
Two of the three available modifications of said shotgun - Saiga-12C and Saiga-12K - have been constructed as service weapons.

As seen from the transparencies, there is a significant resemblance between the "Saiga-12" and the AK rifles: Top (bolt) cover, fire-mode selector, buttstock, pistol grip are identical.
Although the receiver looks very much the same, it has been considerably modified.
On the whole, 65 % of components of the SAIGA-12 shotguns are derived from

the AK47 construction.
For the purpose of retaining original size of receiver, on the one hand, and a necessity of providing room for a large bolt, on the other hand designers came to an original solution - the upper location of internal bolt carrier's guiding rail was changed. In the "Saiga-12" shotguns the rail is located at the receiver's bottom.
As for the bolt carrier and trigger mechanism, there are several important alterations too. First, a portion of the right side of the rod which connects bolt carrier with piston is milled off at an angle to ensure trouble-free operation of the mechanism of extraction of a larger shell.

To match the size of shells, the ejection opening in the right side of the top cover above receiver is also made larger. A stamped steel-sheet sliding shutter has been provided on the guiding rod of a return spring to prevent excessive penetration of dust and other unwanted foreign particles into receiver. Due to application of heavy-duty types of cartridges and for the purpose of enhancing proper locking of the top (bolt) cover to the receiver, the protruding base lug of the return mechanism, which also functions as a retainer of the top cover, has been provided with an additional knob. Thus, to remove the top cover proceed as follows: depress the knob and, holding it in such a position, push the extending locking lug inside the cover - the cover easily comes out from its recess. In contrast to the original AK assault rifle, "Saiga-12" has a gas regulator which could be placed in either position "1" or position "2" depending on the type of ammunition - standard 70 mm or "Magnum" 76 mm shells. The weapon operates with both types of ammo.
The additional locking knob and the gas regulator have been made due to the following considerations. It has become a standard in the Russian small arms design school, that the speed of recoil of bolt carrier should be 4 m/sec. Such speed enables stability of reloading without the need for a gas regulator. In the "Saiga-12" shotgun due to usage of heavy-duty ammunition, the speed of recoil of the bolt carrier is substantially greater. With the gas regulator the recoil speed is reduced to a safe level. Further research on the gas engine of the "Saiga-12" resulted in creating a system which functions with 70 and 76mm-long shells without changing the position of gas regulator. So in reality the regulator is required when it comes to utilization of high velocity loads.
More alterations were made in the trigger mechanism of the "Saiga-12" by eliminating an auto-sear. Hence, the selector functions only in two modes. The upper position marked "S" is safety and the lower position marked "F" is fire.
A considerable advantage of the construction of the "Saiga-12" universal magazines is in their versatility in regard to the size of shells. Conventional pump-actions are sensitive to the cartridges of different lengths. Different length of the shells loaded into a horizontal magazine

in a "head-to-tail" manner means irregularity of feeding stroke which invariably may lead to jamming. The "Saiga-12" vertical single column magazine enables the capability of using ammunition of the two sizes in a random combination. Capacity of black glassfiber-reinforced polyamide magazines is "Standard" 5 rounds or "Special" 7 rounds. For experimental purposes the factory devised and manufactured welded sheet-metal magazines which hold 10 rounds.

Table 1. KINETIC PARAMETERS OF SAIGA-12

Length of barrel	Size of shell	Shot load	V10 E10
580 mm	12/70	33 g	311 m/sec 1,600 J
580 mm	12/73	53 g	302 m/sec 2,500 J
430 mm	12/70	33 g	290 m/sec 1,500 J
430 mm	12/73	53 g	280 m/sec 2,300 J

As seen from the above diagram, decreasing the length of barrel by 26 %, the velocity loss is only 6.75 %, while the energy loss equals 6.25 % (shell size 12/70). Corresponding loss of values of the above parameters in the case of 12/73 mm shells equals 7.28 % and 8.0 %.
Taking into account greater ergonomic comfort of the weapon with the shorter barrel, its portability, the "Saiga-12K" with the barrel 430 mm long makes a better fighting shotgun than the "Saiga-12" with non-folding buttstock.

At this point let us consider such a parameter as the psychological effect of the weapon.
Most assignments for the development of new police type weapons require that the weapon should be (1) in semi-auto only and (2) must not have an aggressive appearance.
We at IZHMASH agree that a fully automatic shotgun is nonsense. However, in our opinion, a special-purpose fighting shotgun must, on the contrary, look mean and aggressive. The statistics that we have shows that an aggressively looking weapon in many cases helps avoid critical development of a conflict situation.
In several real-life cases, the impressive appearance of the "Saiga-12K" shotgun prevented critical progress of a conflict and made usage of the weapon for effect unnecessary.

One criminal, when asked why he preferred to give up rather than resist and fight the police, confessed that the "Kalashnikov"- looking weapon with a horrible-size muzzle was more than a convincing argument.

Table 2.

ACCURACY POTENTIAL OF THE SAIGA-12
(ambient temperature - 34?C; side wind velocity: 2.5 m/sec.; range: 35 m)

Length of shell	Shot size	Hit probability	
		full choke	cylinder
76 mm	Buck Shot	100 %	92 %
70 mm	AAA	73 %	53 %
70 mm	1	70 %	42 %
70 mm	3	69 %	42 %
70 mm	5	67 %	41 %
70 mm	6	65 %	40 %

Table 3.

SPECIFICATIONS OF THE "SAIGA-12" SHOTGUNS

Modification:	Saiga-12	Saiga-12C	Saiga-12K
Weight, empty and without magazine, kg	3,8	3,6	3,5
Overall length, ÍÍ *)	1145	1060	910

Length, with buttstock folded, mm	-	820	670
Length, with detachable pistol grip, mm	930	-	-
Length of barrel, ÍÍ	580/680	580/680	430
Magazine capacity, rds	5 & 7	5 & 7	5 & 7
Weight of magazine, empty, kg:			
- 5-rd version:	0.175	-	-
- 7-rd version:	0.235	-	-
Length of magazine, mm:			
- 5-rd version:	165	-	-
- 7-rd version:	229	-	-
Optimal range of fire, Í:			
- shot	35 - 70	35 - 70	35 - 70
- slug	50 - 100	50 - 100	50 - 100
Sights:	The front sight consisting of a brass bead and the rear sight of an open U-notch type are attached to a serrated rib. By turning the screw with a miniature flywheel the front sights can be adjusted for elevation zero. The rear open U-notch type sight is adjustable for windage zero.		
Finish:	Black phosphate, with lacquer coating		
Furniture:	Black fiberglass-reinforced polyamide handguard, pistol grip and buttstock.		
Accessories:	Sling, carrying pouch, cleaning kit included.		

Optical sights and
night-vision devices - optional.

Note: Overal length of the "Saiga-12" and "Saiga-12C" weapons with 680 mm long barrels equals 1,245 and 1,160 mm respectively.

STANDARD OPERATIONAL PROCEDURES

All modification of "Saiga-12" have the following operational procedures. The operator should shift the selector into the lower position marked "F" to bring the weapon into firing mode. By pulling the extending side handle of the
bolt carrier all the way back, the hammer is cocked and retained by the sear. Driven back to its initial position by the return spring, the bolt strips the first round from the magazine and rams it further into chamber. Turning on its axis, the bolt comes with its two lugs into recesses in the barrel extension and locks the barrel. The weapon is ready to fire. To deliver a shot, pull the trigger. The trigger extension pushes the sear and releases the hammer. The hammer, driven by the multiple-strand steel-wire main spring pivots on its axis and hits the striker. After a shot is fired, a portion of combustion gas escapes from the barrel into gas chamber through the opening in the barrel side. The piston receives an impulse and pushes the bolt carrier towards rear until pressure drops to a safe level. The slot on the inner side of receiver turns the bolt to the right, the bolt releasing its two locking lugs from recesses in the barrel block. The bolt carrier travels on, the empty shell is extracted and then ejected from the receiver. While the bolt group keeps on moving, the single-strand steel-wire return spring is compressed generating a return impulse. The hammer once again rolls down and engages with the sear. As soon as the carrier slams the rear wall of the receiver, driven by the return spring, the bolt carrier commences its forward motion. The whole cycle is repeated. All these procedures happen in a fraction of a second.
As it was mentioned above, the trigger mechanism of "Saiga-12" is a replica of that of the AK original assault rifle with the difference that the autosear has been removed from its construction. At all times the gun is capable of delivering single shots only, while reloading is done automatically. Each time an operator wants to shoot the next round, the trigger should be released and depressed until the magazines runs out of ammunition.

On the whole, the "Saiga-12" semiautomatic shotguns feature good reliability and simplicity of operation of the well-proven and extensively fielded AK system.

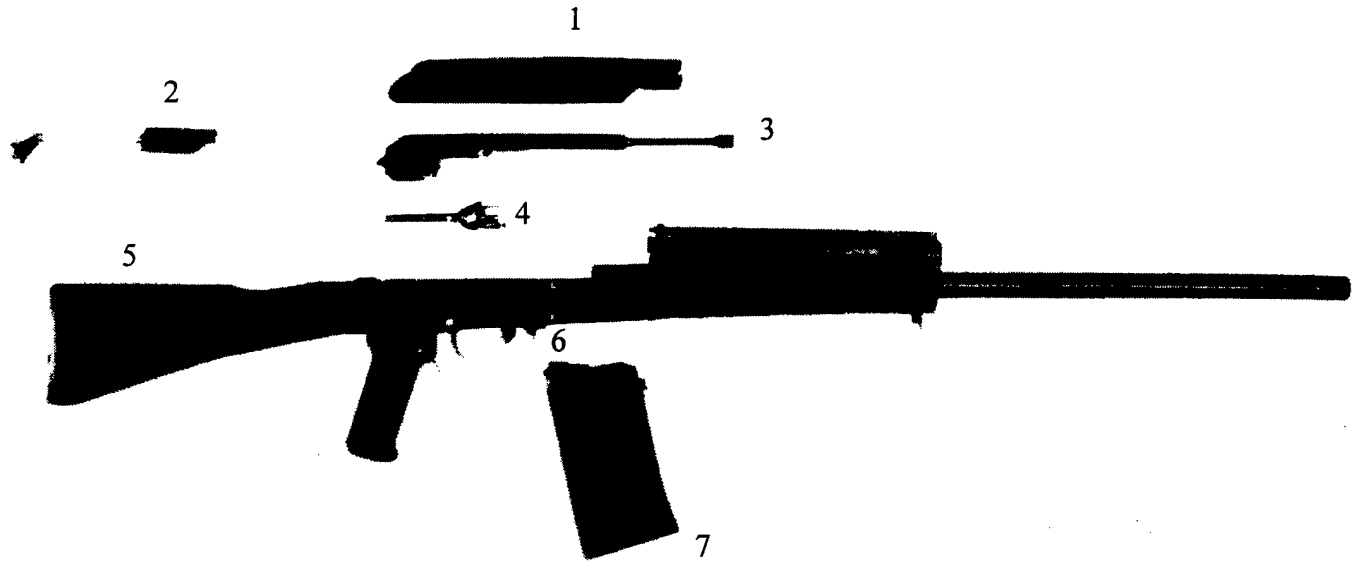


Fig. 1. SAIGA-12C, field stripped:
1. Top bolt cover.
2. Return mechanism.
3. Bolt carrier with piston.
4. Bolt.
5. AK-type folding buttstock.
6. Safety lever.
7. Box-type detachable 5-rd magazine.

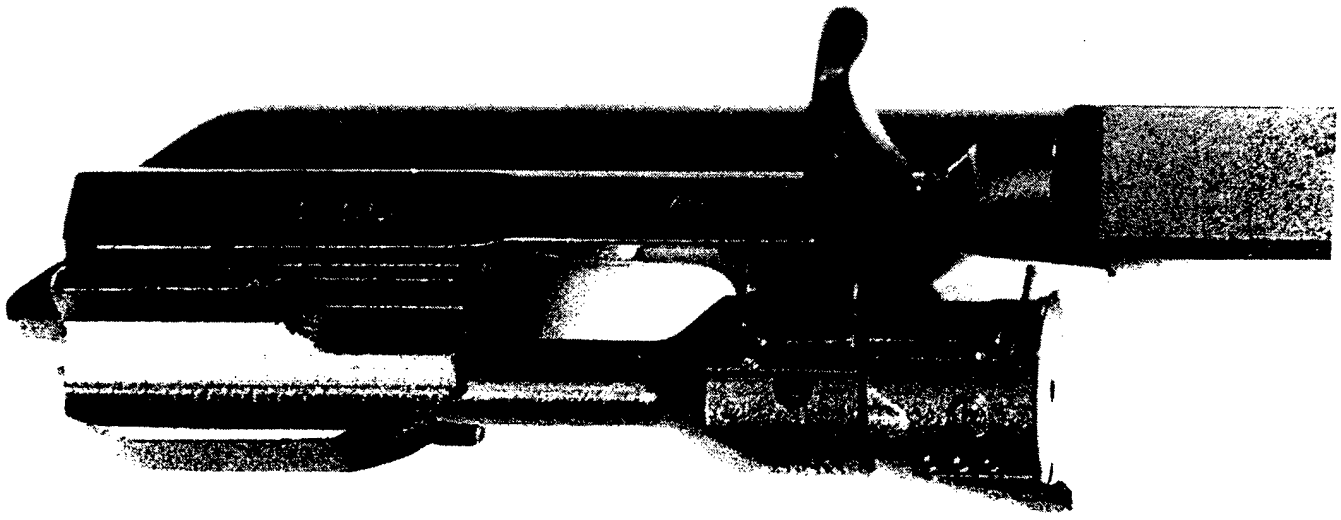


Fig. 2. Bolt carrier with bolt. Bolt carrier's extension is milled off at an angle to allow trouble-free ejection of empty shells.

THE SAIGA-12 SERIES COMBAT SHOTGUNS



Fig. 1. SAIGA-12, with non-folding buttstock, 580-mm long barrel.

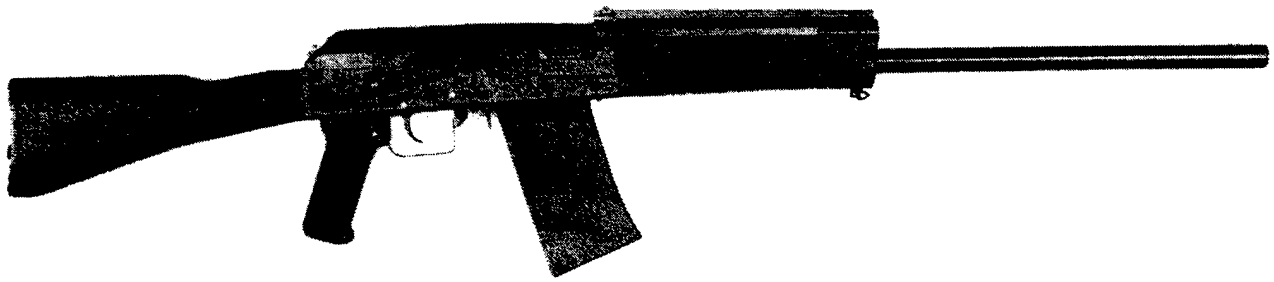


Fig. 2. SAIGA-12C, with folding buttstock, pistol grip and 580-mm long barrel.



Fig. 3. SAIGA-12K, with folding buttstock, pistol grip and 430-mm long barrel.



Fig. 4. SAIGA-12, with quickly detachable pistol grip.

KINETIC PARAMETERS OF SAIGA-12

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Overall length, мм *)	1,145	1,060	910
Length, with buttstock folded, mm	-	820	670
Length, with detachable pistol grip, mm	930	-	-
Length of barrel, мм	580 or 680	580 or 680	430
Magazine capacity, rds	5 & 7	5 & 7	5 & 7
Weight of magazine, empty, kg:			
- 5-rd version:	0.175	-	-
- 7-rd version:	0.235	-	-
Length of magazine, mm:			
- 5-rd version:	165	-	-
- 7-rd version:	229	-	-
Optimal range of fire, м:			
- shot	35 - 70	35 - 70	35 - 70
- slug	50 - 100	50 - 100	50 - 100

NDIA
Small Arms Systems Section
Annual Conference June 15-18 1998

Electronic Individual Weapon (EIW):

A Concept Update

Brian W Lacey
Weapons Systems Sector, DERA MoD
Peter J Haysman
Future Systems & Concepts, BAe Royal Ordnance

BRITISH AEROSPACE
Royal Ordnance

DERA

Electronic Individual Weapon
The Focus for Change

- Current (percussion) ignition systems are in excess of 100 years old: new technologies offer potential for significant system performance improvements.
- Advances in electronic systems and sensors offer potential for greater degree of weapon control (rate of fire, burst length, etc).
- Interfaces with Future Infantry System Technologies simplified.
- Electronics offer potential to increase reliability, security and ease of use.

BRITISH AEROSPACE
Royal Ordnance

DERA

Electronic Individual Weapon Advantages

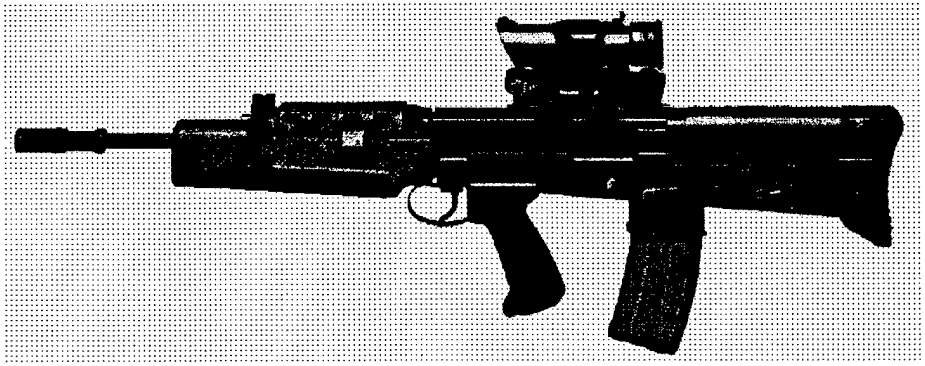
- Interactive interface with Future Infantry System Technology (FIST) - e.g. weapon status indicated in soldier's display - and other battlefield systems become possible.
- Elimination of mechanical linkages reduces design constraints (especially weapon/man interface).
- Rate-of-fire control offers potential to improve dramatically burst-fire consistency.
- Potential to improve reliability and security (weapon coding and immobilisation).

BRITISH AEROSPACE
Royal Ordnance

DERA

Electronic Individual Weapon Configuration

- L85A1 Individual Weapon based system



- Mechanical trigger group replaced by electronic control module
- 5.56mm electrically initiated ball round ammunition
- On-board sensors for loaded round and barrel temperature
- On-board battery power
- Reprogrammable electronic control module for test purposes

BRITISH AEROSPACE
Royal Ordnance

DERA

Electronic Individual Weapon
Weapon Features

- Re-programmable rate-of-fire and burst length for each selector switch setting.
- LED indicator (auto-dimming at night) shows: ready to fire status, cook-off temperature warning, low battery warning.
- Non-volatile memory records total number of rounds fired.
- Trigger has conventional weapon "feel".

BRITISH AEROSPACE
Royal Ordnance

DERA

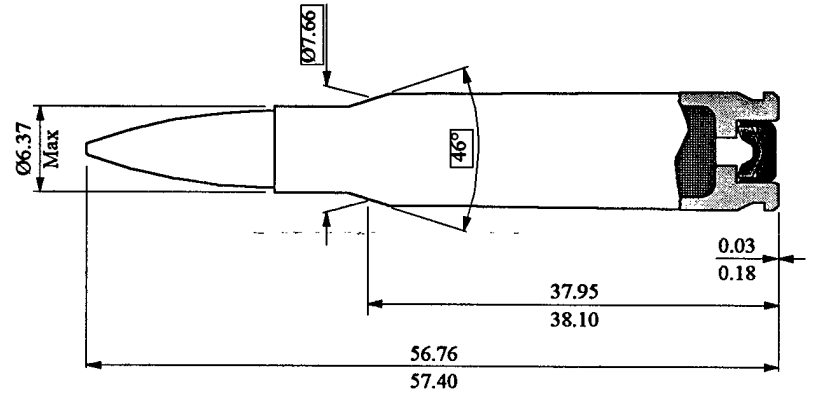
Electronic Individual Weapon Ammunition Features

- Ammunition uses standard cartridge case, propellant composition and bullet
- Glass to metal seal incorporates an electrically initiated primer
- Bridgewire technology offering greater reliability and acceptable route for manufacture

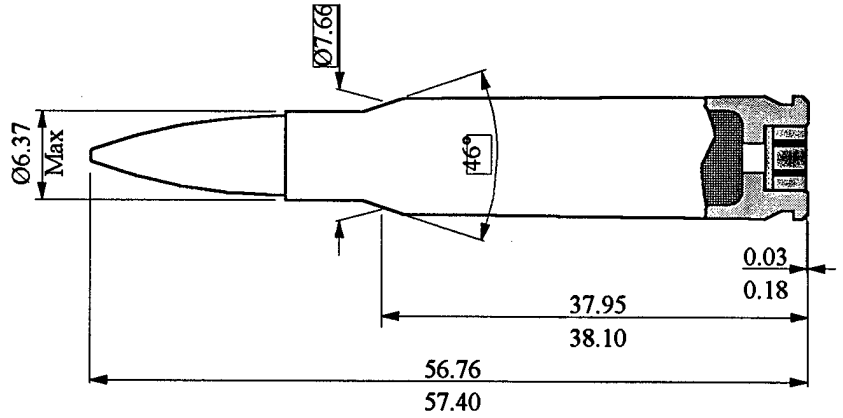
BRITISH AEROSPACE
Royal Ordnance

DERA

Electrically Individual Weapon
5.56mm Ammunition



Standard Percussion Ball Round



Electrically Initiated Ball Round

BRITISH AEROSPACE
Royal Ordnance

DERA

Electronic Individual Weapon System Safety Features

- Barrel, bolt and bolt-locking mechanism are unchanged from standard L85A1.
- Electrical circuit to firing contact (pin) is not completed until the bolt carrier is fully forward.
- Battery power is only connected to the firing circuit when the safety switch is set to "Fire".
- The firing circuit is interrupted by two transistor switches, one operated solely by the trigger, the other by the micro-processor.
- The state of the trigger switch is checked each time the safety switch is set to "Fire".

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Electronic Individual Weapon Program Outline

- The EIW program in 1997 focused on determining the maturity of the technology and providing data on its system performance.
- Approach was to produce weapons and ammunition for live-firing by soldiers under controlled conditions. This required Ordnance Board (OB) clearance, following successful completion of a testing program defined by the OB.

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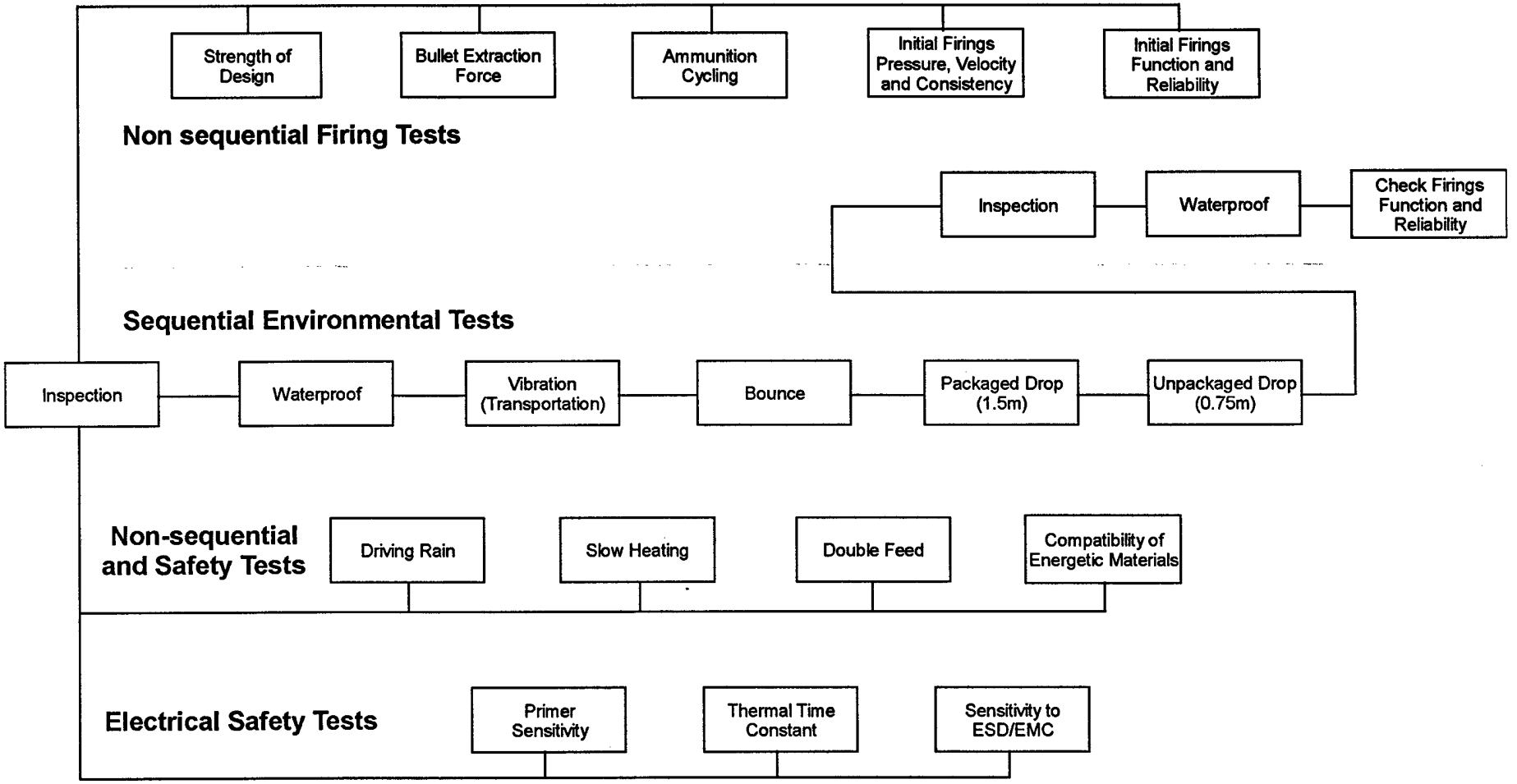
Electronic Individual Weapon
Scope of Ordnance Board Tests

- Weapon and Ammunition : full program of tests, including :
  - weapon : including functioning, drop and immersion
  - ammunition : full ammunition schedule
  - electrostatic discharge (ESD) and electromagnetic compatibility (EMC)

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Electronic Individual Weapon
Ordnance Board Tests for Field Firing Clearance



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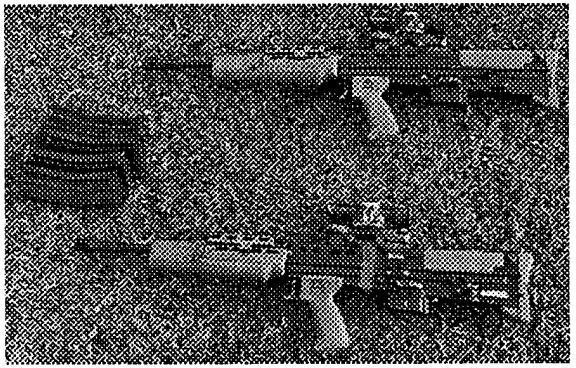
Electronic Individual Weapon
Manned Firing Trials



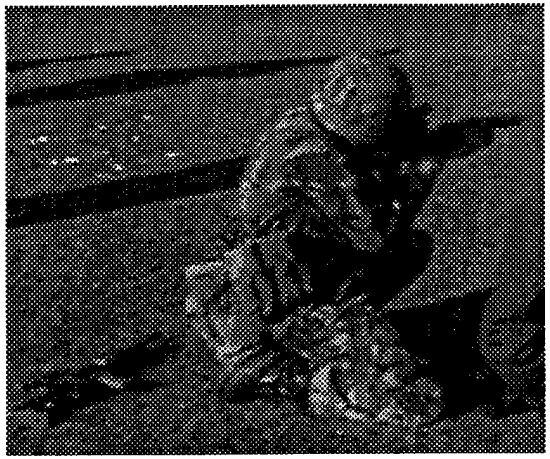
Prone



Prone



L85A1
EIW



Kneeling



Standing

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Electronic Individual Weapon Manned Firing Trials

- Aimed to provide supporting data on EIW system performance, especially :
  - accuracy / dispersion characteristics of EIW under controlled manned firing conditions
  - informed user views on ease of use / current system layout
  - potential EIW benefits and risk reduction areas for future attention

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Electronic Individual Weapon
Summary of Manned Firing Trials

- Three firers : each firer used an EIW and a standard L85A1(as a baseline comparison)
- Firings in prone / kneeling / standing positions
- Single shot and burst fire (both weapons)
- EIW97 burst fire cyclic rates were 300 / 450 / 700 rpm, firing at 30m and 50m
- Taguchi experimental design for data capture dictated serials and firing sequence
- Selected serials repeated for proof mount firing of EIW / L85A1 to capture basic weapon dispersion data

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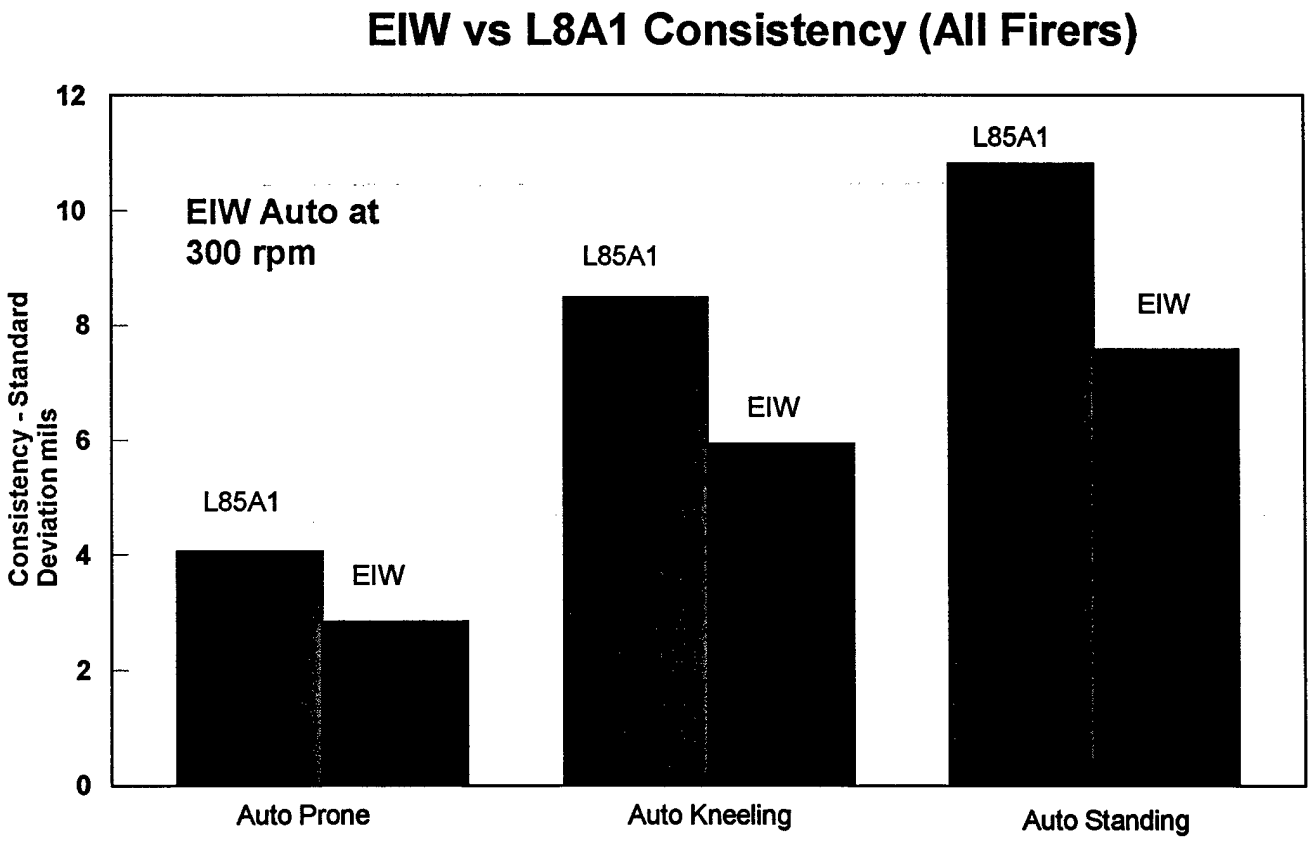
Electronic Individual Weapon Trials Results

- EIW firing at 300 rpm gave an overall 30% reduction in burst fire dispersion compared with either L85A1 or EIW at higher rates of fire
- EIW firing at 300 rpm gave 19% more hits on Figure 11 targets compared with either L85A1 or EIW at higher rates of fire
- Excellent reliability of EIW weapon and ammunition during manned firing of approximately 1030 rounds

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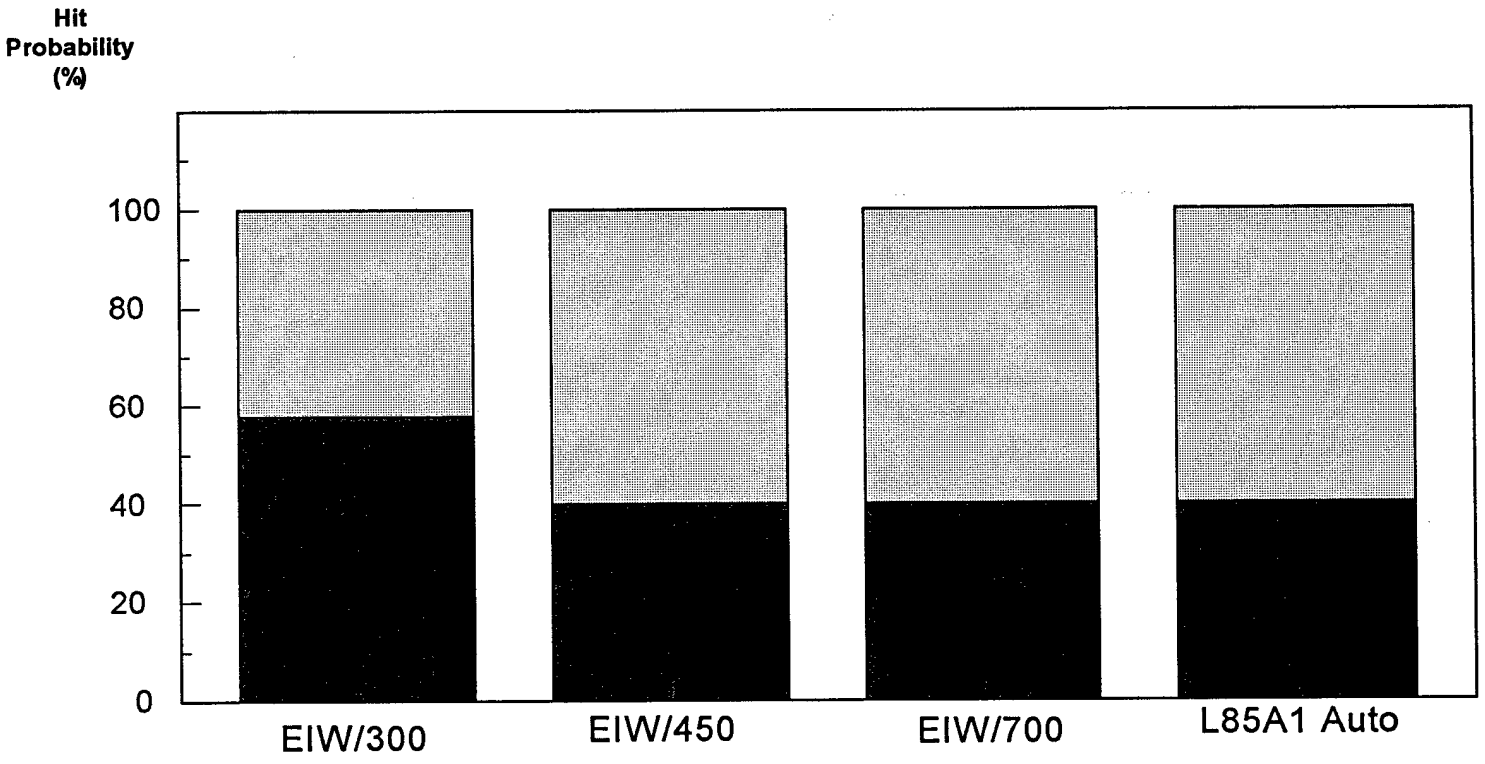
Electronic Individual Weapon Consistency in Burst Fire



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Electronic Individual Weapon
Hit Probability on Figure 11 Target



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Electronic Individual Weapon

Marksman Firer (Prone, 50m, 3 round burst)

Weapon	Mean Radius mm	Standard Deviation mm	SD mils[1]
EIW @ 300 rpm	138.5	135.4	2.71
L85A1	197.6	193.2	3.86
Difference	59.1	57.8	1.15

30% improvement in consistency

[1] SD=MR*0.9775 Ref.Statistical Measures of Accuracy for Riflemen and Missile Engineers. Frank E. Grubbs

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Electronic Individual Weapon
Firer Feedback

- General : all preferred the slow rate of fire (300 rpm) in burst fire
- Selected comments on EIW :

  "Slow rate of fire meant less recoil...movement of weapon is a lot less, i.e. the high right effect has gone."

  "If adapted to LSW, slow rate would make a large difference...our fire would be at least 80% more accurate at longer range."

  "Slow rate only-lot better for an infanteer. More hits on enemy at range means we are a more effective fighting force."

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Electronic Individual Weapon
Way Ahead

- **System Developments** : optimisation of system features (e.g. trigger mechanism, weapon control module)
- **Technology Migration** : Light Support Weapon variant (ELSW) has been manufactured for testing in 1998. Consideration being given to application of the technology to other systems.
- **System Enhancements** : EIW now included in UK FIST Technology Demonstrator program. Investigations also into smart sighting systems (fire on target recognition).

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Electronic Individual Weapon
Specific Areas for Future Development

- Application to multi-function weapons (one trigger programmable to operate all functions)
- Integration with Future Soldier system (FIST)
- Investigation of optimum ergonomic positioning of trigger switch and other controls
- Security coding of weapon (e.g. by transponder / digital coding)
- Fire on target recognition
- Alternative power sources

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Electronic Individual Weapon Summary

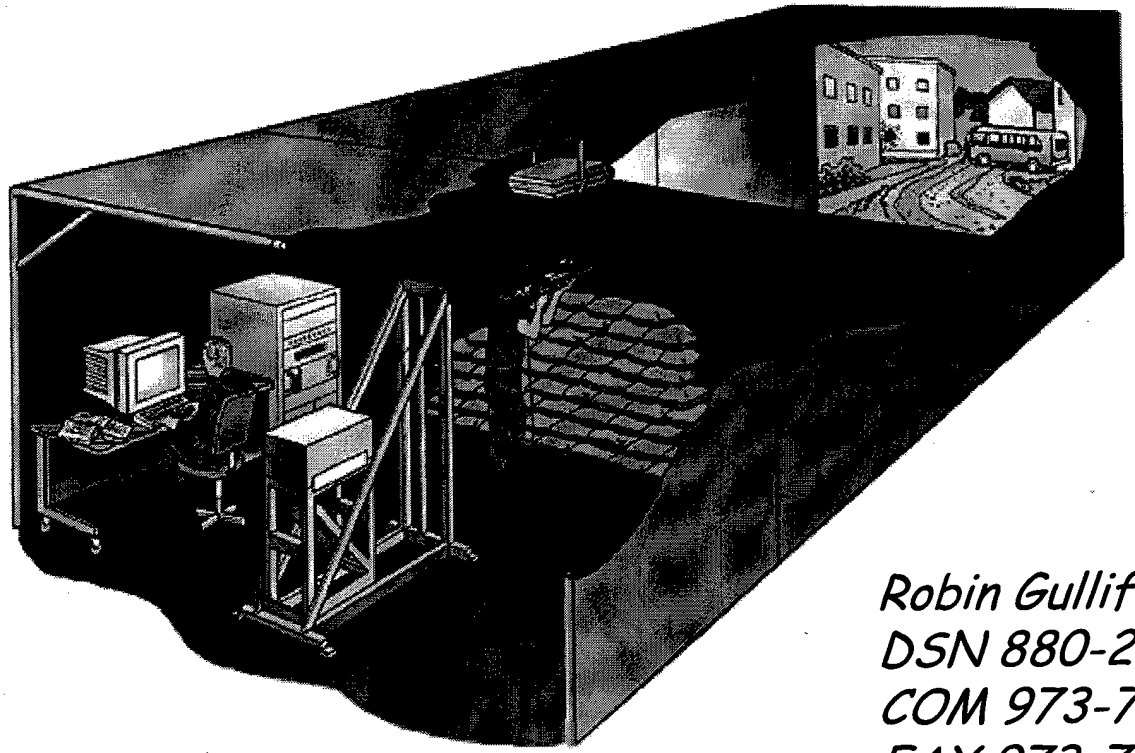
- EIW technology proven in live firing trials by troops
- System has proved reliable
- Slow rate of fire (300 rpm) gives 30% reduction in burst fire dispersion, 11% improvement in hit probability against a Figure 11 target
- Technology migration to other weapons has begun (ELSW) and incorporation of EIW into UK FIST TD program
- Potential application to other systems, including multi-function weapons
- Areas for future developments identified

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DERA

NDIA SMALL ARMS SYSTEMS
16-18 JUNE 1998

SMALL ARMS SIMULATOR



Robin Gullifer
DSN 880-2218
COM 973-724-2218
FAX 973-724-2204
e-mail: rgullif@pica.army.mil

Light

SIMULATOR BACKGROUND

» ***History***

- Developed by Naval Air Warfare Center, Training Systems Division (NAWCTSD)
- Basic Research and Development Funded by Live Fire Testing and Training Initiative
- Built from Existing Training Systems, but

More Accurate Than Any Trainer!

.1 MIL TRACKING ACCURACY!

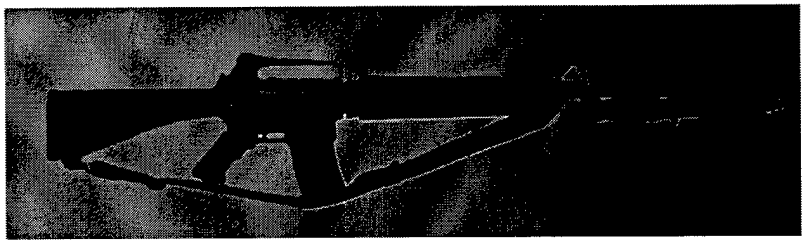
SIMULATOR STUDIES

»*STUDIES CONDUCTED*:

- M16 Validation
- M203 Validation
- Close Combat Optic (CCO)
- Objective Individual Combat Weapon (OICW) Aiming Study
- OICW Aiming Study for Combat ID
- Unsupported Firing
- M4 Carbine Alternate Butt Stock
- Rapid Target Acquisition/Helmet Orientation System (RTA/HOS) for Force XXI Land Warrior (FXXI LW)

SIMULATOR STUDIES

- *M16 Validation Study*
  - Duplicated the Advanced Combat Rifle Intermediate Range
  - Ran Infantry Soldiers Through 66 Target Scenario
  - Results Examined by AMSAA



- ***Conclusion: Simulator Correctly Models the M16 Rifle!***

SIMULATOR STUDIES

» *M203 Validation Study*

- Conducted Firing Test to Gather Data
- Duplicated Range in the Simulator
- Ran Infantry Soldiers Through 16 Target Scenario
- Correlation Between Live Fire and Simulator Results



» ***Conclusion: Simulator Correctly Models the M203 Grenade Launcher!***

Light

SIMULATOR STUDIES

» *M68 Close Combat Optic (CCO)*

- 24 Soldiers from Army, Marine Corps, Air Force and Navy
- 32 Target Scenario with Multiple Targets
- Evaluated the CCO Located in Three Different Locations
- Compared Results to Iron Sight Firings
- Results:
  - No Statistically Significant Difference in Hit Performance Between CCO and Iron Sight
  - CCO Near Performance Better Than CCO Mid or Far
  - Decrease in Time to Get on Target for CCO v. Iron Sight
  - Aim Error for CCO Slightly Larger for CCO v. Iron Sight

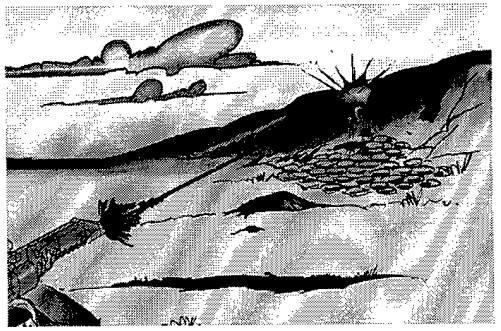
» ***CONCLUSION: M68 Improves Performance!***

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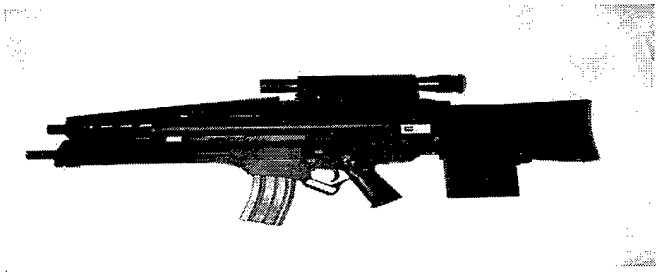
SIMULATOR STUDIES

» *Objective Individual Combat Weapon (OICW) Aiming Study*

- Goal: Gather Aiming Information Based Upon Posture and Weapon Weight
- 12 Soldiers Volunteered
- Data Used to Help Design Fire Control System Based Upon the Gunners Natural Wobble



- 16 Targets
  - Stationary and Moving, 75-300m
  - Kneeling and Supported Postures

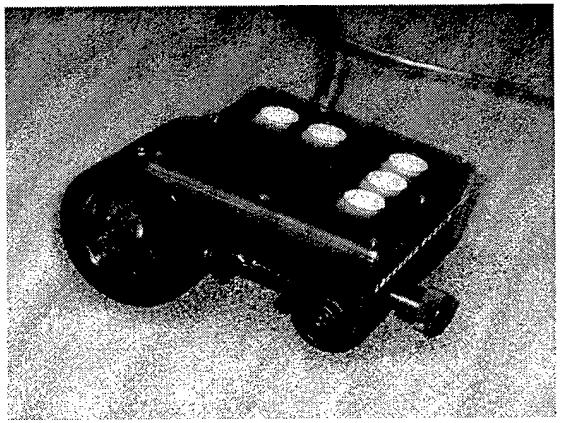


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SIMULATOR STUDIES

» *Combat ID Analysis*

- Data Collected from OICW Study Used to Examine the Ability to Hold on Target for Extended Periods of Time
- Results Influenced the Design of Dismounted Infantry Combat ID System in Terms of Beam Width and Time Line Implications



SIMULATOR STUDIES



» *Unsupported Firing*

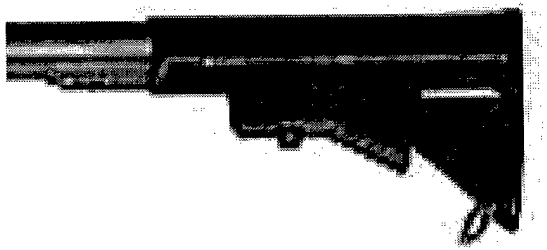
- Goal: Gather Aiming Information to Characterize the Aiming Error When Firing From an Unsupported v. Supported Position
- 24 West Point Cadets Fired Against the Record Fire Course
- Data Collected Analyzed for Aim Error, Used in Error Budget Analysis on Land Warrior System

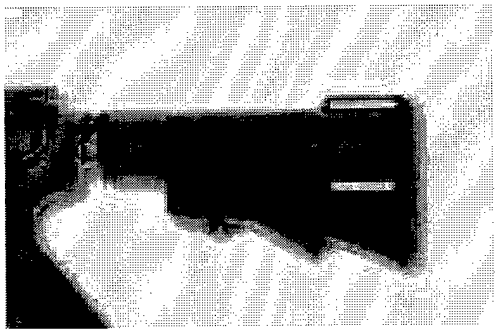
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M4 CARBINE ALTERNATE BUTTSTOCK STUDY

» *M4 Carbine Butt Stock*

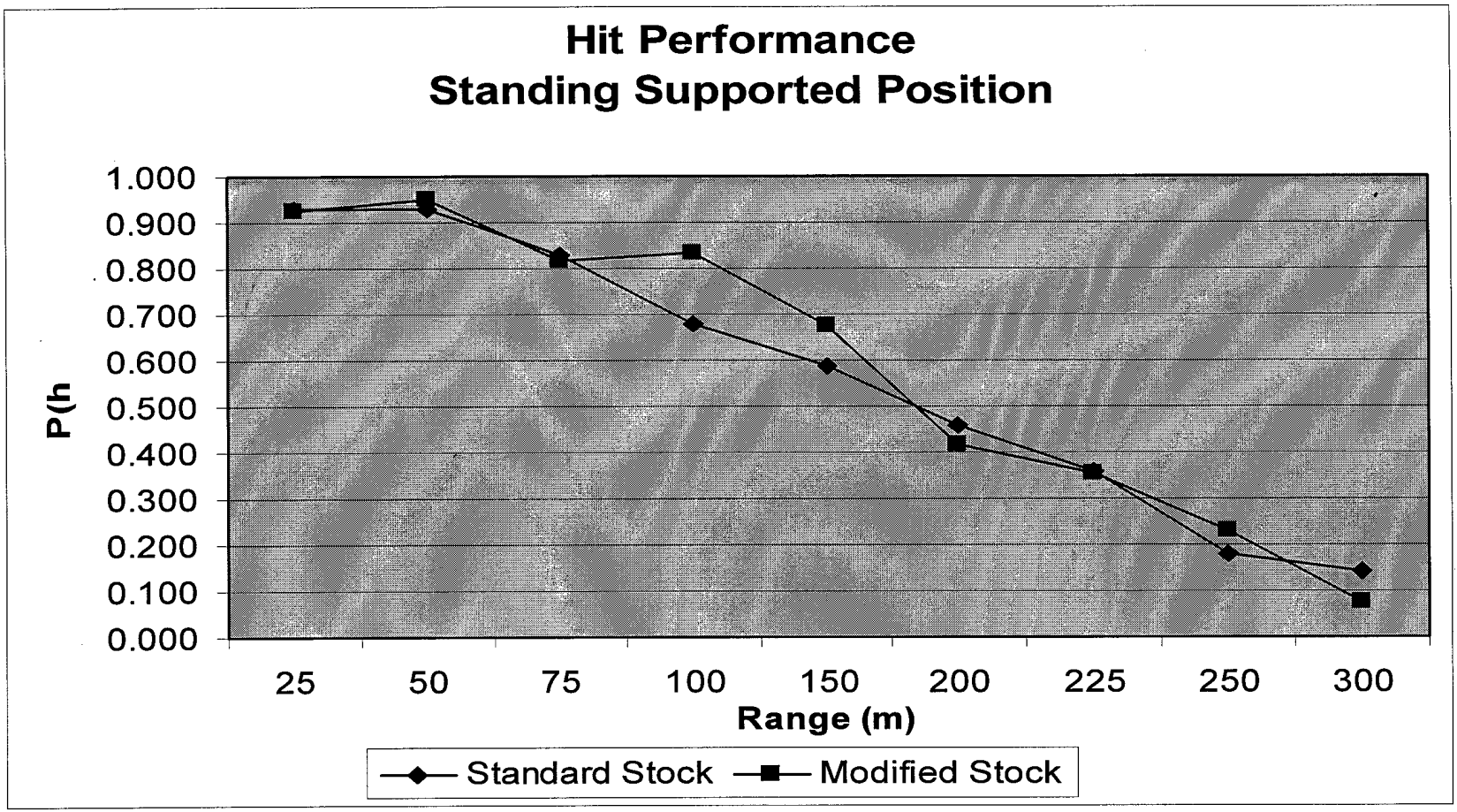
- Goal: Quantify Performance Difference Between Fielded Butt Stock and New Improved Butt Stock
- Used Stereo-Lithographic Model of New Butt Stock
- 14 Local Soldiers Fired 40 Target Scenario From Standing and Prone Supported Positions





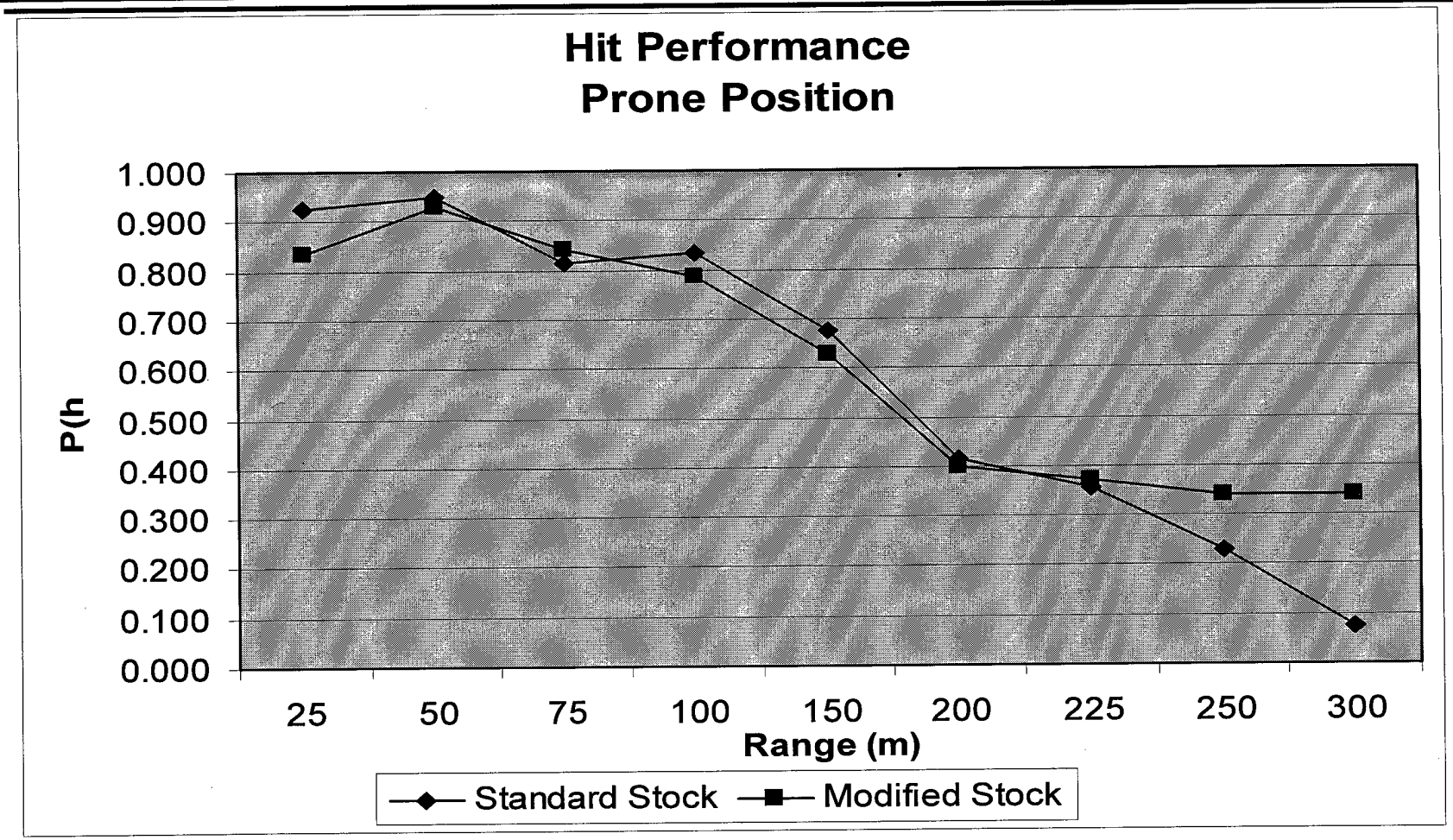
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M4 CARBINE ALTERNATE BUTTSTOCK STUDY



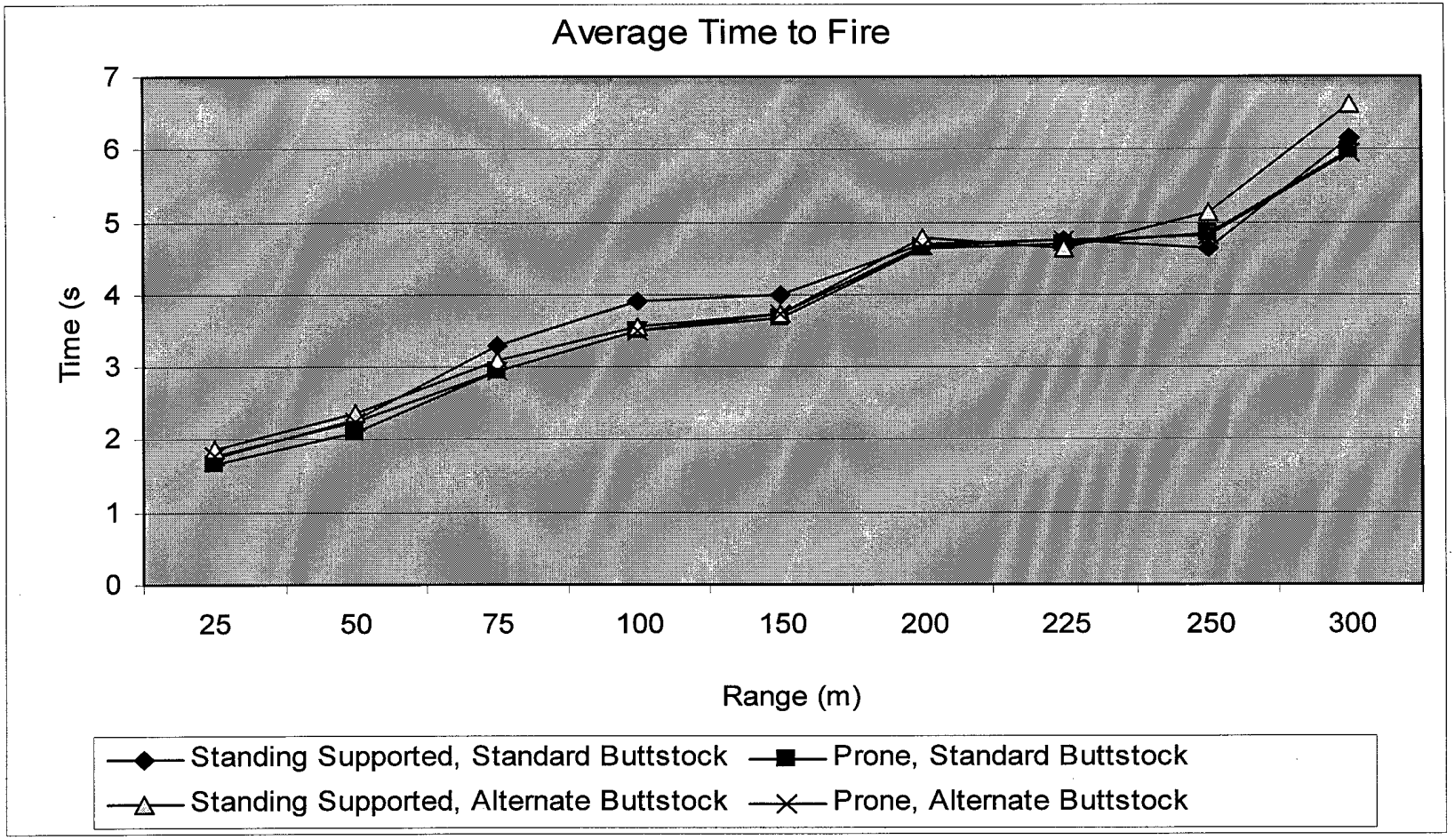
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M4 CARBINE ALTERNATE BUTTSTOCK STUDY



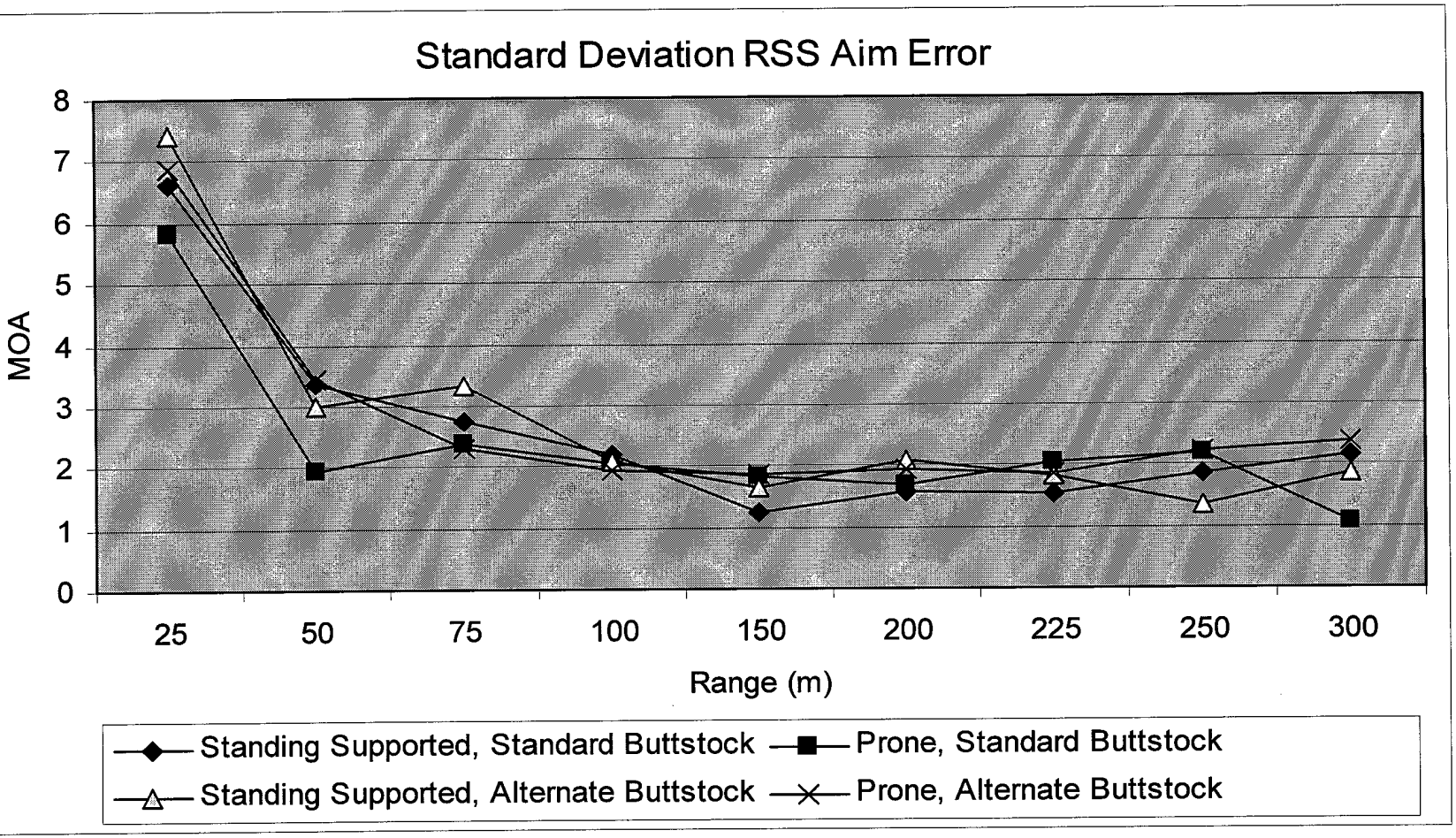
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M4 CARBINE ALTERNATE BUTTSTOCK STUDY



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M4 CARBINE ALTERNATE BUTTSTOCK STUDY



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M4 CARBINE ALTERNATE BUTTSTOCK STUDY

»Conclusions:

-Change in Buttstock:

- -Does Not Alter Weapon System Performance
- -Does Provide Improved Buttstock with Sling Attachment
- -Does Provide More Familiar Interface Since Buttstock is Similar in Size and Shape to the M16

-There is No Statistically Significant Difference in Performance Between the Existing Buttstock and the New Improved Buttstock for:

- -Hit Performance
- -Time to Fire
- -Aim Error

Light

FXXI LW RTA/HOS SIMULATOR EFFORT

» *Force XXI Land Warrior Simulation Efforts*

- RTA/HOS (Helmet Orientation Sensor/Rapid Target Acquisition) 20-22 Jan 98
- Quantify the Impact on the Engagement Timeline When Switching From I^2, Wide Field of View to Thermal, Narrow Field of View
- Evaluate Aim Error When Using Remote Aiming Technique
- Evaluate Performance When Firing Unsupported



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FXXI LW RTA/HOS SIMULATOR EFFORT

» **RTA/HOS Configuration:**

- Soldier Equipped With LW Image Intensified (I^2) Helmet Mounted Display With Filter to Block Tracker Spot From View
- HOS System Attached to Back of Helmet, Adding Weight
- Wiring Harness with Mini-Computer and LW DCIM



- Weapon Mounted Sensors:
  - 4 lb. Block Representing Integrated Sight
  - Video Camera
  - Weapon Sensor Which Includes the Compass
  - Button for Switching Between Thermal and I^2

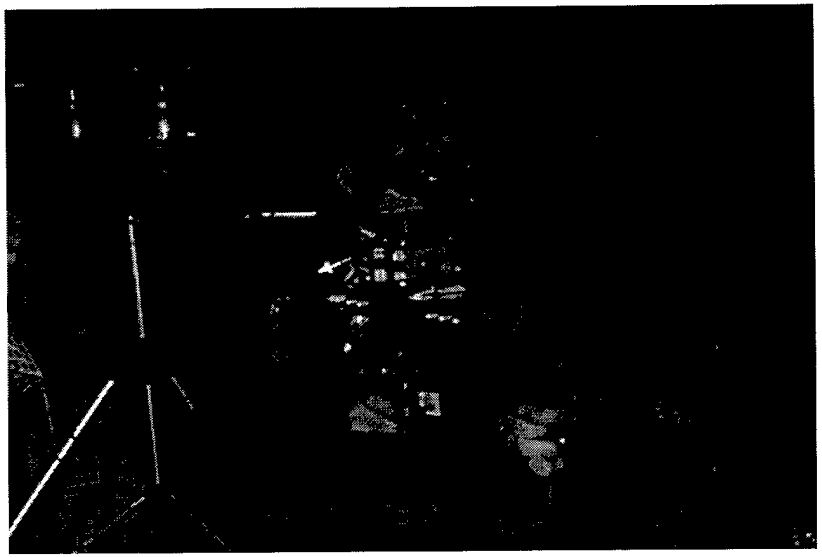
FXXI LW RTA/HOS SIMULATOR EFFORT

»LW Configuration:

- Same as RTA/HOS Configuration, But Weight Added to Weapon in Form of LRF/DCA Stereo Lithography Model and PAQ-4C

»Test Set-up

- Two Weapon Configurations:
  - LW: M4 with 4 lb. Sight, LRF/DCA, and PAQ-4C
  - RTA/HOS: M4 with 4 lb Sight
- Two Firing Positions:
  - Standing Unsupported
  - Kneeling Supported



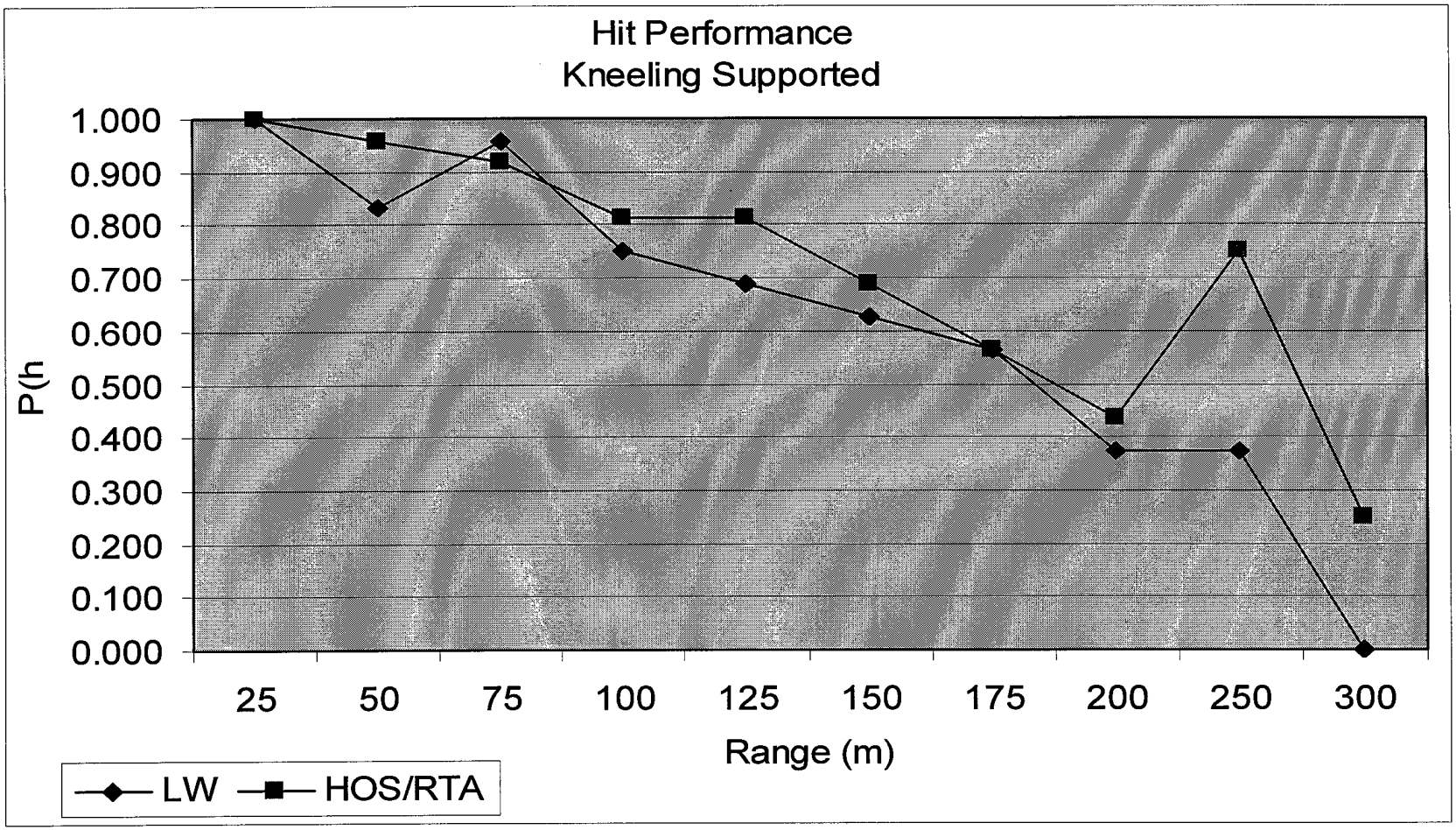
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FXXI LW RTA/HOS SIMULATOR EFFORT

» *Test Description:*

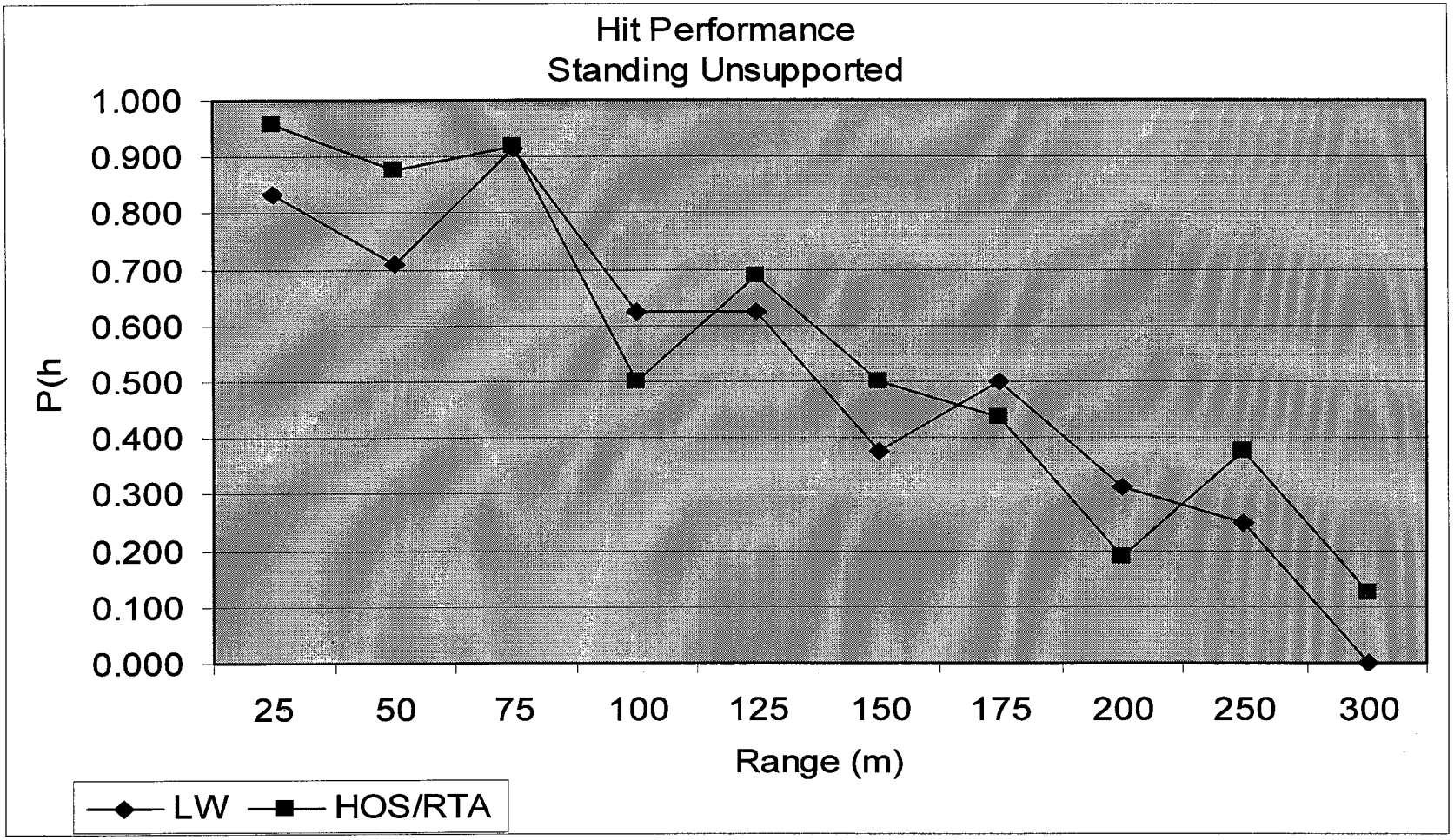
- Participants: 4 Soldiers, 4 Marines
- Training Scenario: 10 Targets Located at Various Ranges
- Test Matrix:
  - 2 Positions: Standing Unsupported, Kneeling Supported
  - 2 Weapons Configurations:
    - LW: M4 w/4lb. Sight, LRF/DCA and PAQ-4C
    - RTA/HOS: M4 w/4lb. Sight
- Test Scenario: 21 Targets Between 25-300m With 2-4s Between Targets

FXXI LW RTA/HOS SIMULATOR EFFORT



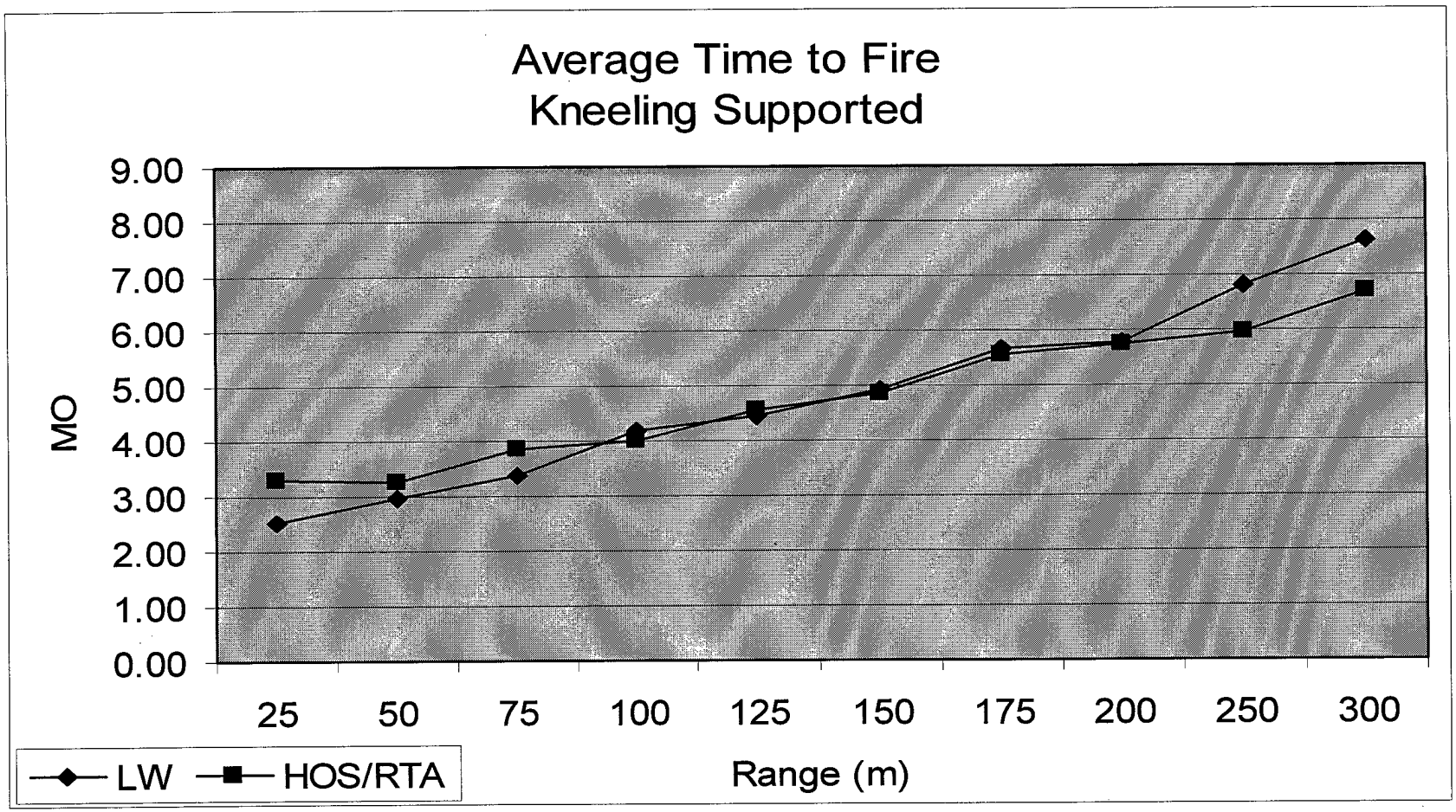
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FXXI LW RTA/HOS SIMULATOR EFFORT



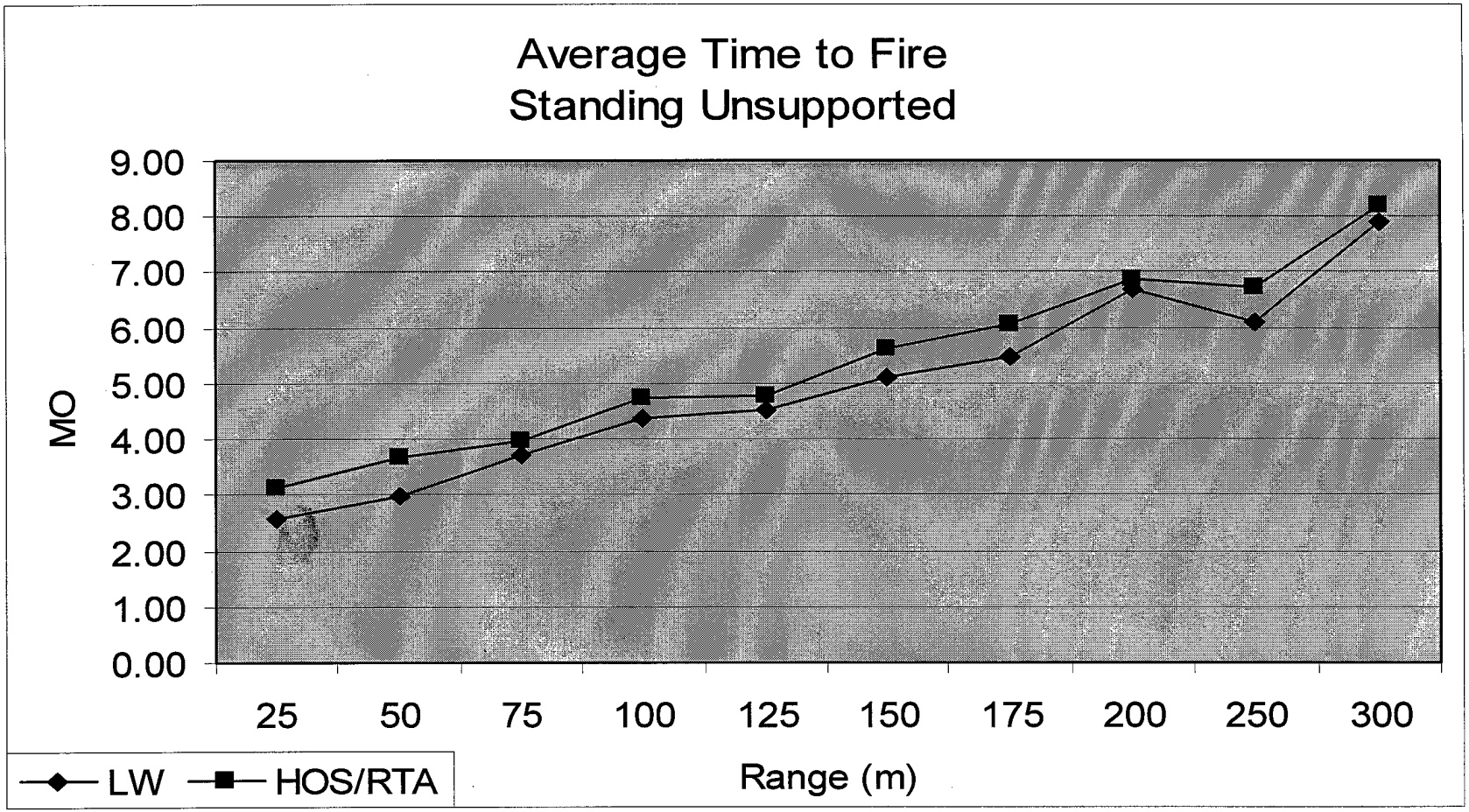
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FXXI LW RTA/HOS SIMULATOR EFFORT



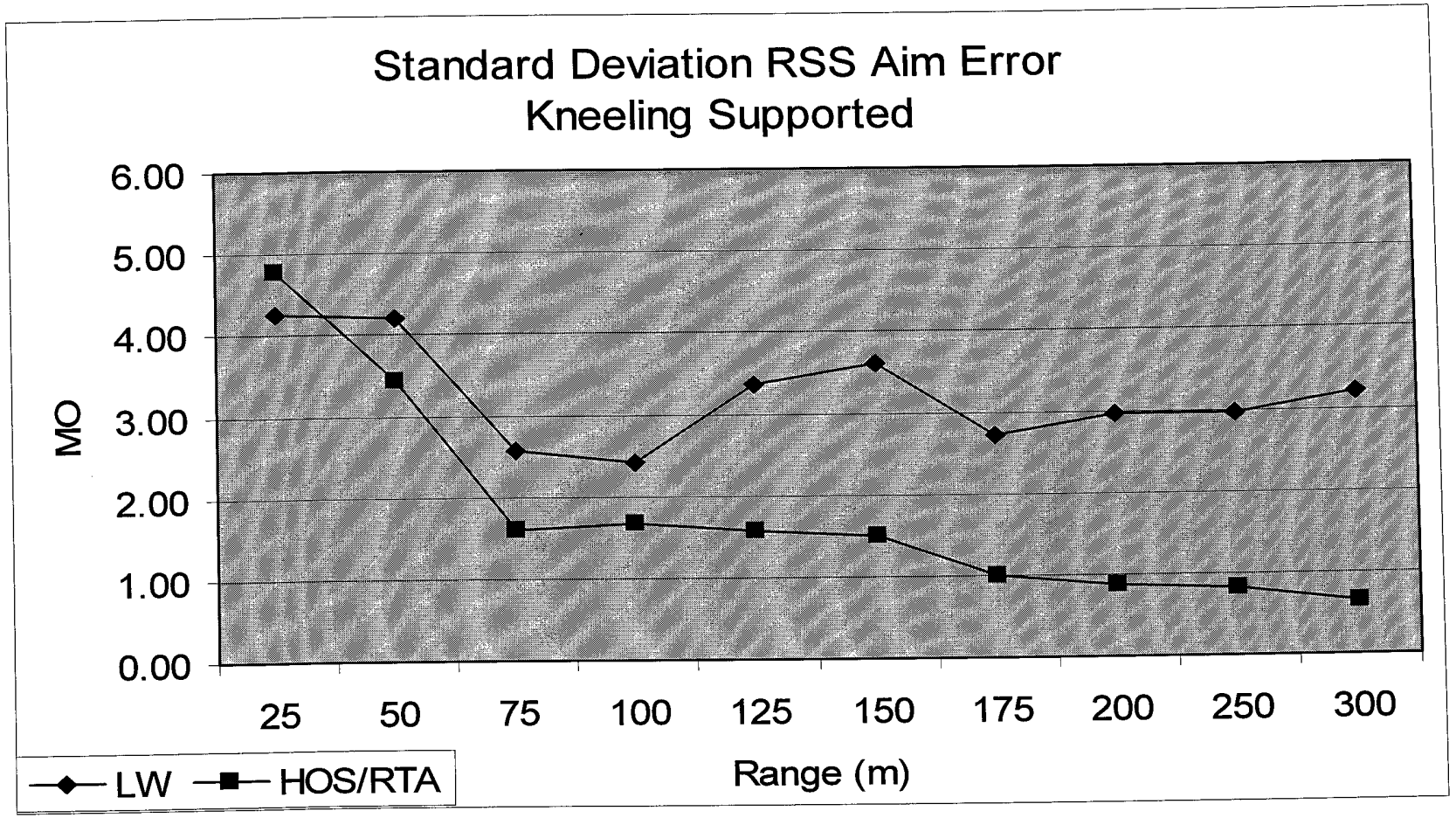
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FXXI LW RTA/HOS SIMULATOR EFFORT



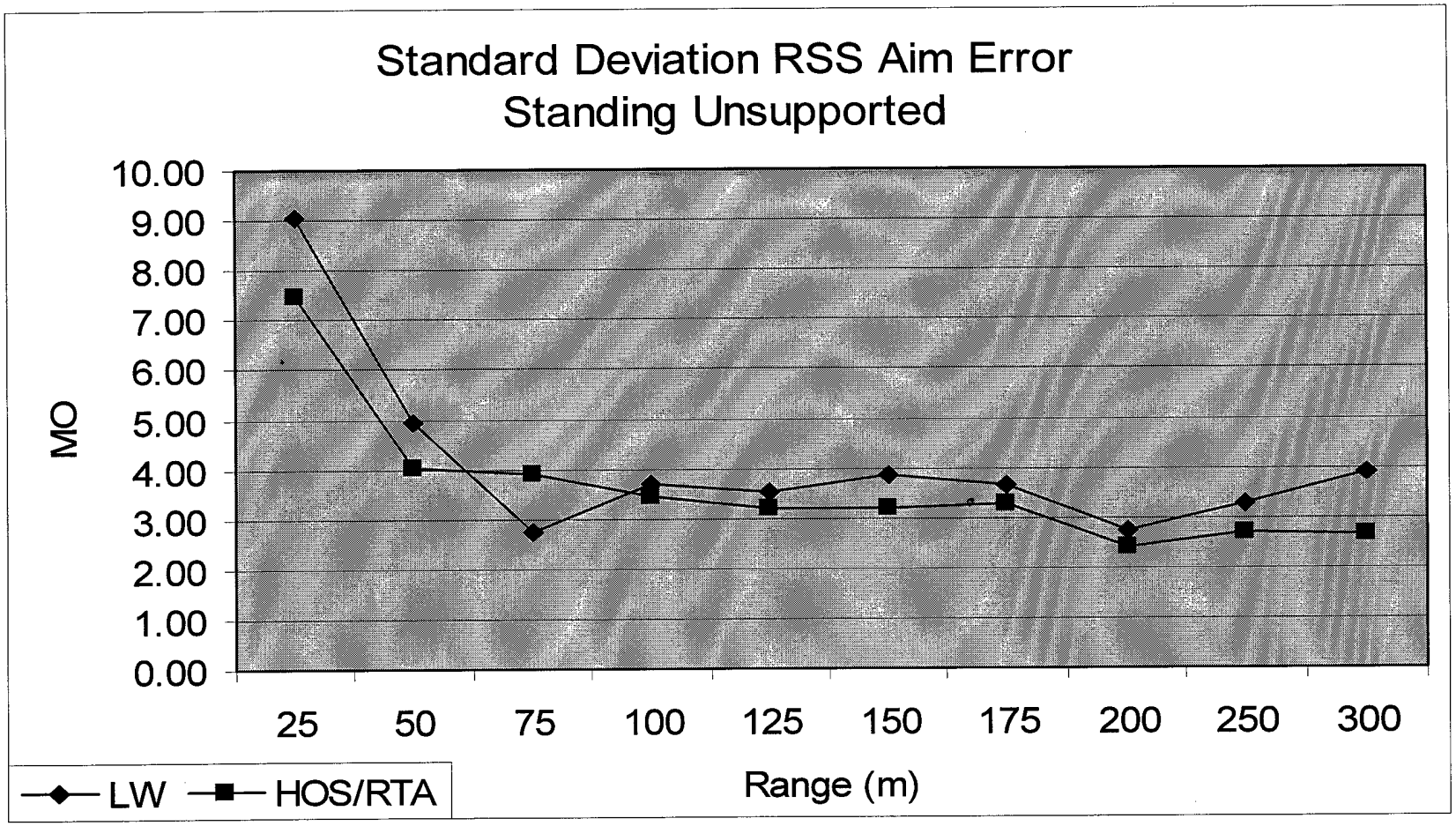
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FXXI LW RTA/HOS SIMULATOR EFFORT



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FXXI LW RTA/HOS SIMULATOR EFFORT

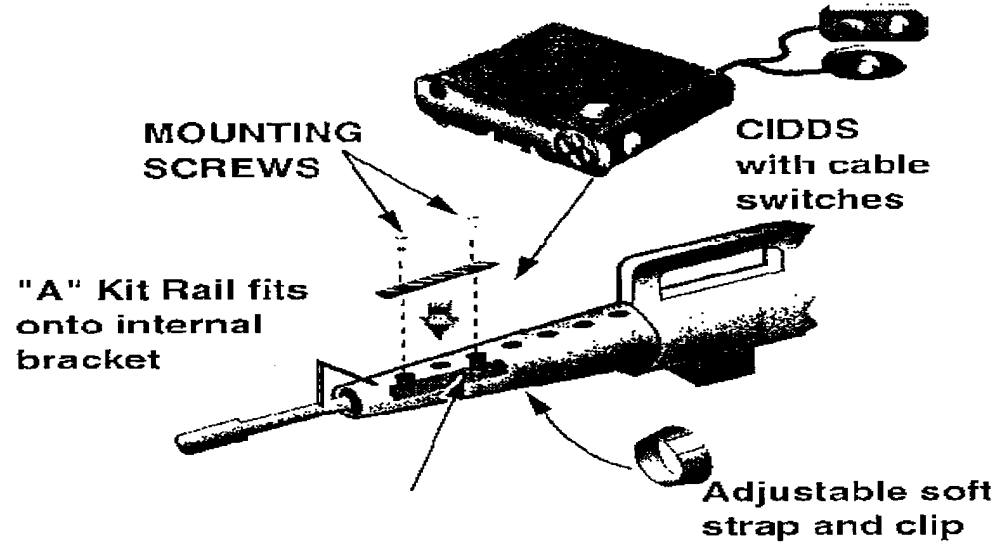


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FXXI LW RTA/HOS SIMULATOR EFFORT

- Conclusions:
  - Simulator Data Collected For Supported & Unsupported Configurations On:
    - Hit Performance
    - Time to Fire
    - Aim Error
  - There is No Statistically Significant Difference in Performance Between Land Warrior and RTA/HOS for:
    - Hit Performance
    - Time to Fire
    - Aim Error

FUTURE STUDIES



» Combat ID Simulation Efforts

- Weapon Equipped With CID Unit
- Simulator Modified to Accept ID Capability: Targets Will Be Randomly Tagged as Friend or Unknown, Audible and Visual Signal Returned After Identification
- Effort to Identify the Impact on Target Engagement Timeline of Adding ID Function

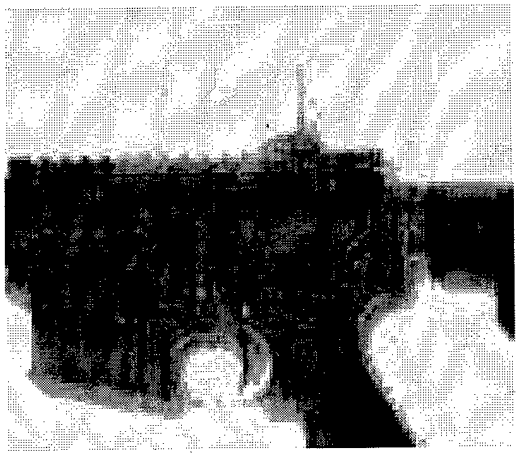
FUTURE STUDIES

»OICW

-Perform Technical Testing of Weapon System

-Train Soldiers on Use of Weapon System Including Fire Control





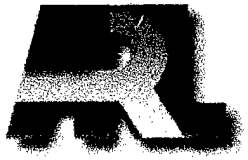
»Back-up Iron Sight (BUIS)

-Determine Performance Parameters When Using the BUIS

SUMMARY

»*FUTURE GROWTH*

- Expand System to Accommodate Fire Control Features Such as Optics, Laser Rangefinders, Combat ID
- Expand Weapons Base to Include Crew Served Weapons
- Multi-lane Capability and Interoperability with Other Simulators



Army Research Lab



Wind Sensing - The Sniper's Essential Cue

Raymond Von Wahlde

Army Research Lab
Kent Building (120)
APG, MD 21005-5066
(410) 278 - 9738
vonwahld@arl.mil

1998 Small Arms Systems Section Annual Conference, Exhibition & Firing Demonstration

Columbus, Georgia

Advanced Weapons Concepts Branch, BWCD



Army Research Lab

Importance of Knowing Cross Wind

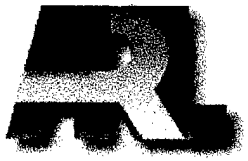
- Joint Service Small Arms Program (JSSAP) 1993 Sniper Conference

- "What is the single most difficult challenge that you face in successfully engaging a target at long range?"

» "*Wind* and all elements."; Carlos Hathcock, USMC (ret)

» "*Wind* and distance (estimation)."; Ken Howard, SEAL

» "*Wind* reading."; D.J. Riddle, USMC



Army Research Lab

Cross Wind Estimation

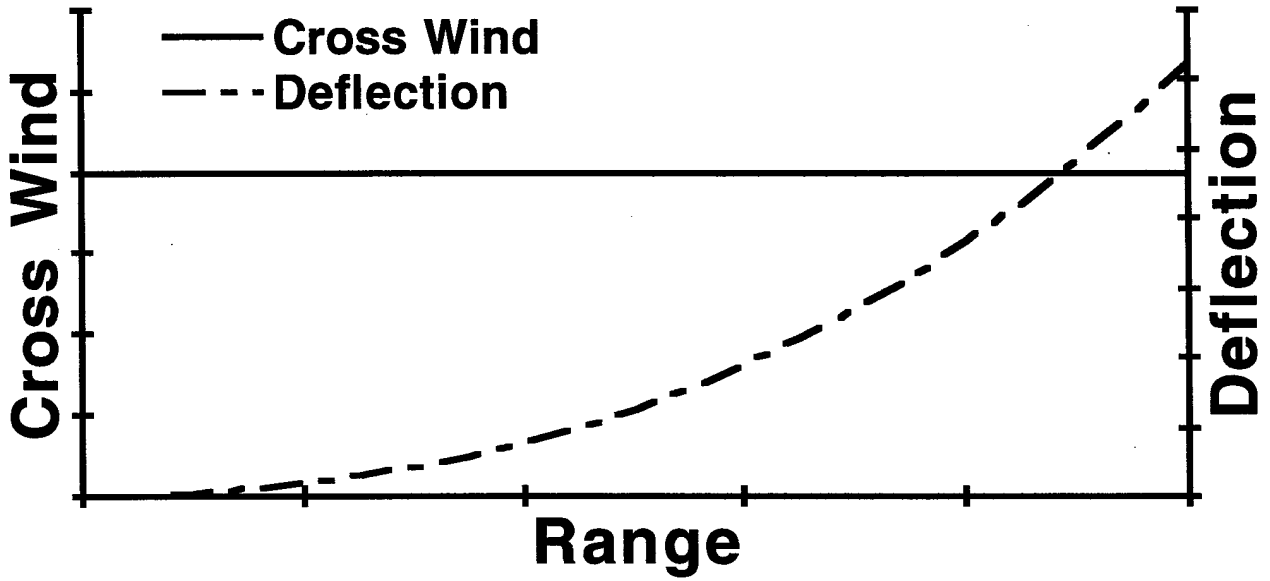
- The horizontal component of the wind vector perpendicular to the line-of-fire.
  - » Estimate speed and direction
  - » Measurment at his location
  - » Observing Environment, (foliage motion, dust, etc.)
  - » Shimmer or mirage
  - » "Kentucky Windage"

- **Tacit Assumption:**

  Cross Wind is Constant vs. Range

Army Research Lab

Cross Wind Deflection



$$Z = W_Z * (t - R / V_0)$$

Z = Deflection W_Z = Cross Wind Speed

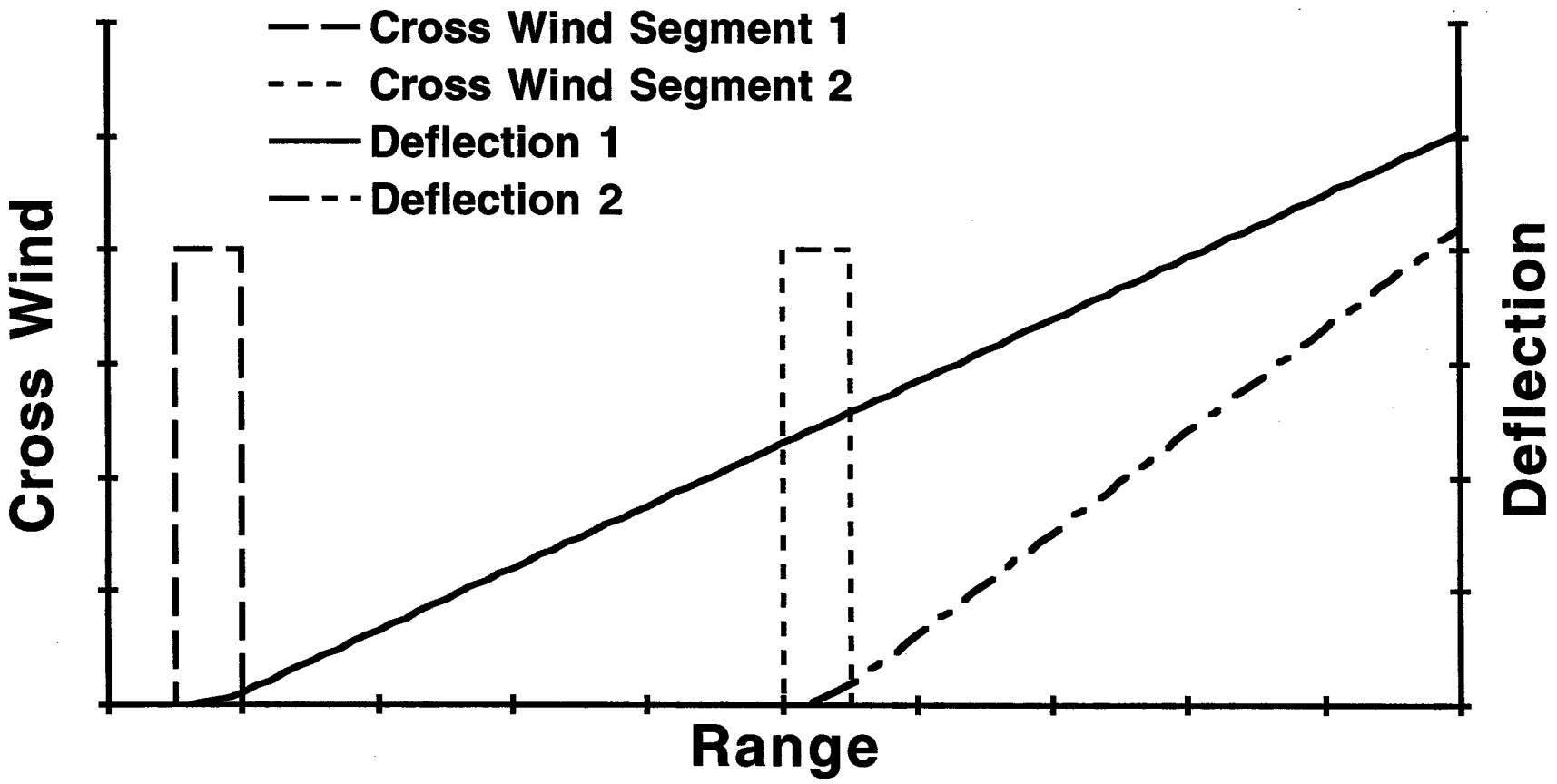
R = Range t = Time of Flight to R

V_0 = Starting Velocity

e.g.: 1 m/s CW, .300 WinMag, 884 m/s MV, 1.75 TOF, .62 m at 1000m

Army Research Lab

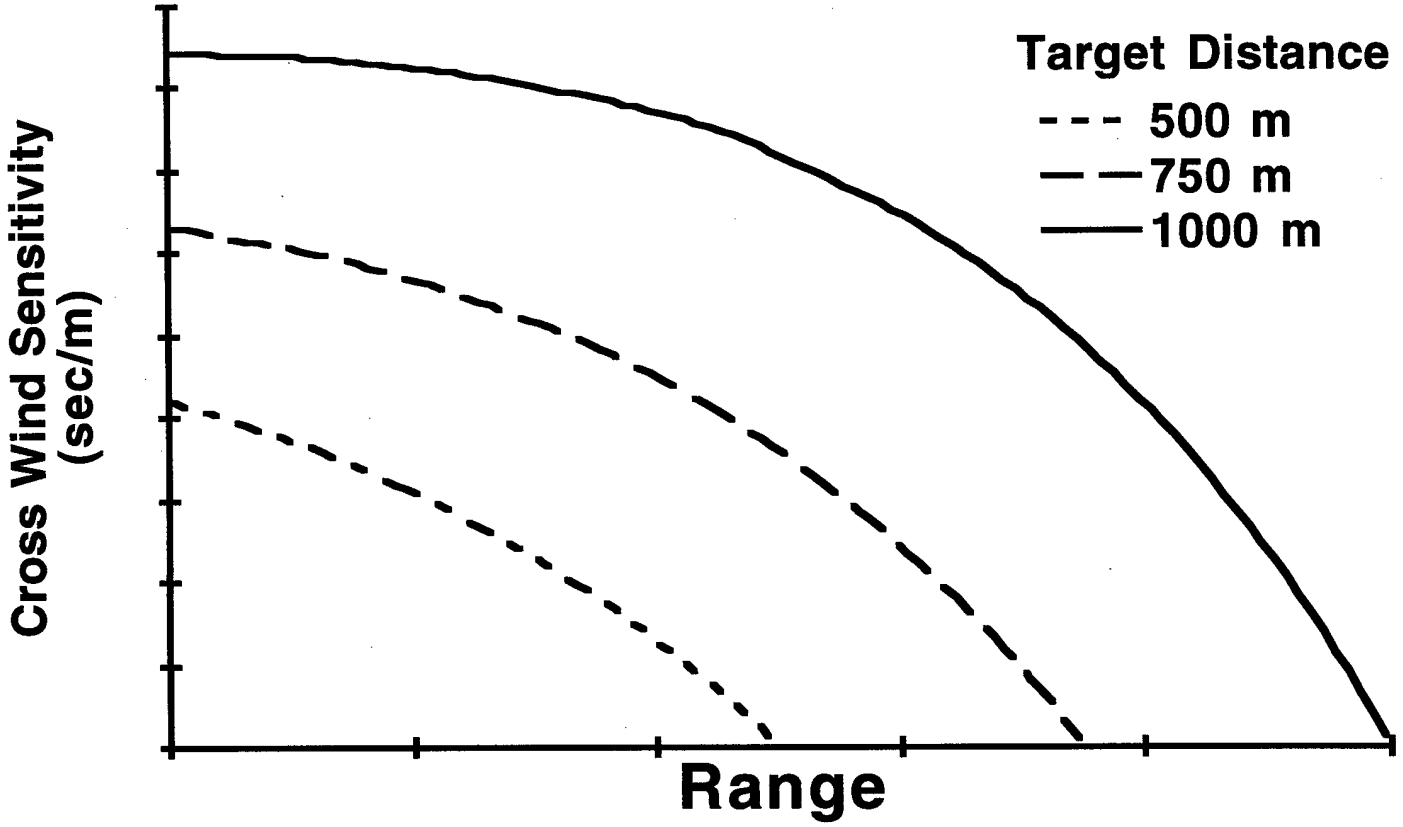
Cross Wind Sensitivity



Army Research Lab

Cross Wind Sensitivity

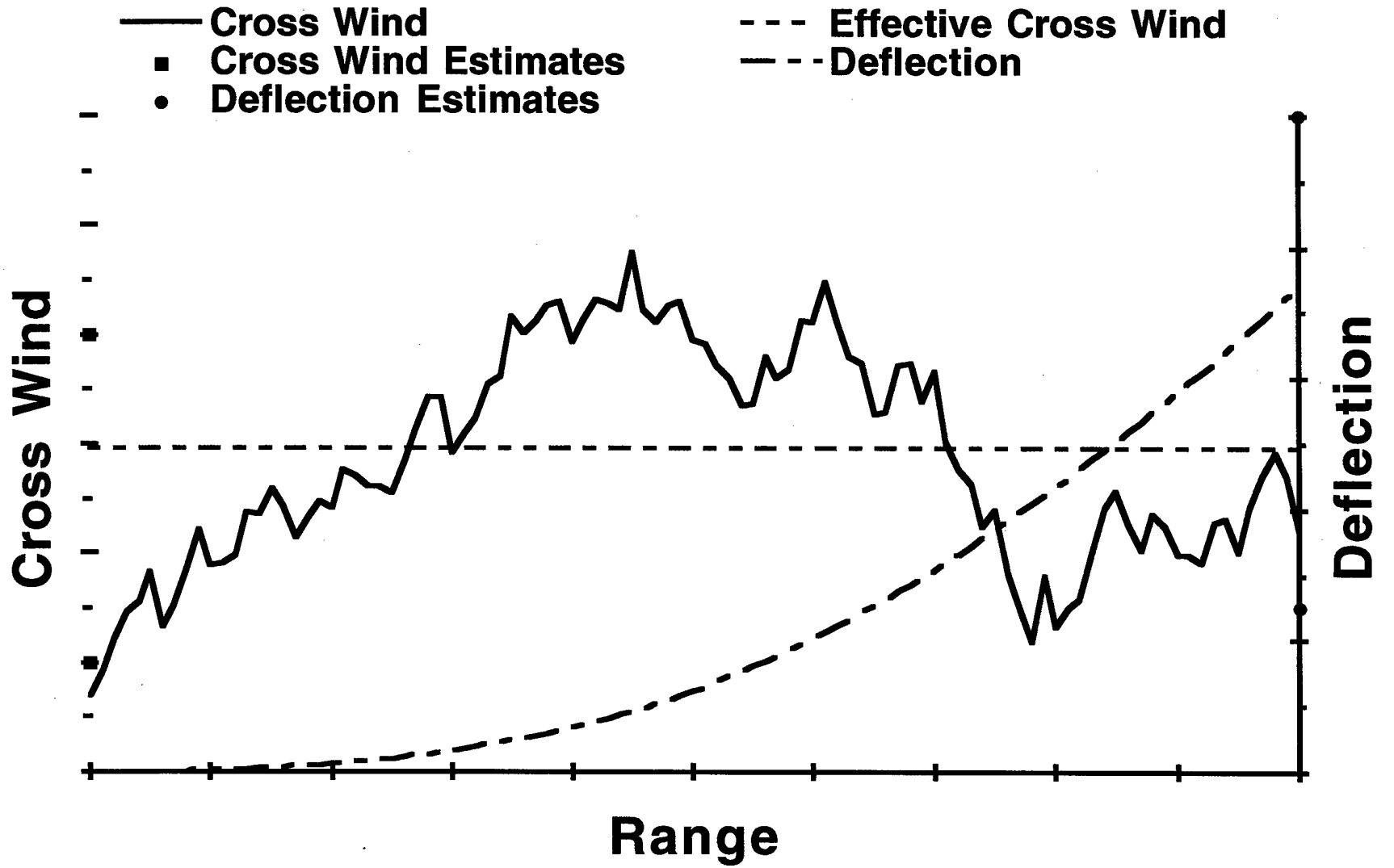
- (Deflection at Target Distance) / (Cross wind speed) / (Wind width)



- Bullet is more sensitive to cross winds nearest shooter.

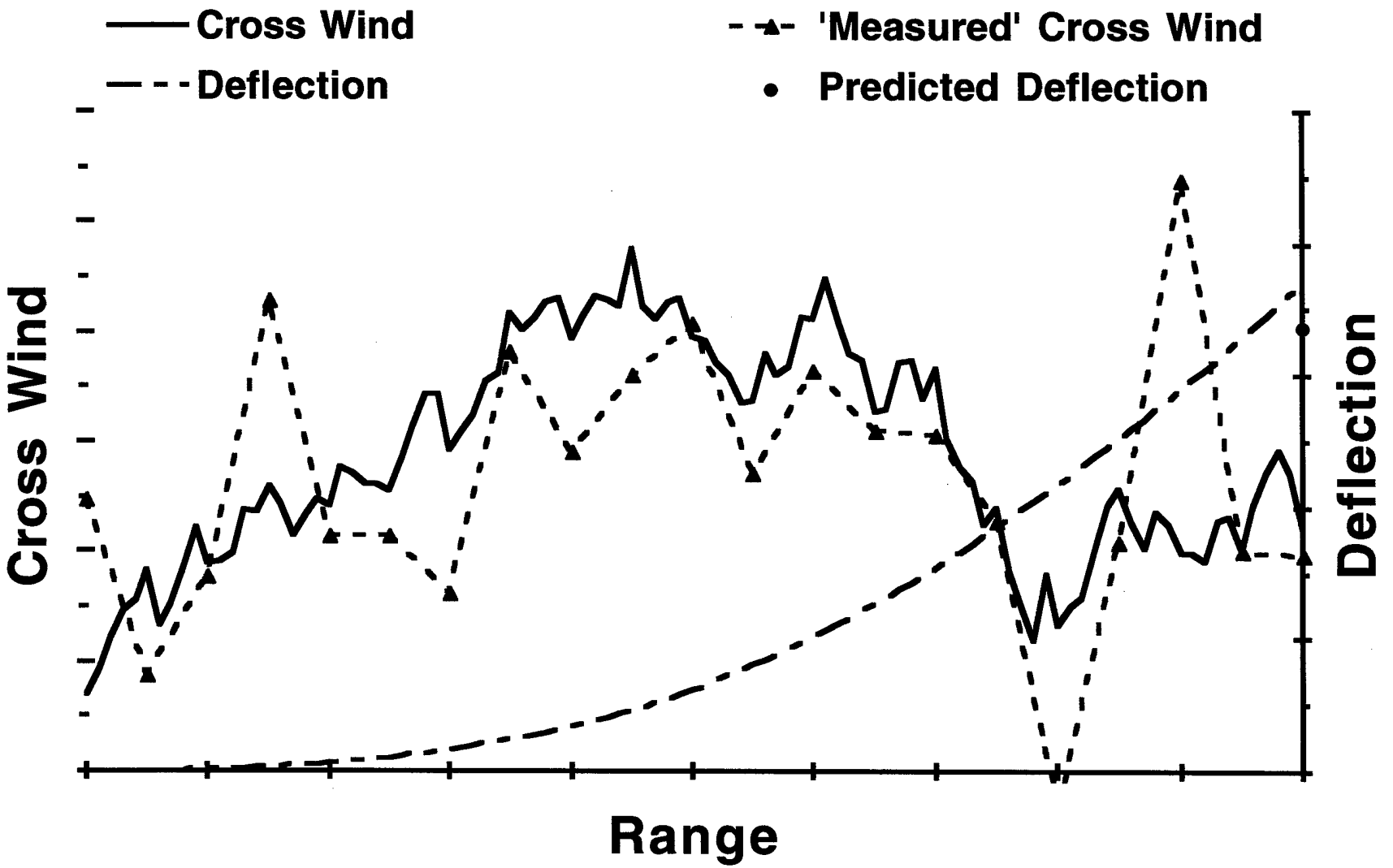
Army Research Lab

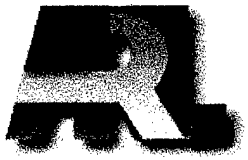
Variable Cross Wind



Army Research Lab

Cross Wind Measurement





Army Research Lab

Laser Cross Wind Sensor SBIR

- **Small Business Innovative Research (SBIR) topic: A96-032**
  TITLE: Laser Cross Wind Sensor
- **OBJECTIVE: Develop and demonstrate**
  - » **a compact,**
  - » **lightweight,**
  - » **rugged,**
  - » **eye-safe,**

  wind sensor capable of measuring cross wind profiles for ballistic wind corrections.
  - » **real time**
  - » **1 m/s accuracy**
  - » **1500 m**
  - » **range wind and range to target desirable.**
- **Four Phase I contracts.**
- **Three Phase II contracts.**

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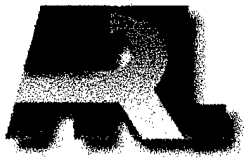
LASER Cross Wind Sensing Techniques

Laser Doppler Velocimetry

- Range-resolved, aerosol velocities measured along laser beams
- Divergent beams directed to sides of firing line
- Transformed into Range and Cross Wind Components
- Advantage:
  - Range-resolved Cross Wind
- Disadvantage:
  - Divergent beams
- Issue:
  - Transformation

Laser Scintillation

- Akin to "mirage" windage technique
- Laser-illuminated target
- Distortion of "speckle" pattern gives "ballistically" weighted reading of intervening cross wind.
- Advantage:
  - Directed along line of fire
- Disadvantage:
  - Weighted average
- Issue:
  - Multi Weighted Readings



Army Research Lab

LASER Cross Wind Sensing SBIR Contractors

Laser Doppler Velocimetry

Optical Air Data Systems

- Fiber optic components
- Ultra-compact system
- Unique signal processing technique

Phil Rogers (301) 299-6197
P.O. Box 34601 West Bethesda, MD 20827
PROGERS_OADS@msn.com

Coherhent Technologies Inc.

- Bulk laser components
- Velocity pattern algorithm
- Potential for smaller angle
- Confidence level of measurement shown
- Longer update time

Phil Gatt (303) 604-2000
655 Aspen Ridge Dr. Lafayette, CO 80026
PHILG@ctilidar.com

Laser Scintillation

Scientific Technologies Inc.

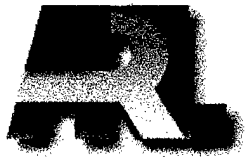
- "Fast Track" proposal
- Matching dollars
- Fewer weighted readings

Dr. Ting-i Wang (301) 948-6070
205 Perry parkway, Suite 14
Gaithersburg, MD 20877
scti@netrail.net

Brimrose

- Actual demonstrated prototype
- Live fire tests
- More weighted readings

Dr. Susan Kutcher (410) 931-7200
5020 Campbell Blvd. Baltimore, MD 21236
office@ brimrose.com



Army Research Lab

Laser Cross Wind Sensor

- Utilize fiber optic components.
- Be incorporated into a spotting scope.
- Use Scintillation technique for cross wind and doppler technique for range wind.
- Provide a cross wind correction to the spotter.
- Also function as a laser range finder.
- Eye-safe.

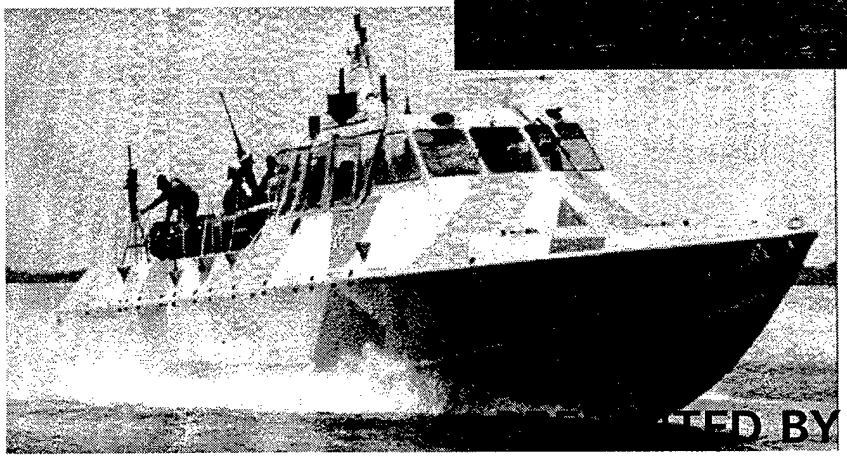
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1998 NDIA SMALL ARMS SECTION CONFERENCE

SURFACE WARFARE MOUNTING SYSTEMS







PRESENTED BY:

SGT. JOHNSON

NSWC CRANE DIVISION

15 June 1998

NSWC

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PURPOSE

THE PURPOSE OF THIS BRIEFING IS TO PRESENT THE LATEST SMALL ARMS AND ARMAMENT SYSTEM MOUNTING TECHNOLOGY FOR THE VARIOUS DOD AGENCIES ONGOING AT NSWC CRANE

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3 AREAS OF FOCUS

1 SEA SYSTEMS - MOUNTING STRUCTURES FOR NAVY SHIPS AND SPECIAL WARFARE CRAFT

•

2 AIRCRAFT SYSTEMS - HELICOPTER PLATFORM SYSTEMS ON ARMED HELO, UH-1N, HH-60H

•

3 LAND VEHICLE SYSTEMS - LIGHT STRIKE, DESERT PATROL, HMMWV

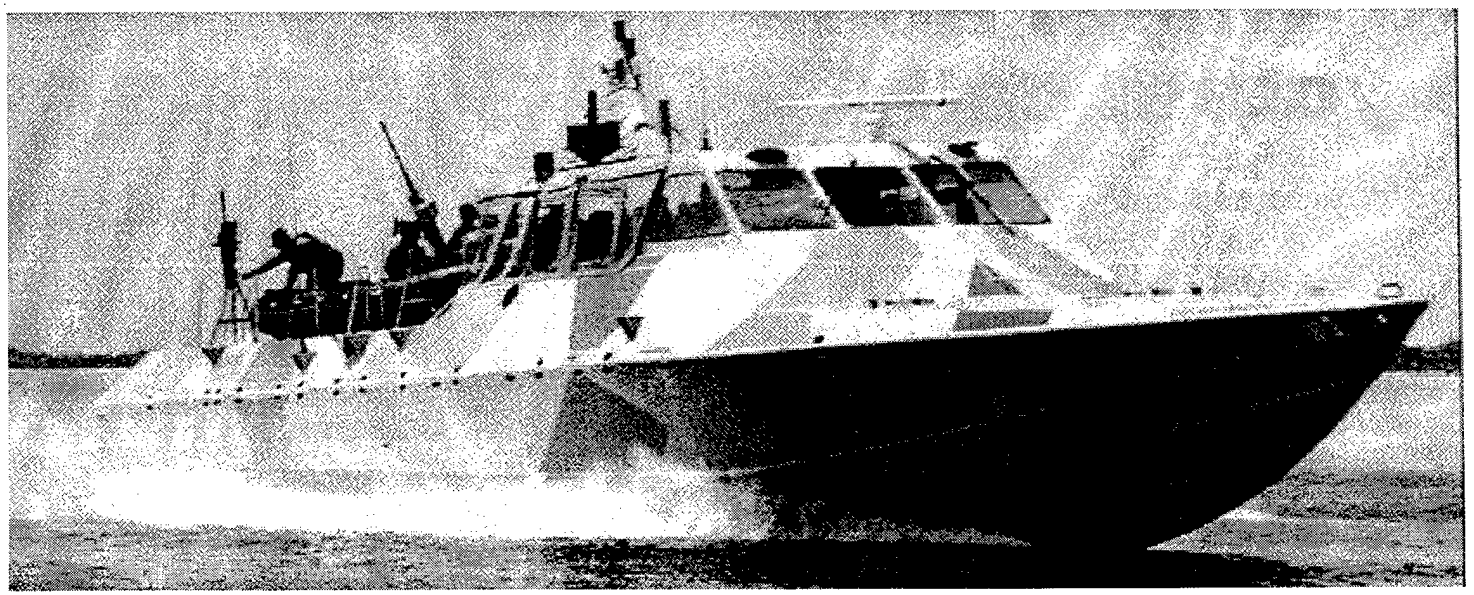
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1 - SEA SYSTEMS

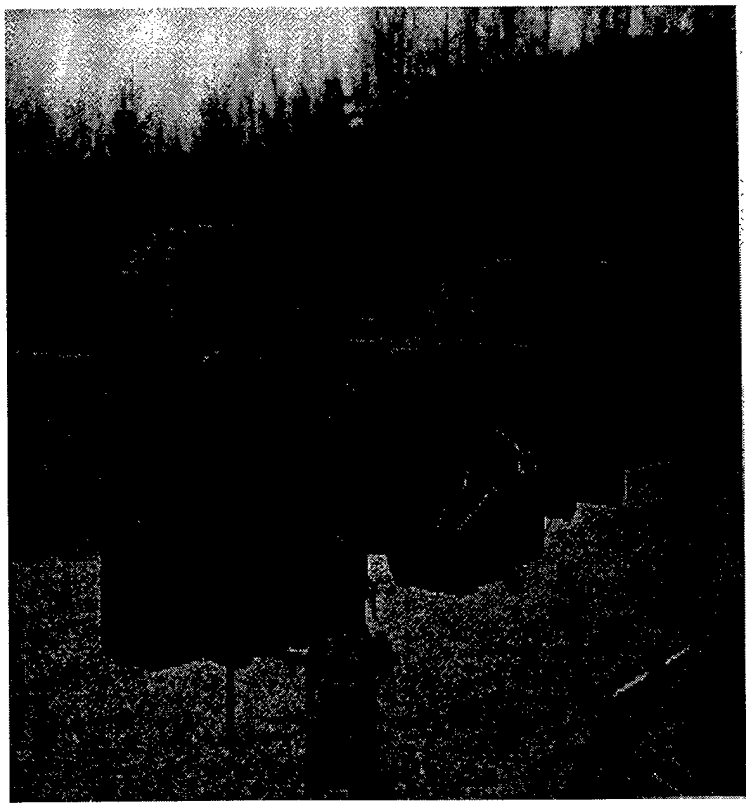


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MK95 TWIN .50 CALIBER MOUNT

MOUNT WEIGHT:

108 LBS

420 LBS WITH GUNS & AMMO

2- M2HB MACHINE GUNS

500 ROUNDS OF AMMUNITION

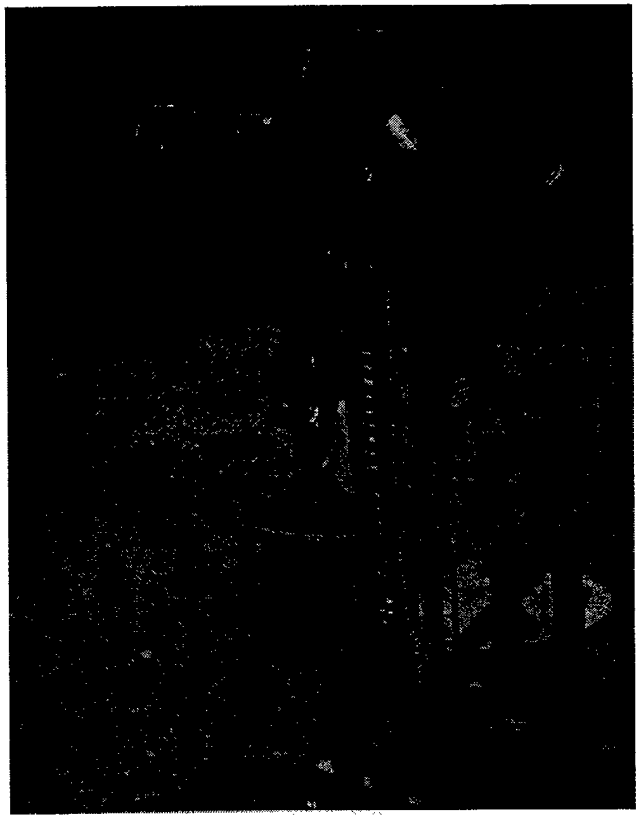
SOFTMOUNT TECHNOLOGY

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MK44 7.62MM MINIGUN SYSTEM

-SYSTEM WEIGHT:
167 LBS WITH GUN & AMMO

-GAU-17 7.62MM MACHINE GUN

-1500 ROUNDS OF AMMUNITION

-3000 SHOTS PER MINUTE

-24 VDC POWER SUPPLY

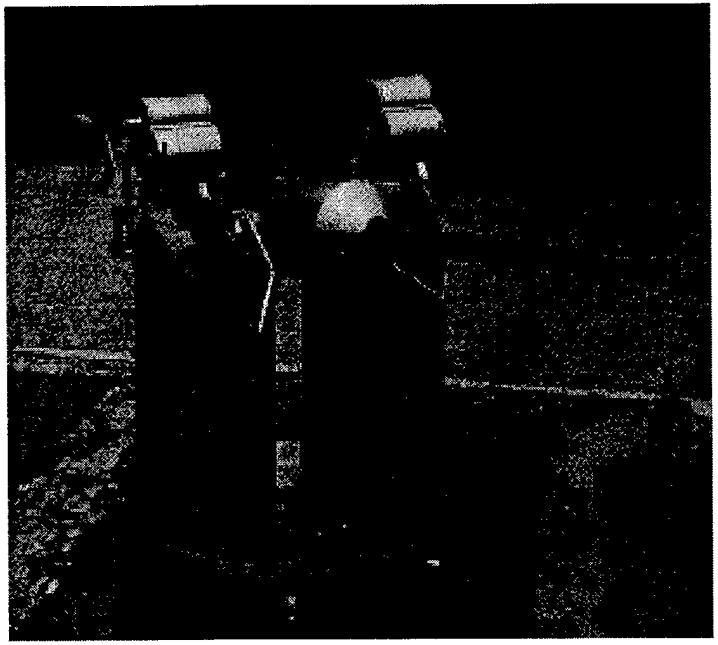
-COMMON WEAPON WITH ARMY, AIR FORCE, NAVAIR, WARCOM

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MK98 25MM WEAPON SYSTEM

-25MM CHAIN GUN (180 SPM)

-HIGH RATE 25MM CHAIN GUN (400 SPM) MK45

-TWIN .50 CALIBER MG

-COMPOSITE AMMUNITION CANS

-DUAL FEED CAPABILITY

-FUTURE STABILIZATION

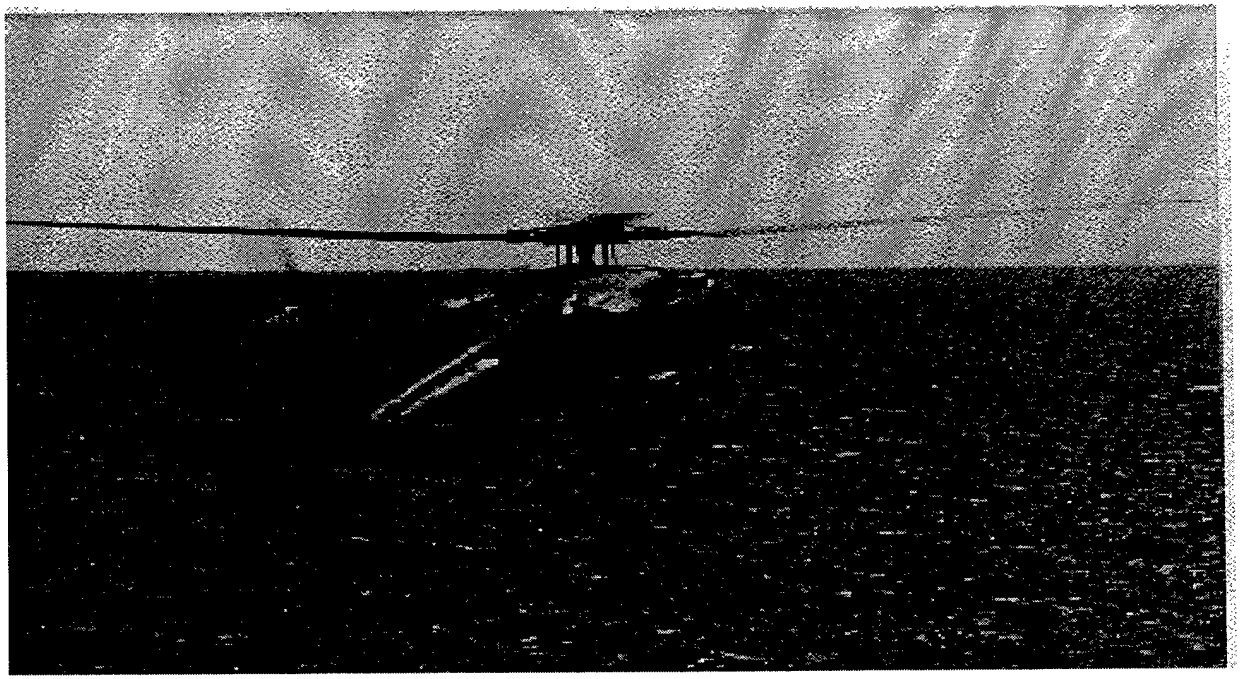
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2 - AIRCRAFT SYSTEMS



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ARMED HELO PROGRAM

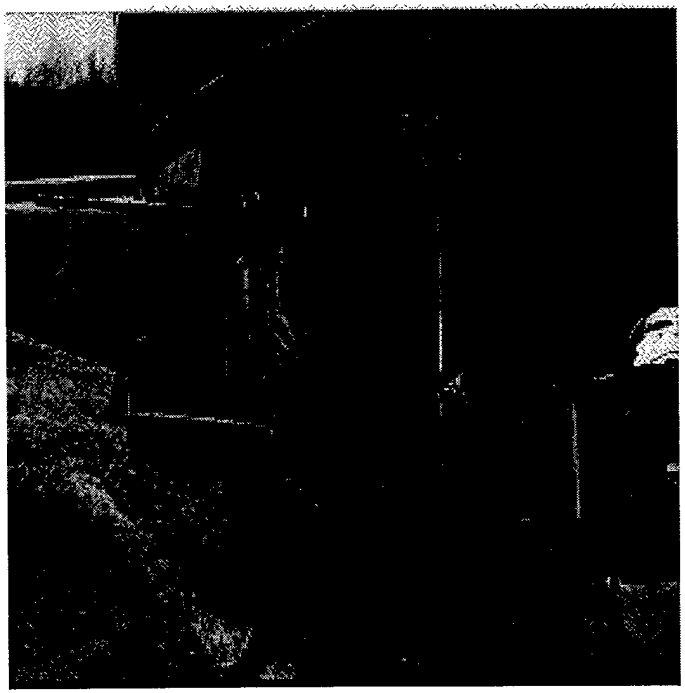
- -GAU-16 .50 CALIBER MG
- -MK94 MOD 1 SOFT MOUNT
- -INTERCHANGABLE DECK PLATE
- -INBOARD OR OUTBOARD STOW
- -NAVY FLIGHT CERTIFIED
- -LASER SIGHT AVAILABLE

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UH-1N WEAPON SYSTEMS

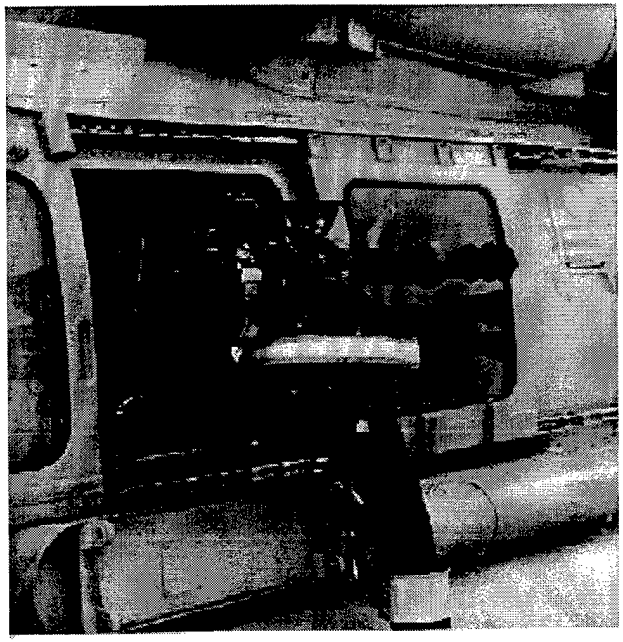
- -XM-218 .50 CALIBER MG
- -M240D 7.62MM MG
- -GAU-17 7.62MM MINIGUN
- -DEFENSIVE ARMAMENT SYSTEM

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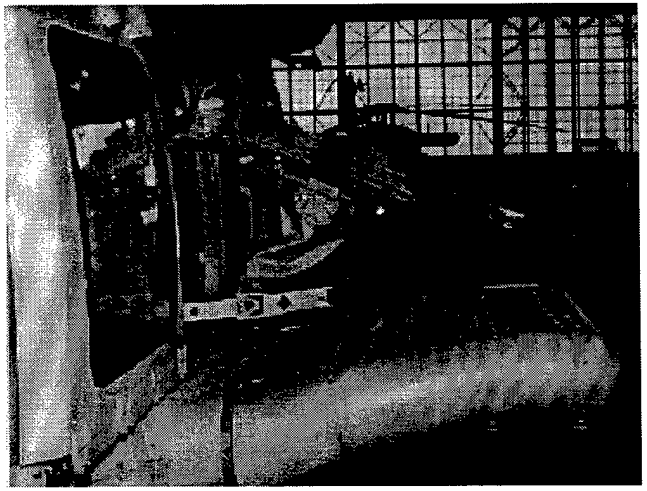
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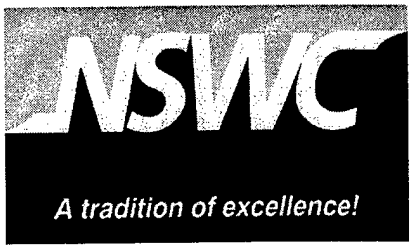


HH-60H WEAPON SYSTEMS

- -GAU-17 MISSION KIT
- -M240 7.62MM MG
- -M60 7.62MM BASIC MG



15 June 1998



1998 NDIA SMALL ARMS SECTION CONFERENCE

- **CONCLUSION**
  - MULTIPLE APPLICATIONS BETWEEN SEA, AIR, AND LAND SMALL ARMS MOUNTING SYSTEMS
  - MAXIMIZING USE OF COMMON COMPONENTS
  - IMPROVING SOFTMOUNT TECHNOLOGY
  - IMPLEMENTING USE OF LIGHT WEIGHT MATERIALS
  - MAINTAIN SAFETY CERTIFICATION FOR NEW HARDWARE
  - SIMULATED LIVE FIRE TESTING CAPABILITY ASSOCIATED WITH ADVANCED STRUCTURAL ANALYSIS YIELDS A USEFUL PRODUCT

15 June 1998

A Unique Crosswind Compensated Fire Control Device for Small Arms

Gideon Bar-Tal, Sagie Tsadka, Ehud Azoulay
Soreq NRC, Electro-optics Division
Yavne 81800, Israel

Abstract

In order to increase the lethality of small arms, efforts have been undertaken in two different directions: Improved munitions and advanced Fire Control Systems (FCS).

Our paper describes a unique and novel addition to FCS's – Crosswind compensation.

The adverse effects of crosswind on the ballistics of a projectile are well known, but until now could not be corrected. The crosswind influences the flight of projectiles at short and medium ranges, causing a deflection of the projectile from its aim point and thereby reducing hit probability.

In the case of shooting at small targets from distances of several hundred meters the projectile trajectory is greatly affected by crosswinds. Even moderate crosswinds of less than 10 knots (5m/sec) will cause miss distances of about 25 cm for ranges of 200 meters and more than 1 meter at ranges of 500 meters. This is true for all of the commonly used small arms munitions, such as 5.56 mm (0.2") and 7.62 mm (0.3") caliber bullets. Measurements taken and calculations made in order to quantify the crosswind influence on the projectile's trajectory will be presented in this paper.

The new FCS will perform the combined task of measuring the range to target and the crosswind along the projectile's path. Combining the ballistic parameters of the projectile and the measured information the system processor will calculate a correct aim point.

The operation technique is based on transmitting a low power laser beam along the line of sight to the target, receiving the reflected signal from the target and analyzing its turbulence induced spatio temporal power fluctuations.

Experimental results, which show significant improvement in hit accuracy when shooting at distances of 500 meters under various crosswind conditions, are presented.

Cross Wind Measurement – Principle of Operation

The unit is built around a low power laser that transmits a collimated narrow beam towards the target. The beam is reflected back from the target and detected by the system receiver. The receiver is composed of two horizontally separated detectors (Figure 1). Since the beam passes through the atmospheric turbulence on its way to the target and back to the receiver, it accumulates intensity fluctuations across its phase front due to the diffraction of the refractive-index irregularities that comprise the turbulent medium. According to Taylor's hypothesis, for short time periods, it is true that the refractive-index irregularities drift with the atmospheric wind with no significant change in their shape or spatial distribution (the "frozen" turbulence hypothesis). Therefore, the diffraction pattern of the beam on the target and on the receiver plane also drifts with a velocity that is related to the crosswind component along the optical path. By temporally analyzing the intensity fluctuations in 2 separate positions on the receiver plane, it is possible to compute the crosswind velocity (figure 2).

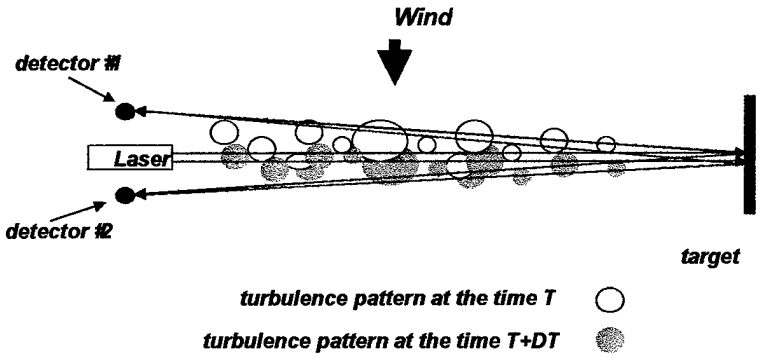


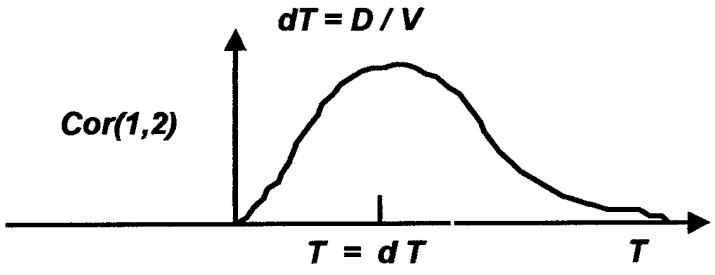
Figure 1 Graphic Presentation of Measuring Technique



detector #1 signal as a function of time



detector #2 signal as a function of time



Time correlation between the two signals

Figure 2 Correlation Function Calculation

Test Results

The crosswind measurement tests were conducted in two stages. The first was designed to demonstrate the accuracy of measurement, and the second to demonstrated the improved performance of the sniper in live firing tests when using the system.

Wind accuracy measurement

The tests were conducted on a 500 meter long target range. Along the measurement path, 3 anemometers were equally spaced which accumulated data over a time period of more than 34 hours. The data was averaged and compared to the output of our wind measurement device. The test results are shown in figure 3 where we can see the good correlation between the two measurement techniques.

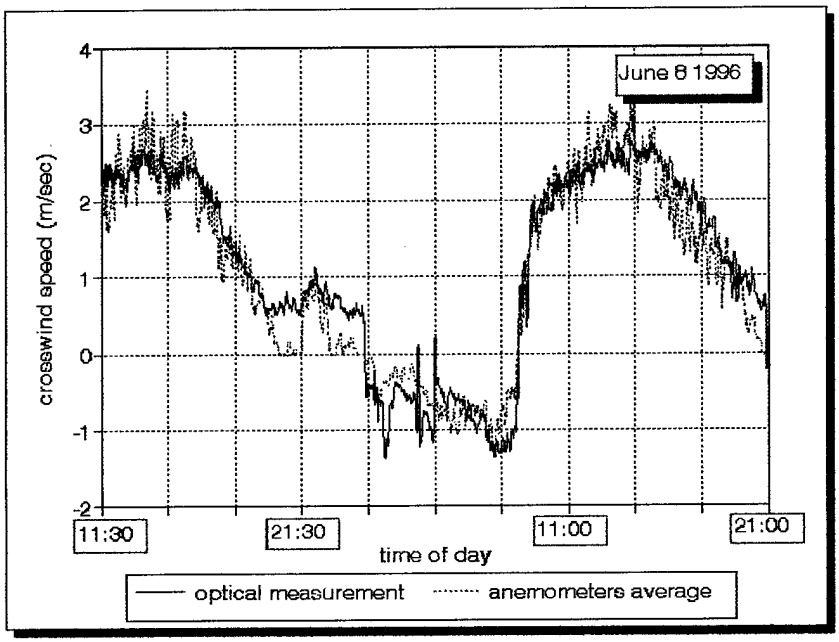


Figure 3 Comparison between Anemometer and Optical measurements

From the results one can see that the wind as measured by individual anemometers are very fluctuative in nature, because they provide results at a point along the path. On the other hand the output as measured by the crosswind sensor is much smoother because it provides results that are an average along the total distance. Another point of interest is that at very low wind speeds (under 0.5 m/sec) the anemometers tend not to give results at all. This is due to the static friction of the device that tends to cause the propeller to stick.

Live fire tests

These tests were conducted along the same 500 meter target range. The sniper shot fired SR86 rifle with a X10 telescope. The rifle was first boresighted at a range of 100 meters and then corrected in elevation for the 500 range. The sniper shot at will at a predefined point on the target. With each shot the crosswind effect on the bullet was calculated and a predicted impact point computed. The test results are shown in figure 4 comparing the true point of impact with the predicted point.

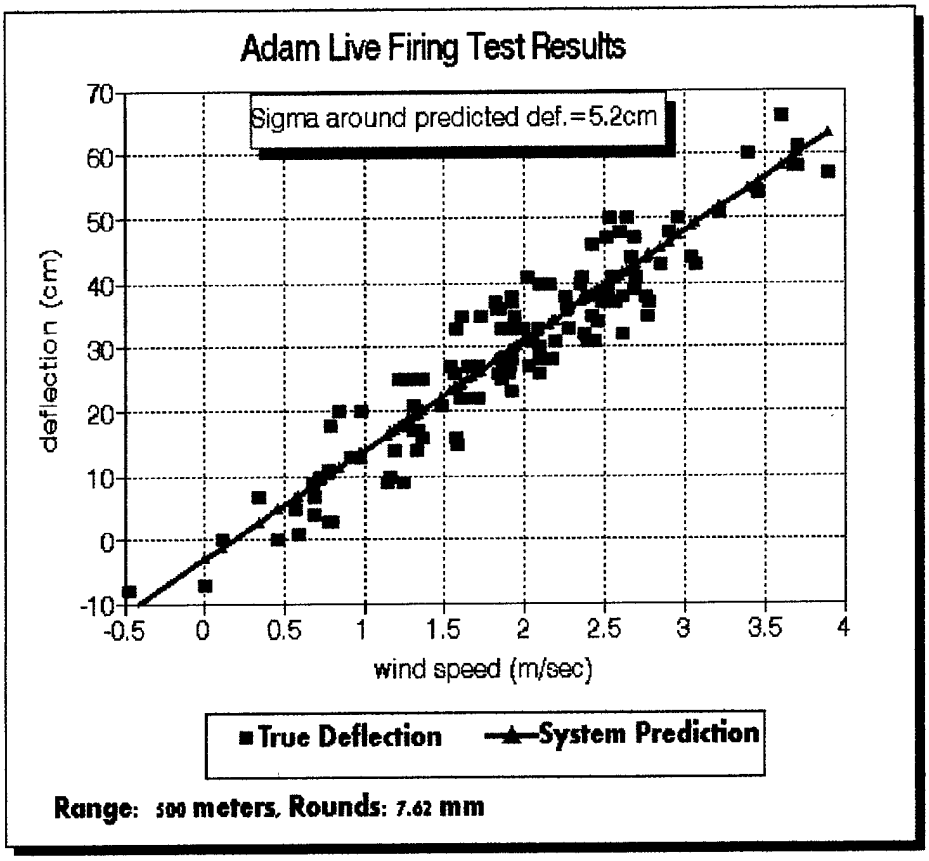


Figure 4 Live fire test results

From the test results in figure 4 one can see the crosswind effect on the horizontal deflection. Even at moderate wind speeds of 3 m/sec the deflection of the bullet is about 50cm. The points of impact are very close together but the horizontal deflection is such that they will miss a human target. With our measurement device we can predict the point of impact (the black line) and show that the true points of impact are distributed about the line. The average true deflection from the prediction point is only 5 cm, which is almost an order of magnitude improvement from the uncorrected horizontal deflection.

Measurement System

The system is an active Electro-optical measurement device built around a low power Nd:YLF laser lasing in the 1.047μm range. Two low noise detectors detect the optical signal, returning from the target. The detected signal is amplified and digitized in a pre amplification stage. The digitized signal is sampled by a microprocessor that runs the unique software package that calculates the following parameters:

- ✓ Range to target.
- ✓ Wind speed and direction along the line of fire.
- ✓ Ballistic correction and crosshair correction.

The main system performance characteristics are listed below:

- ✓ Range of operation: 50 - 1000 m
- ✓ Range measurement resolution: 10 m
- ✓ Crosswind Accuracy <1 m/sec
- ✓ Measurement time: <1 sec

Figure 6 is a schematic block diagram of the system, and figure 7 shows the Demonstration model mounted on a Pan and Tilt unit.

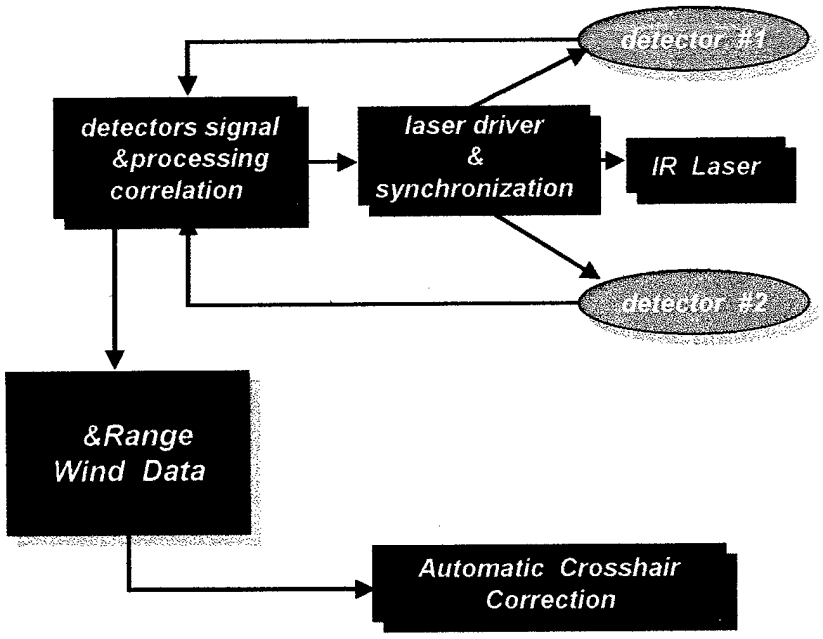


Figure 6 Schematic Bloc Diagram

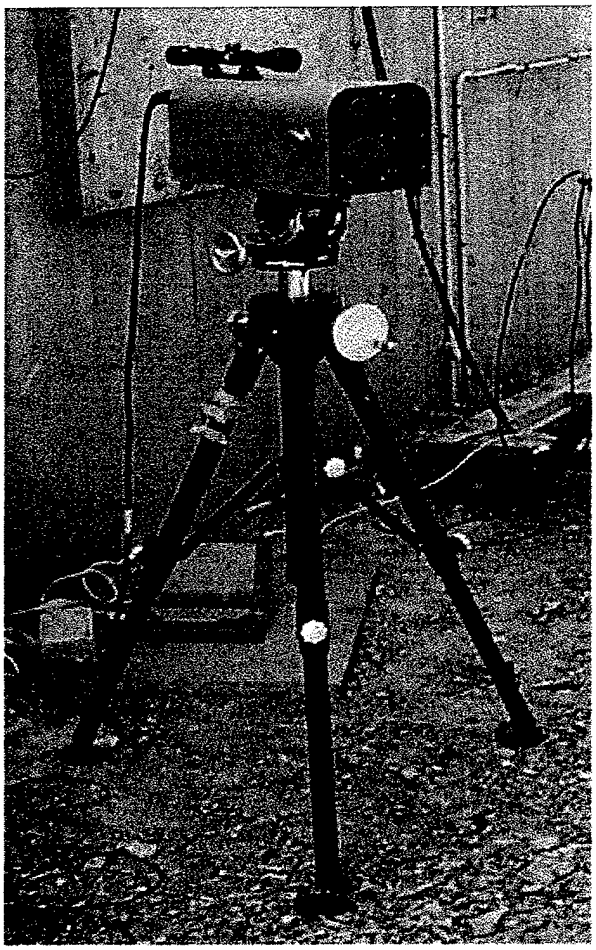


Figure 7 Crosswind Demonstration model

Future Developments and Applications

The technology advances over the last years in both compact high efficiency lasers and electronics has made it feasible today to add new features to Fire Control Systems. FC systems are finding their place in new small arms such as the OICW, OCSW and new sniper weapons (OSW), as well as in larger devices such as unguided rockets and tank guns.

All projectiles tend to either drift with the crosswind when decelerating or fly into the wind when accelerating. System analysis performed on different weapons and munitions show that the effect of the wind on the accuracy is substantial. New FC systems have as yet not incorporated the capability to measure crosswind over the total line of sight, because the technology up to now has not been well developed and proven. The demonstration model along with our unique patented hardware and software package has made it possible today to add crosswind measurements for improved performance.

Improved Night/Day Fire-Control/Observation Device (INOD)

James Soderberg, Marketing Manager
Albert Efkeman, Engineering Team Leader

ITT Night Vision a division of
ITT Defense & Electronics

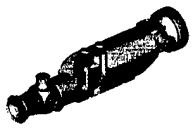
ITT Defense & Electronics

Improved Night/Day Fire-Control/ Observation Device (INOD)



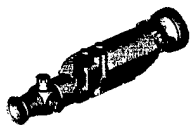
INOD is a Best-Value Procurement to Provide the Joint Special Operations Forces (SOF) With an Integrated Day/Night Scope (Simultaneous Visible and I^2) for Medium and Heavy Sniper Rifles and Strategic Reconnaissance and Observation.

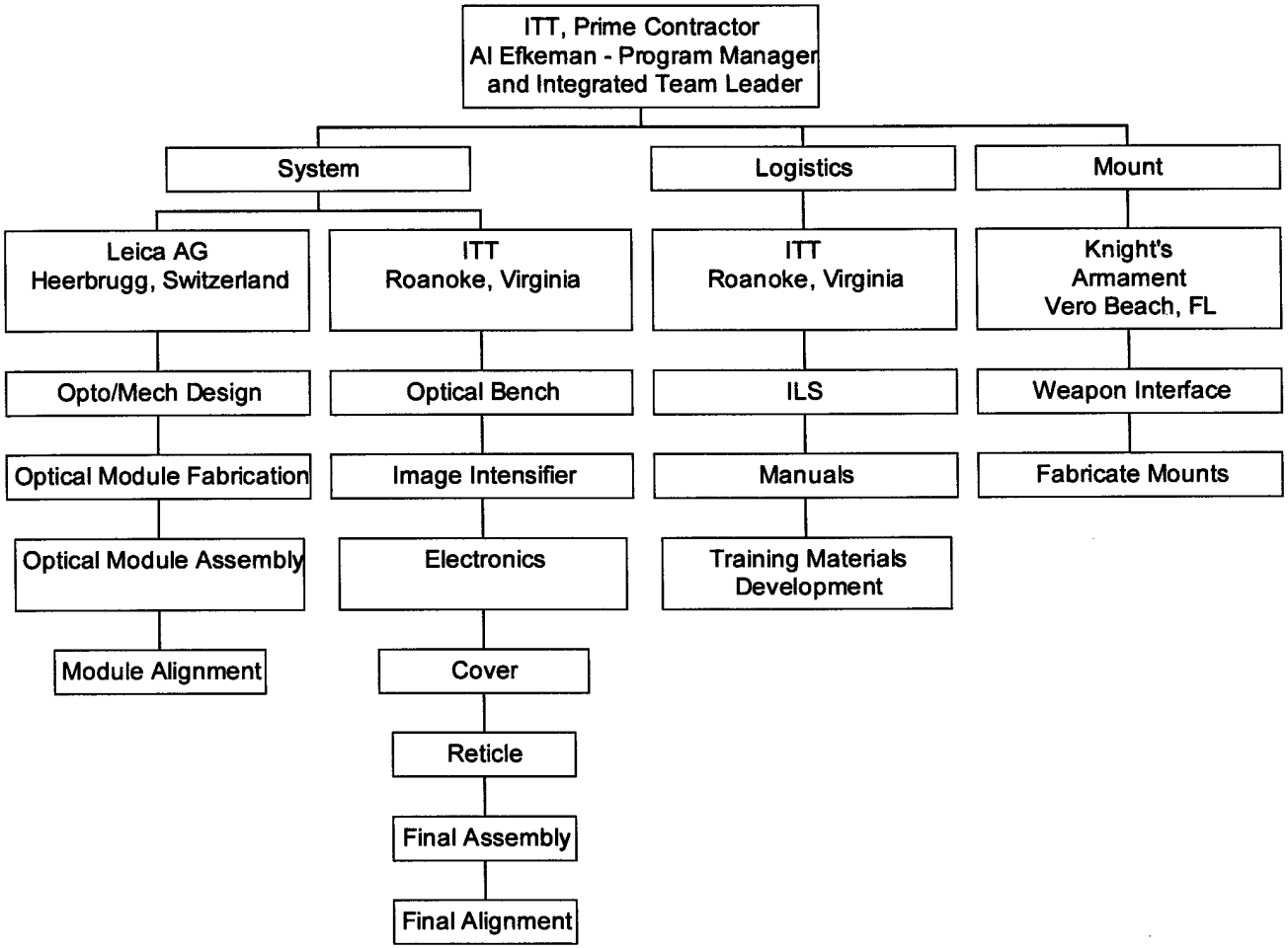
Program Structure/Strategy



- Program-Specific Memorandum of Agreement Between:
  - U.S. Special Operations Command, Program Executive Officer for Special Programs (PEO-SP)
  - Project Manager for Night Vision/Reconnaissance, Surveillance, and Target Acquisition (PM-NV/RSTA)
- U. S. SOCOM
  - Milestone Decision Authority
  - Independent Test Evaluator
  - Joint SOF Requirement for USASOC, NAVSPECWARCOM, and USMC User Communities
- PM-NV/RSTA
  - Manage the INOD Acquisition Program/Strategy
  - Chair TIWGS and Designate IOT&E Activity
- Contractor
  - ITT Night Vision, Roanoke, Virginia

ITT's Integrated Product Team





ITT Industries

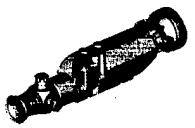


Refer information requests to SFAE-IEW&S-NV-12



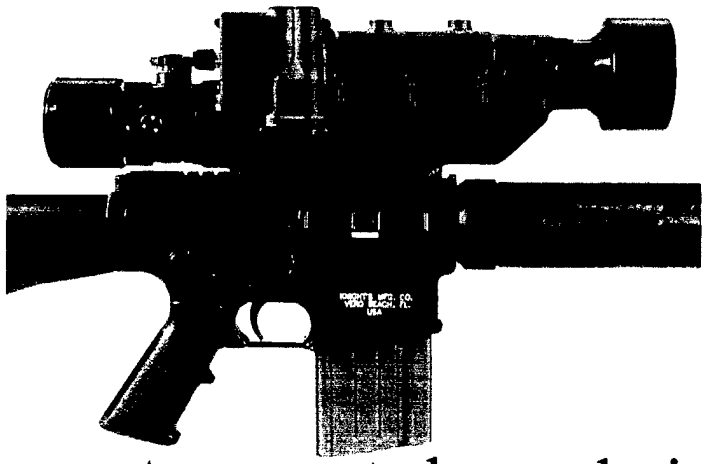
ITT Defense & Electronics

Program Status



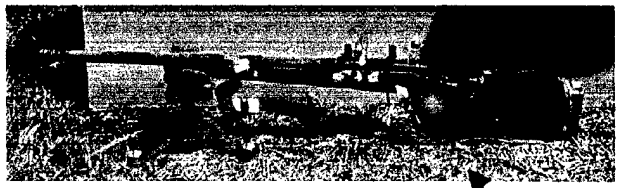
- Award Date: 24 June 1997
- Phase I - Test Analyze and Fix
  - Deliver 3 Medium INODs - Completed 15 May 1998
  - Deliver 3 Large INODs - Completed 11 June 1998
- Government-Conducted Testing - May 19 - June 31, 1998
- Phase II - Modify Systems Based on Evaluation
  - Deliver 6 Medium INODs
  - Deliver 6 Large INODs
- Government-Conducted Testing
- Production - Approximately 1,400 units (1999 -2002)

System Overview

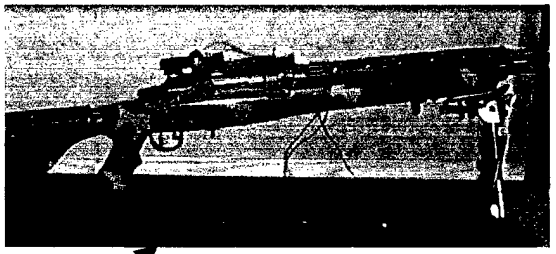


- INOD Requirements presented new design challenge different from all other night vision systems:
  - Simultaneous viewing of day and night channels
    - Demanded near-perfect image registration
    - Demanded near-perfect distortion matching
  - Day use determined system magnification for night channel
  - Limited day objective diameter requirement challenged low-light-level performance for night channel
  - Tight boresight retention for both channels under severe weapon shock

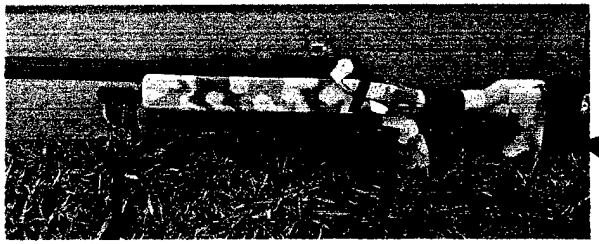
INOD Interfaces to These Weapons



M40A1



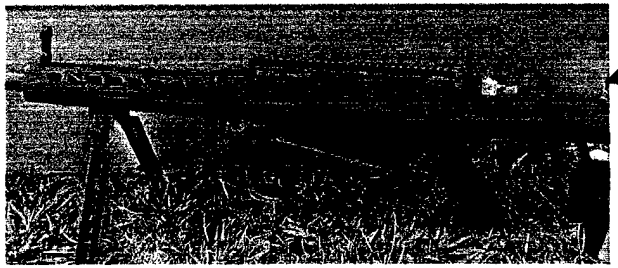
DMR



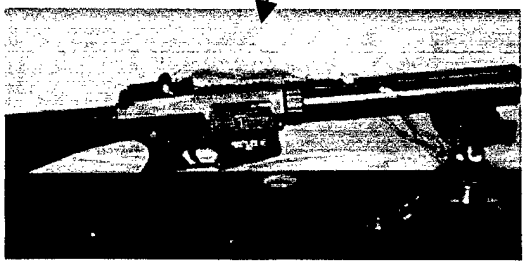
M88 SASR PIP



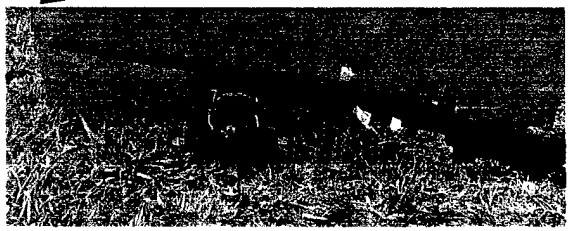
M24



M82A1A



SR-25

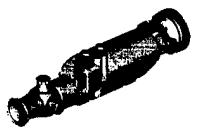


300 Winchester Magnum

ITT Industries

Refer information requests to SFAE-IEW&S-NV-12

System Overview - System Requirements for Two Magnifications



Medium INOD

- 10X
- Objective maximum diameter restricted to 73.7 mm (2.9 inches)
- Length limited to 35.56 cm (14 in)
- Weigh less than 2,041 gms (4.5 lbs)
- Eye Relief >2 inches
- Range for man-size target with 90% probability of recognition
  - 1,000 meters under moonlight
  - 550 meters under starlight
- Day range same as Leupold 10X M1
- MIL-DOT reticle and image area same as Leupold 10X M1 scope
- 1/4 MOA adjustments
- Immersion to 3 meters (10 ft)
  - Desired immersion to 20 meters (66 ft)
- Boresight retention of 1/2 MOA
- Battery life of 12-hours on two AA alkaline batteries

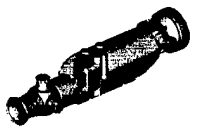
Large INOD

- 16X
- Objective maximum diameter restricted to 90 mm (3.5 inches)
- Length limited to 40.64 cm (16 in)
- Weigh less than 2,772 gms (6.0 lbs)
- Eye relief >2 inches
- Range for man-size target with 90% probability of recognition
  - 1,300 meters under moonlight
  - 700 meters under starlight
- Day range same Leupold 16X M1
- MIL-DOT reticle and image area same as Leupold 16X M1 scope
- 1/4 MOA adjustments
- Immersion to 3 meters (10 ft)
  - Desired immersion to 20 meters (66 ft)
- Boresight retention of 1/2 MOA
- Battery life of 12-hours on two AA alkaline batteries





System Overview - Additional Requests from Users



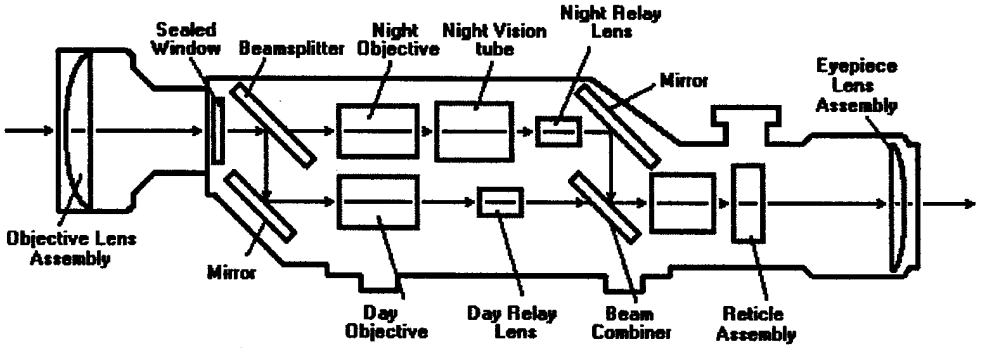
- All controls on right side - Clean surface on left side (during drag)
- Battery housing similar to AN/PVS-14 with battery cartridge - one hand operation to replace batteries
- Minimal color shift between normal daylight scene and that seen through day channel
- "Luna" Rail - Interface
  - Can mount short length of MIL-STD-1913 Rail on top of system
  - Ability to mount IR pointers/illuminators





System Overview - Unique Optical Approach

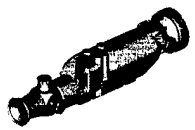


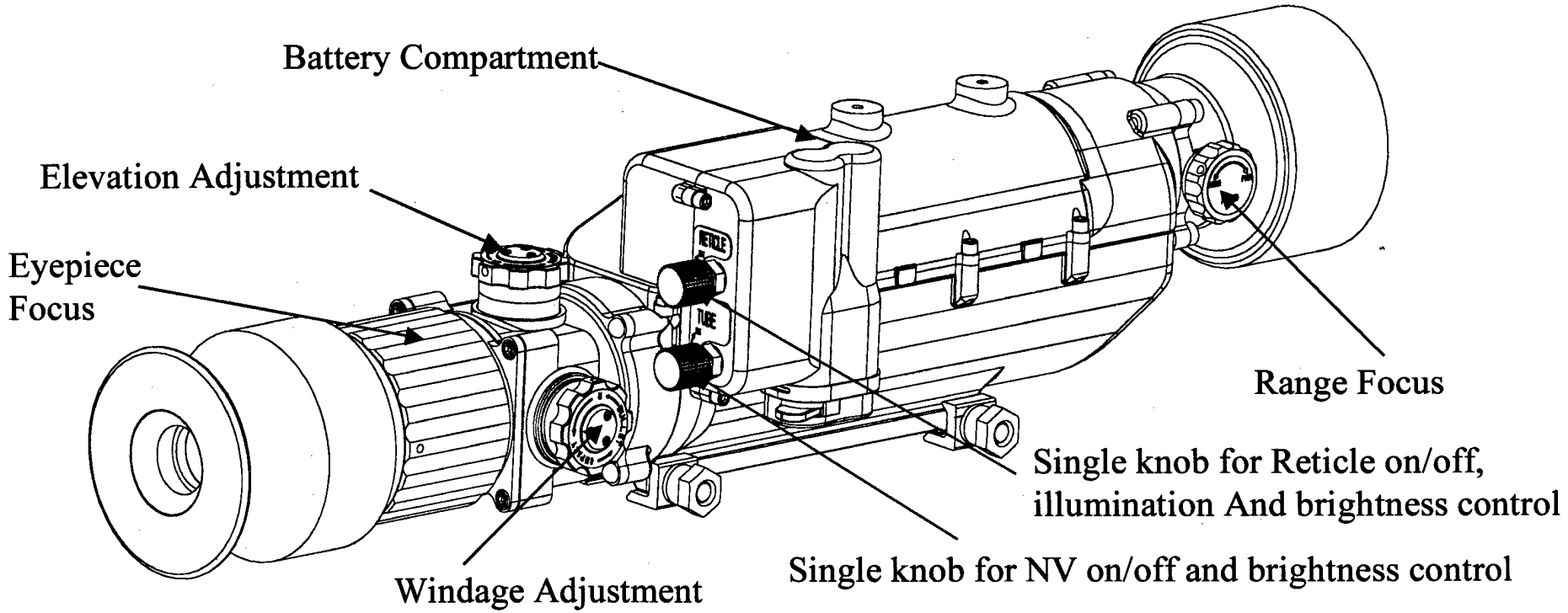




- Separate day and night channels
- Interchangeable afocals allow magnifications other than 10X and 16X
- Common reticle for day and night
- Common eyepiece for day and night
- Thin-plate beamsplitter and beam combiners
  - Reduced weight
  - Reduced coating complexity
- Without Afocal lens, INOD is a 4X day/night sight

System Overview - Controls and Adjustments were specified by Users

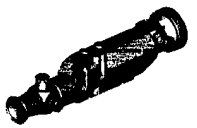




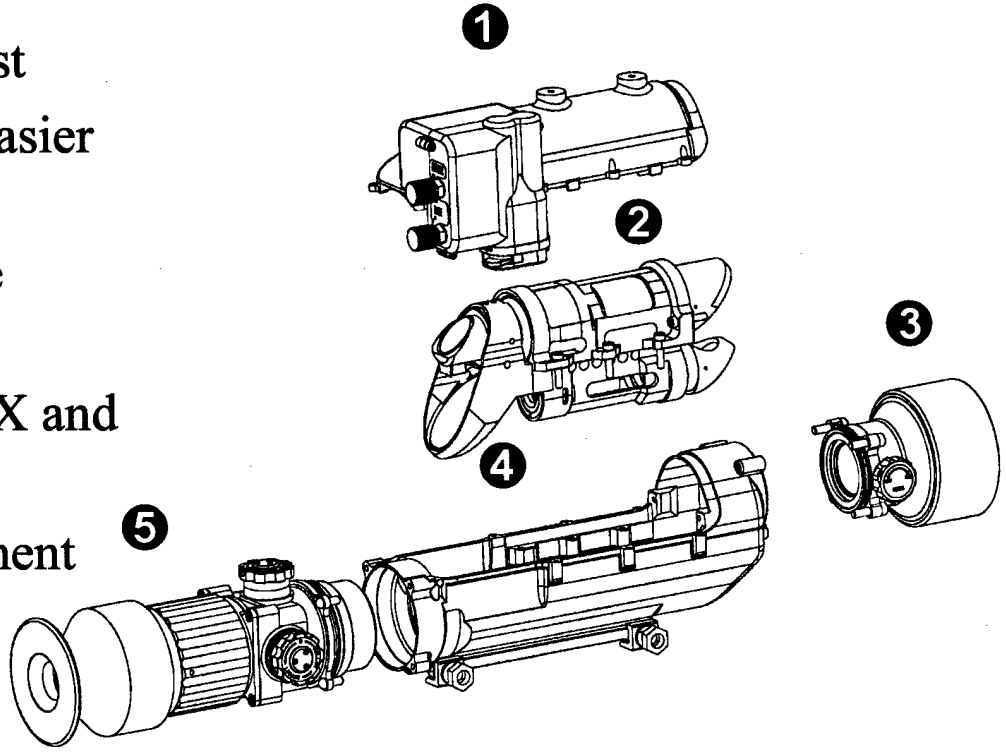
- Night vision and reticle illumination knobs face the user
- Battery compartment at rear oriented vertically - Battery cartridge can drop into user's hand when changing batteries
- Left surface is clean, all controls on right side



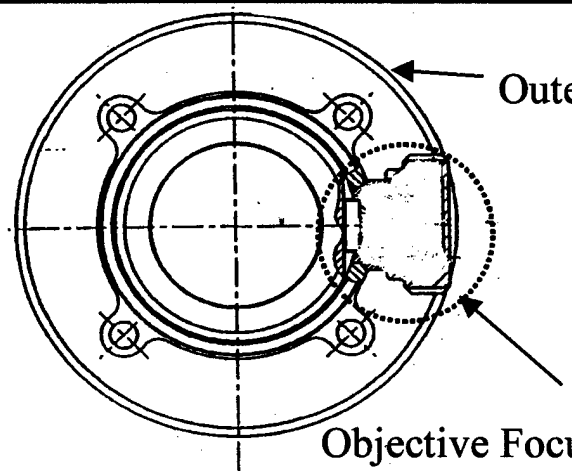
System Overview - INOD consists of Five Major Modules

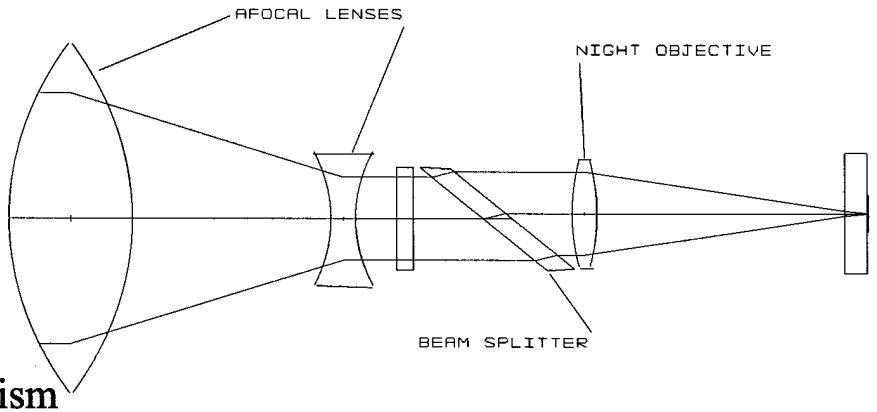


- Easy to pretest critical optical components
- Easier to manufacture, reduces cost
- Interchangeable modules allows easier maintenance
- Permits upgrade without complete redesign
- Permits easy retrofit to change 10X and 16X capability
- Simplifies day/night image alignment
- Modules
  1. Cover and electronics assembly
  2. Optical supermodule
  3. Objective afocal lens (10X and 16X)
  4. Optical bench and weaponmount
  5. Eyepiece and reticle assembly



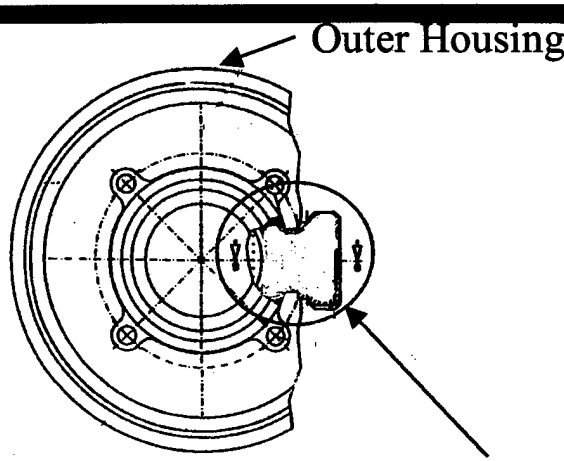
Afocal/Objective Lens - Medium 10X

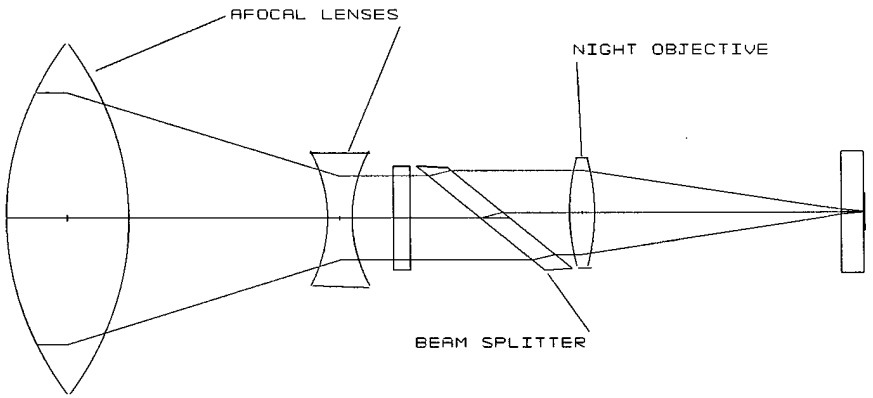




- Objective is offset to account for beam shift in beamsplitter
- FOV limited to 2° to match Leupold (full tube FOV of not seem)
- Effective Focal length of combination is 167 mm
- F/No. is 2.65
  - F/no controlled by afocal not by night objective
  - Can increase afocal size for lower F/no is found necessary
- T/No. is 3.0
- Range focus 50 meters to infinity
- Focus mechanism uses eccentric cam

Afocal/Objective Lens - Large 16X

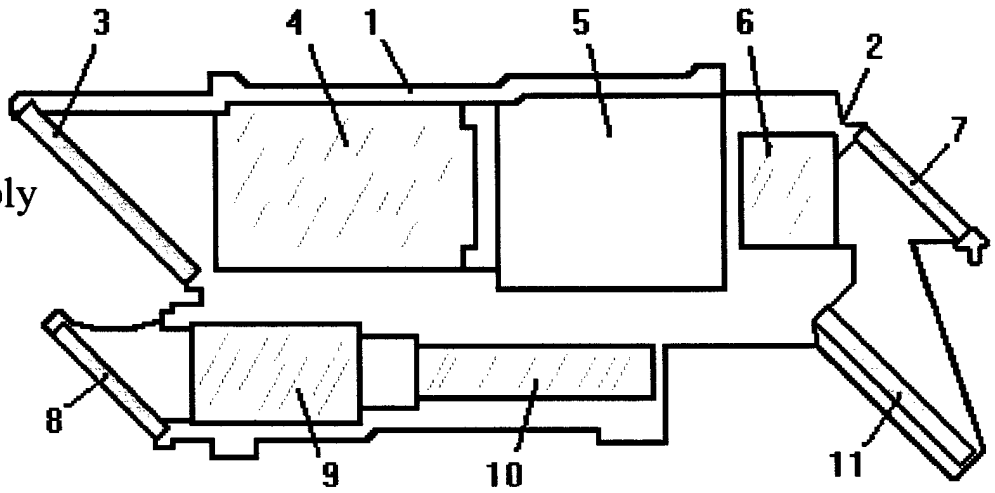




- Objective is offset to account for beam shift in beamsplitter
- FOV limited to 2°, Leupold is 1.5° (full tube FOV not seen)
- Effective Focal length of combination is 267 mm
- F/No. is 3.14
  - F/no controlled by afocal not by night objective
  - Can increase afocal size for lower F/no is found necessary
- T/No. is 3.6
- Range focus 100 meters to infinity
- Focus mechanism uses eccentric cam

Optical Supermodule

- Supermodule major subassemblies are:
  - 1. Supermodule Housing
  - 2. Beamcombiner Housing
  - 3. Beamsplitter Assembly
  - 4. Night Objective Assembly
  - 5. Image Intensifier Tube Assembly
  - 6. Night Relay Assembly
  - 7. Night Mirror Assembly
  - 8. Day Mirror Assembly
  - 9. Day Objective Assembly
  - 10. Day Relay Assembly
  - 11. Beamcombiner Glass

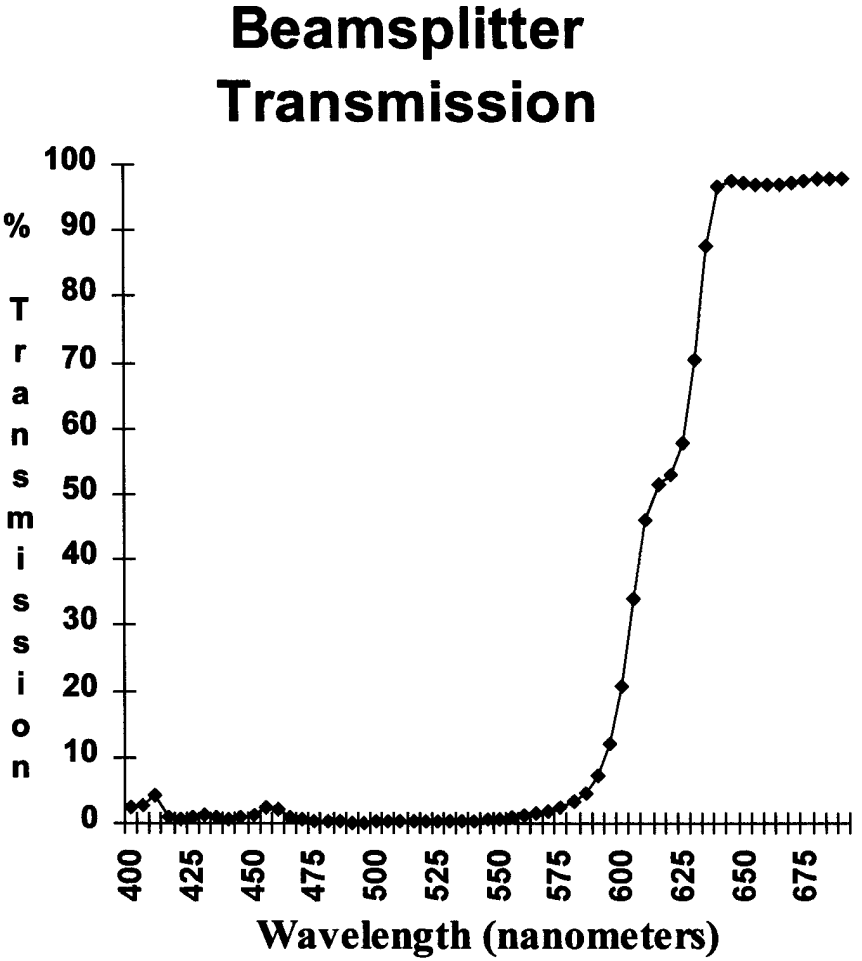


- Supermodule is assembled and aligned prior to installation in optical bench
  - Easy access for replacing image intensifier

Optical Supermodule - Beamsplitter

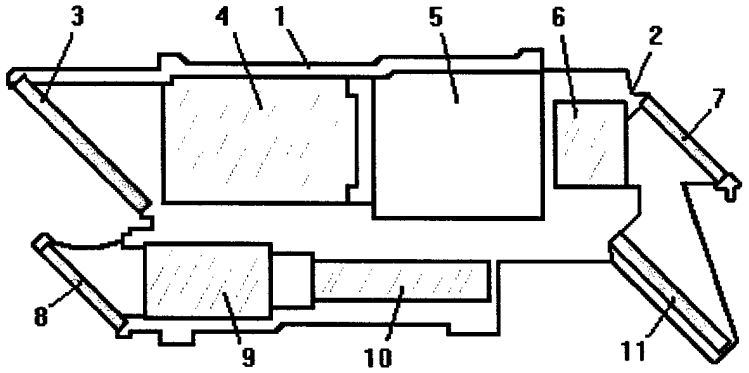


- Used thin-plate beamsplitter to reduce weight
- Front surface a multilayer coating to produce beamsplitter
- Rear surface a simple single layer coating
- Transmission to photocathode shown on chart
  - Provides improved daylight transmission (reduces need for gated power supply)
  - Prevents reticle illumination from being seen through front of scope
- Two faces parallel within 5 arc seconds to preclude double image at tube input





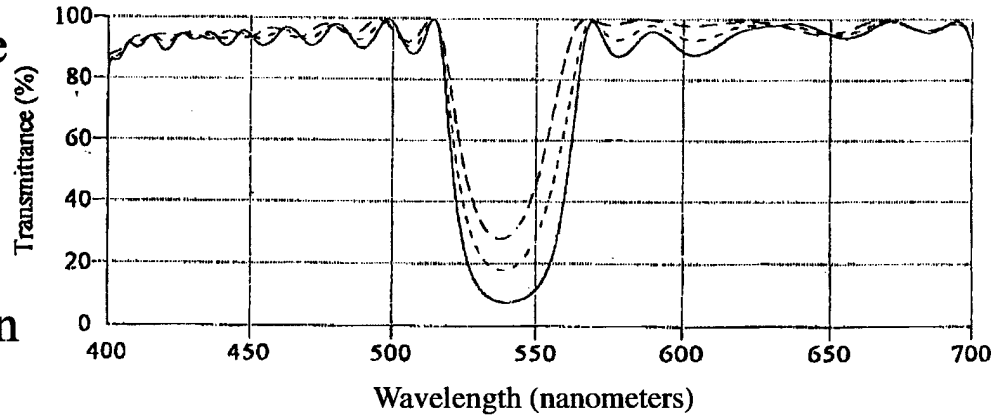
Optical Supermodule - Adjustments for Image Overlay



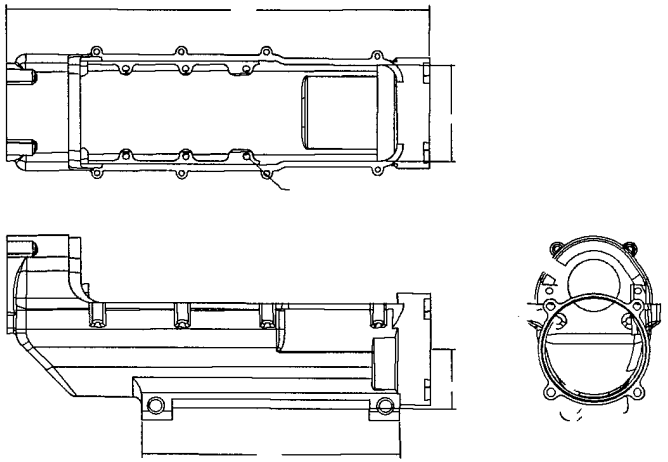
- Night objective lens (4) focuses image on intensifier tube (5) using simple fore/aft threaded adjustment within supermodule housing
- Intensifier tube is fixed in place - Tubes selected for highest performance (MTF 2nd P.C. sensitivity to offset T-no of Afocal/Objective)
- Tube output image is collimated/focused by adjustment of night relay 1 lens (6). This lens adjustment provides precise image overlay synchronization
- Day objective (9) is fixed in housing: Day channel collimation achieved by moving one part of the day relay (10) fore/aft
- Day/night image magnification is precisely matched by moving another part of the day relay (10) fore/aft and then locked

Optical Supermodule - Beam Combiner

- Used thin-plate beam combiner to reduce weight
- Multi-layer coating on second side of beam combiner to reflect only the green light from the tube
- Reflection of image tube light shown on chart
- Two faces parallel within 5 arc seconds to preclude image shift in day channel
- Removing the single green light from the day channel has minimal effect on perceived color of day scene.

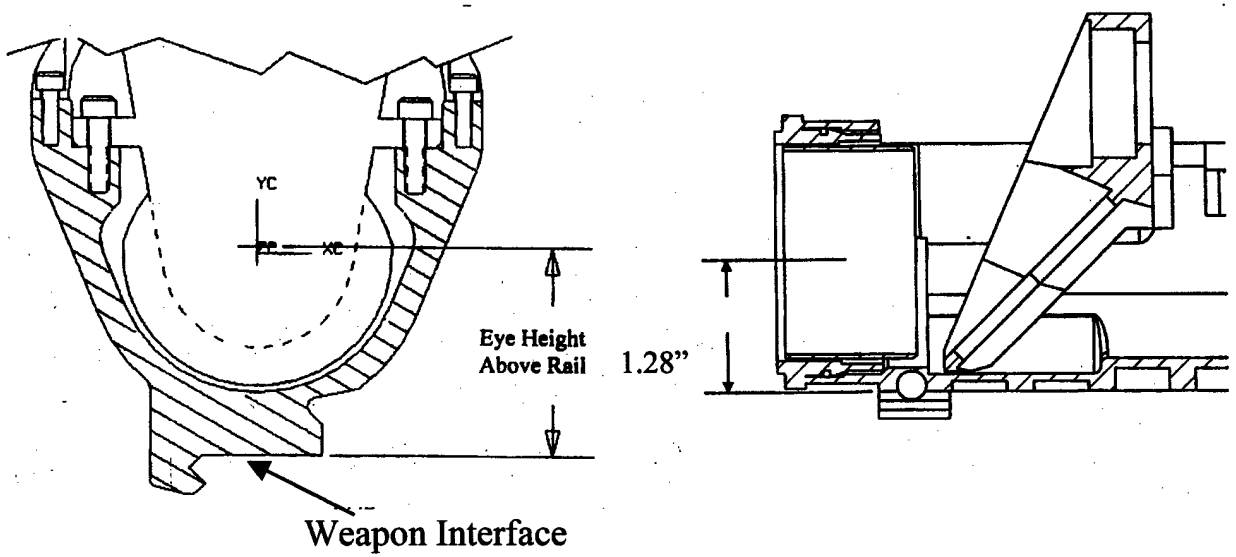


Optical Bench - Mechanical Backbone of INOD



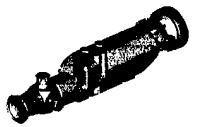
- A single piece part machined from 7075 aluminum
- Bilateral symmetry provides maximum shock and temperature stability
- Supermodule mounting designed to:
  - Apply weapon shock along optical axis and CG of module
  - Prevent rotation of module relative to the optical bench

Optical Bench - Weapon Interface and Eye Height

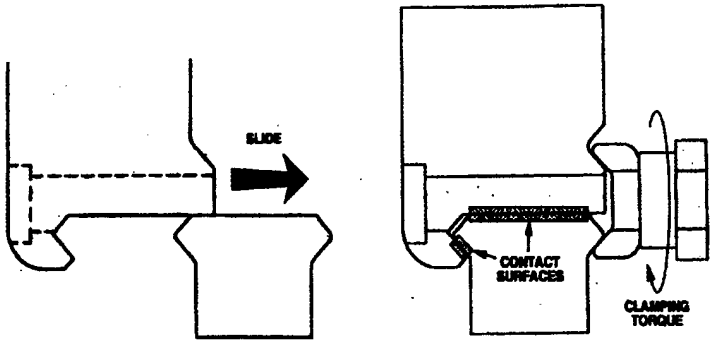


- Weapon interface is integral part of optical bench
  - Provides greatest stability
  - Improves boresight retention
  - Improves strength
- Weapon interface is designed for Picatinny rails
- Supermodule is mounted as low as possible to minimize eye height

KAC Mount vs Standard Mount



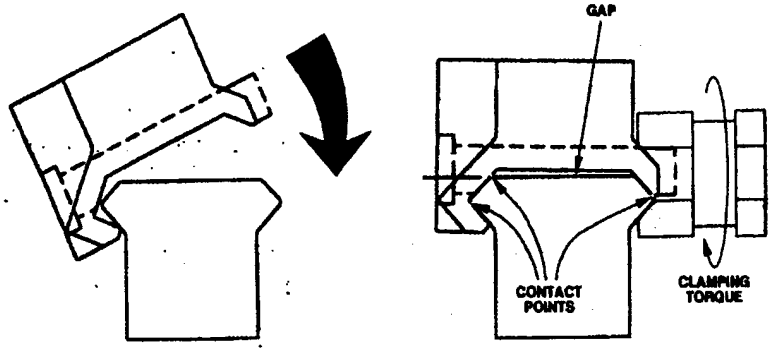
Knights Rail Grabber



Slide and Hook

- Provides full-surface contact areas
- Eliminates negative effect of overtorquing
- Eliminates cant
- Ensures boresight repeatability

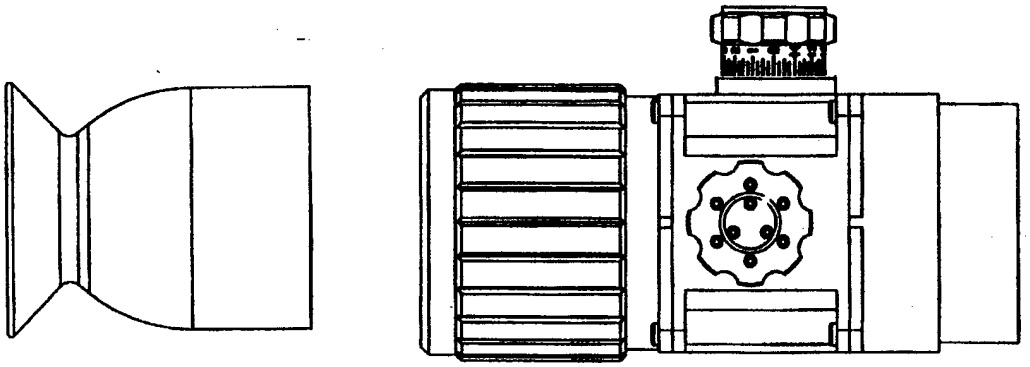
MIL-STD-1913 Rail Grabber



Hook and Rotate (Traditional)

- Metal deforms at contact points
- Clamp overtorque causes deformation
- Clamping torque causes cant
- Boresight repeatability not assured

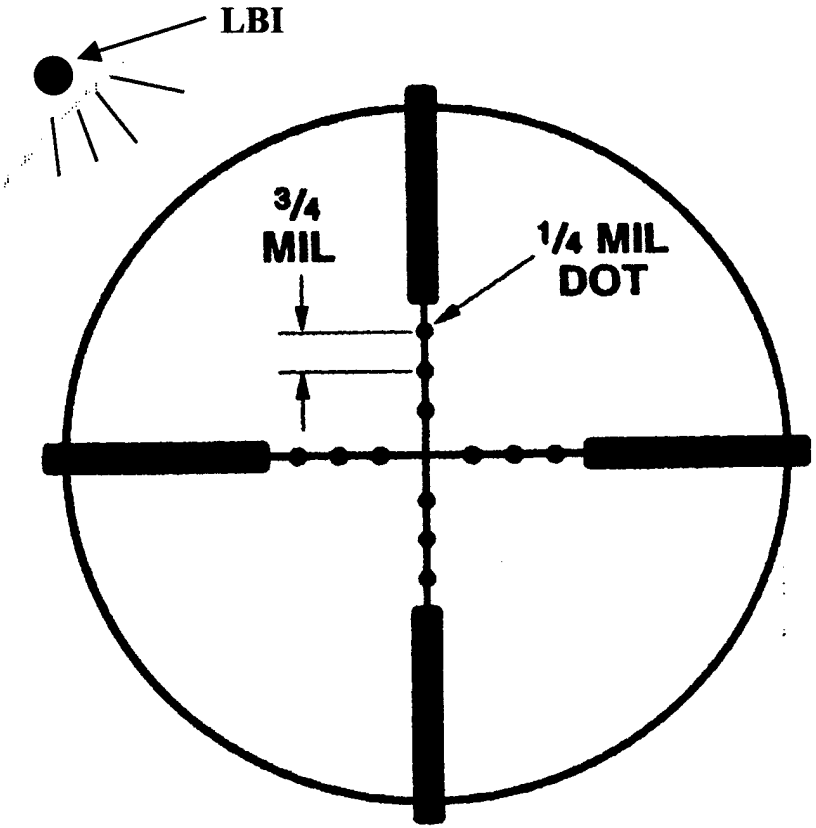
Eyepiece and Reticle Assembly - Adjustment Knobs



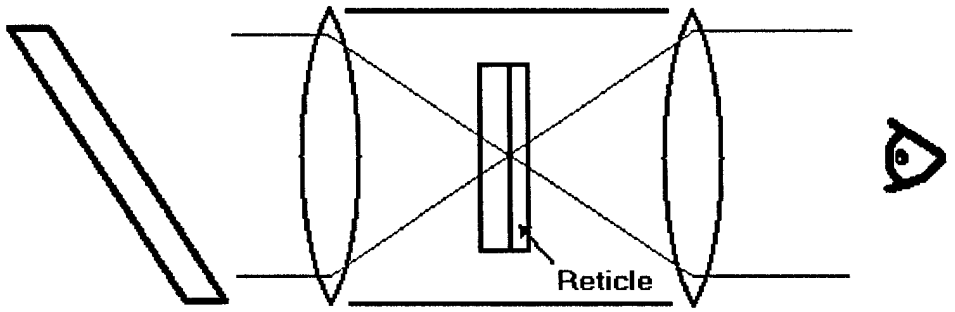
- Windage and elevation knobs feature 1/4 MOA adjustment with positive stops
- Medium INOD provides 60 MOA total adjustment for windage, 90 MOA total adjustment for elevation
- Large INOD provided 60 MOA total adjustment for windage, 90 MOA total adjustment for elevation
- Knobs emulate Leupold style

Eyepiece and Reticle Assembly - Reticle

- Reticle in same as Leupold Mark 4, M1
  - 3/4 MOA from MIL-DOT center to center
  - 1/4 MOA MIL-DOT diameter
- Reticle can be clearly seen in bright sunlight and total darkness
- Reticle can be illuminated with red light
  - Variable brightness adjustment
  - Illuminated reticle cannot be seen from front of scope
- Reticle limits FOV to 2°
  - Cross hair always in middle of FOV
- Low Battery Indicator (LBI) located in upper left FOV

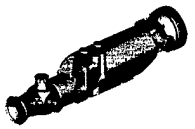


Eyepiece/Reticle Assemblies



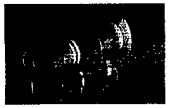
- Different assemblies for Large and Medium systems
  - Optics identical
  - Reticle changes to maintain 0.25 MOA adjustment steps with change in afocal magnification
- Eyepiece adjustable for + 2 to - 2 diopters
- Eyepiece telecentric design to minimize parallax
- Exit pupils size different day and night to match changing eye pupil diameter
  - Day exit pupil is 4 mm (Leupold day sight are 2.5 mm) for dawn dusk operation
  - Night exit pupil is 7 mm
- Eye relief is 55 mm both day and night

Testing ITT Performed on First INOD Systems



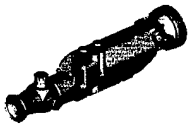
- Optical test (all six systems)
  - Resolution (100% contrast target) daylight, moonlight, and starlight
  - Magnification, distortion (day and night channels, exit pupil and eye relief
  - Reticle step size and adjustment range
- Environmental test
  - Conducted on one of the six available systems
    - Sand and Dust, Salt Fog, Explosives atmosphere, temperature shock
    - 3 meter immersion, 20 meter immersion in a sealed bag,
    - Transit drop, altitude, EMI
  - Reliability verification testing
    - Temperature cycle and simulated weapon shock
  - Conducted on all six units
    - Boresight retention after 100 rounds of weapon shock on the SR-25
    - Weight, size
  - Tested sample parts for 20-meter immersion outside sealed bag





ITT Defense & Electronics

Test Highlights - Day Resolution



- Measured nighttime performance of medium (10X) system

1/4 moonlight ($2x10^{-3}$ fc)	Starlight ($1x10^{-4}$ fc)	Target contrast
3.2 cy/mr	1.2 cy mr	20%
5.1 cy/mr	1.7 cy/mr	30 %
7.2 cy/mr	3.2 cy/mr	100%

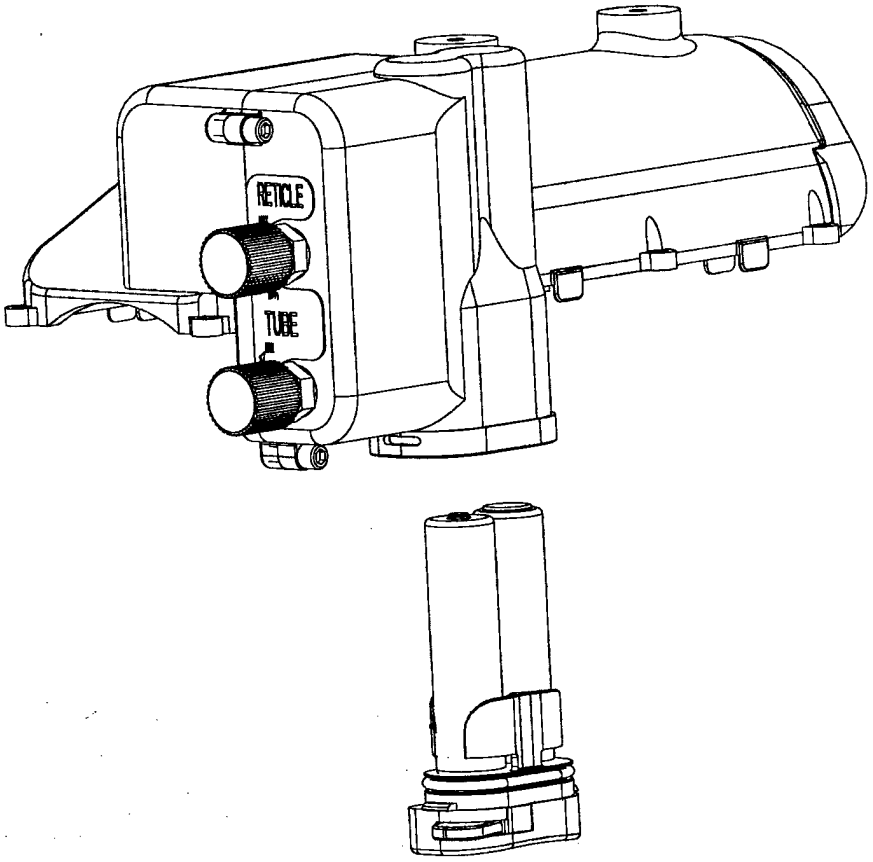
- Resolution prediction and range prediction per NVEOL programs for
  - 0.2 target reflectivity and 0.3 background reflectivity (20% contrast)

1/4 moonlight		starlight	
Resolution	Range	Resolution	Range
3.7 cy/mr	2250 meters	1.5 cy/mr	680 meters

- Measured performance supports range requirements
  - 1000 meters man-size target in BDU
  - 550 meters starlight man size target in BDU

Cover and Electronics Assembly

- Cover is Ultem® for reduced weight and high strength
- Assembly consists of main cover and electrical controls with battery housing
- Uses AN/PVS-14 battery cartridge
- Battery housing is oriented vertically with opening at bottom - Batteries can be easily changed by releasing latch and letting batteries drop into hand
- Cover seals to optical bench with form-in-place-gasket
- "Luna Bumps" integral to top of cover permits attachment of short length of MIL-STD-1913 rail



ITT Defense & Electronics

Test Highlights - Day Resolution

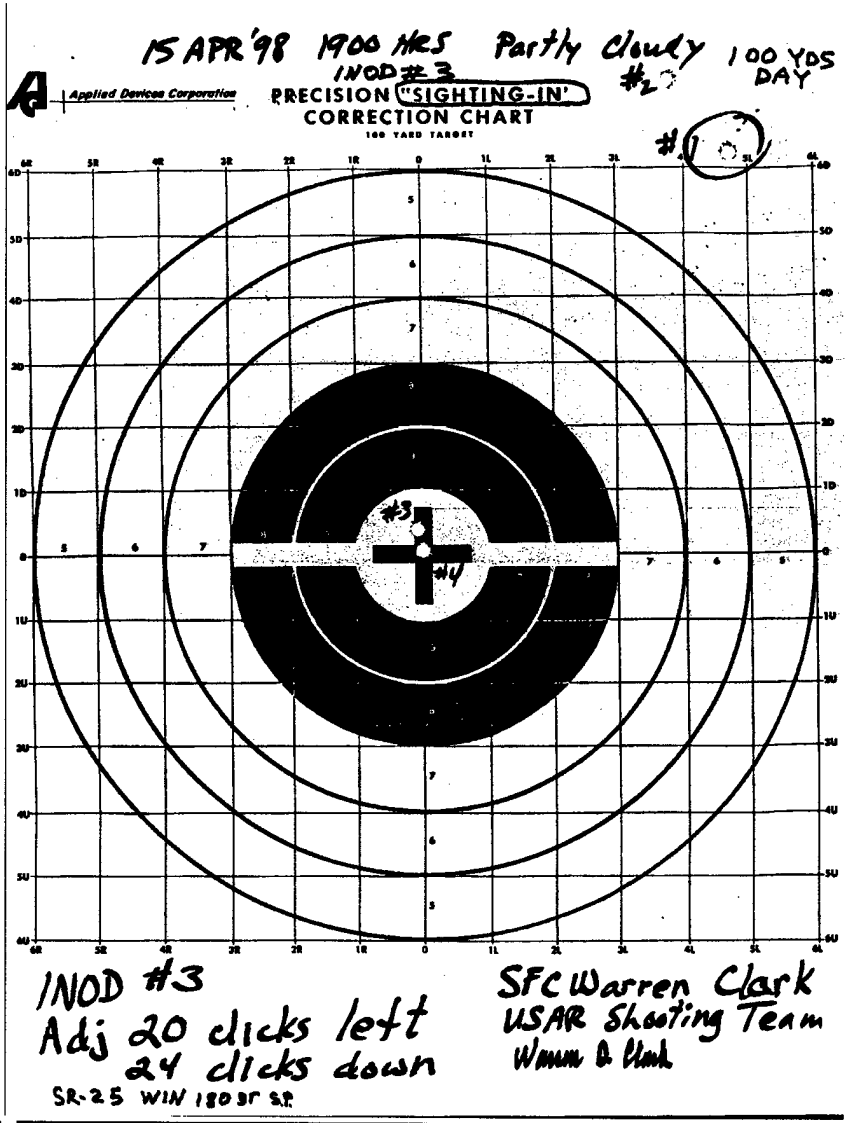


- INOD specification for day channel performance was to match the Leupold Mark 4 M1 10 X and 16 X sights
- To match Leupold performance ITT attempted to match the measured MTF of sample Leupold sight
- Used MTF data for Leupold and INOD sights in the NVEOL resolution prediction program for a 20% contrast target and then compared predicted resolution results to measured INOD results

Sight	Predicted	Measured
10 X Leupold	12.6 cy/mr	Not Done
10 X INOD	13.2 cy/mr	13.7 cy/mr
16 X Leupold	21.4 cy/mr	Not measured
16 X INOD	19.4 cy/mr	19.6 cy/mr

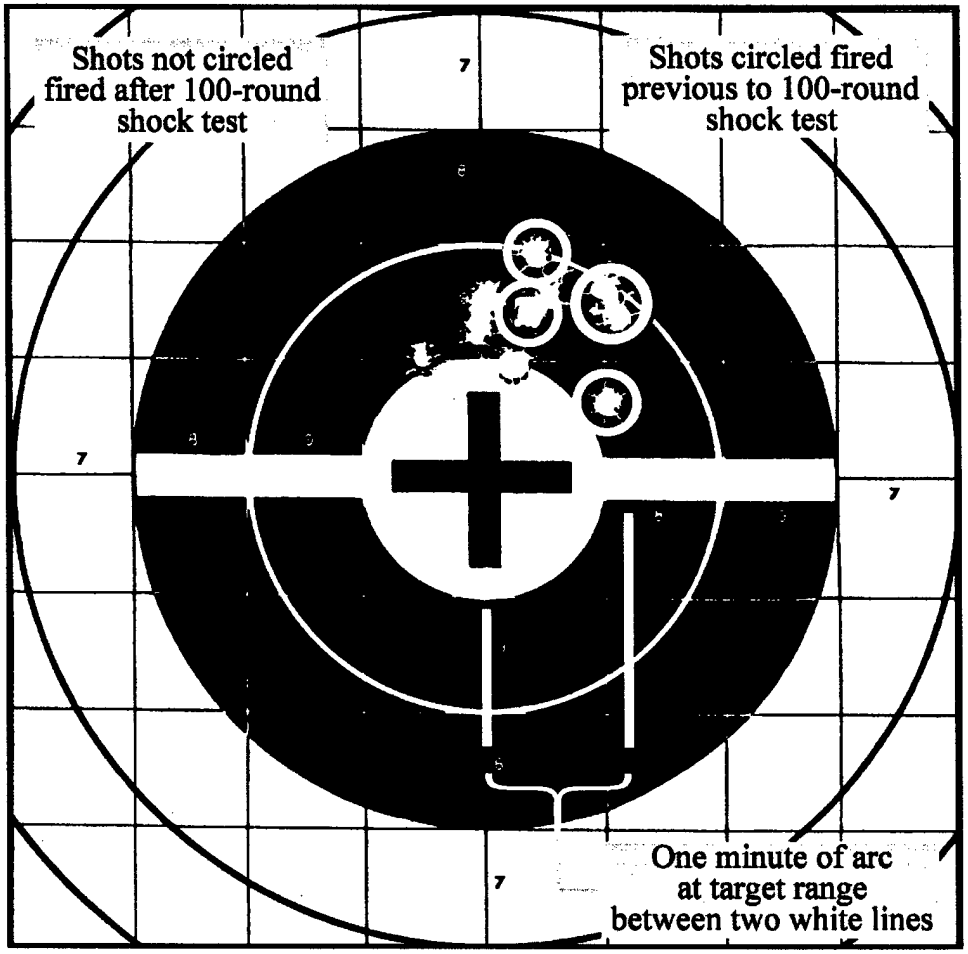
Test Highlights - Boresighting

- Target to the right is a shot pattern showing only four shots used to obtain boresight
- Boresighting done at 100 meters
- Adjustment made by counting 24 clicks down on the elevation and 20 clicks left on the windage adjustment



Test Highlights - Boresighting Retention

- Target to the right is a shot pattern showing five rounds shot before and five rounds shot after firing 100 rounds on the SR-25.
- No adjustment allowed between any shots
- Engineers not trained marksman doing this test.



1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY

BY

FRANK E. FORTINO

GARY HOUTSMA

ARMAMENT TECHNOLOGY TEAM
LIGHT ARMAMENT DIVISION, CCAC
ARDEC, PICATINNY ARSENAL, NJ 07806-5000

Light

ACKNOWLEDGEMENTS:

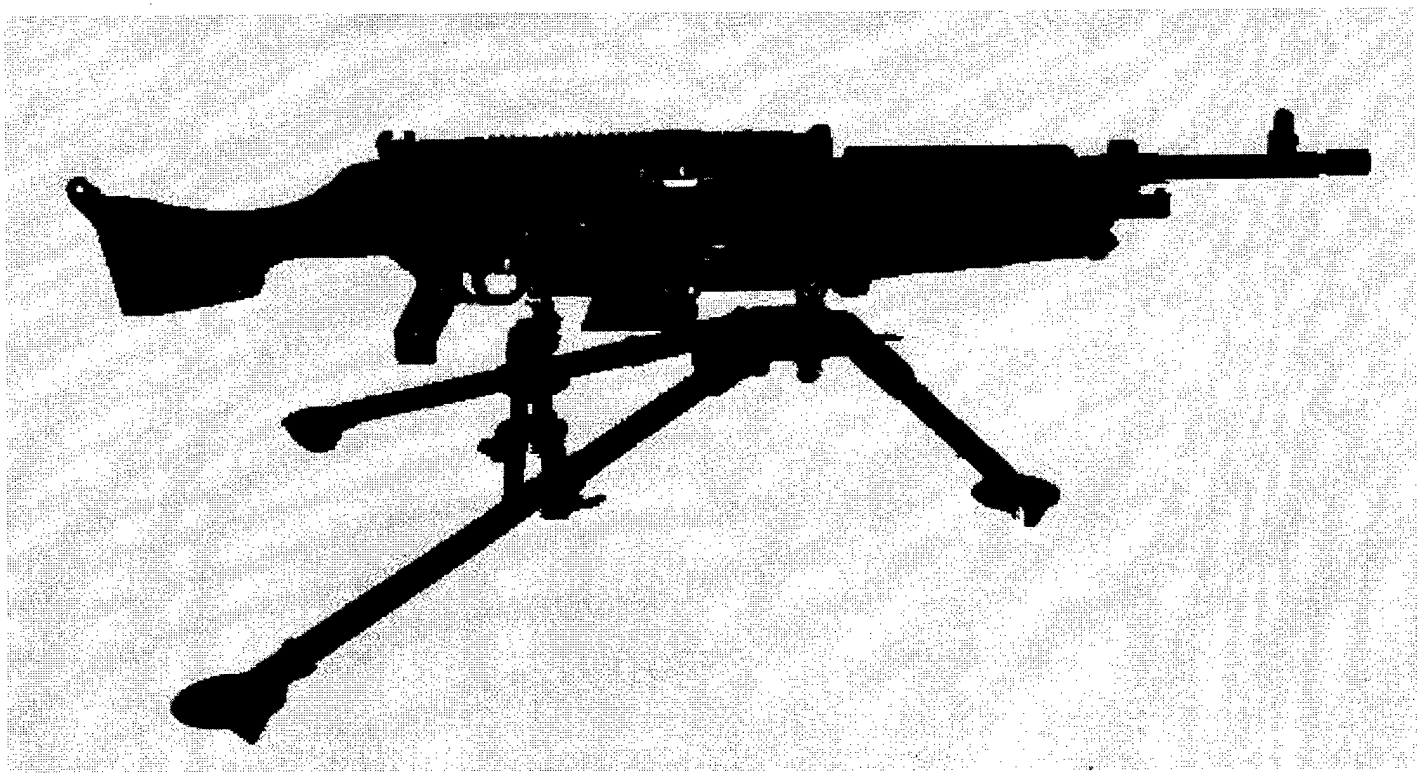
- ARL - TIM BROSSEAU - KINEMATIC INVESTIGATIONS
- ENIDINE CORP - HYDRAULIC BUFFER DESIGN/FABRICATION
- FNMI - BACKPLATE DESIGN REFINEMENT/PRODUCIBILITY INPUT
- PM SMALL ARMS - FUNDING SUPPORT/USER INTERFACE

Light

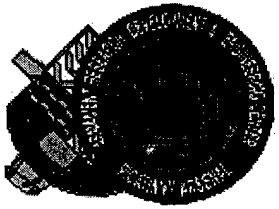
1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY

M240B MG ON M122A1 TRIPOD MOUNT



Light



1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY

Close Combat Armaments Center

BACKGROUND:

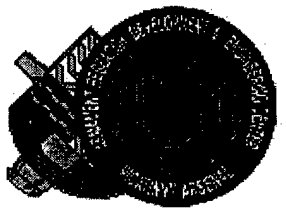
- M240B, 7.62MM MG SYSTEM: TC-STD - APRIL 1996
  FIELDED - AUG 1997

- WEAPON SYSTEM EXTREMELY RELIABLE BUT HEAVIER THAN WEAPON SYSTEM IT REPLACED

- OCT 1996 - ENGR STUDY APPROVED TO EVALUATE METHODS TO REDUCE SYSTEM WEIGHT AND COST

- ENGR STUDY RESULTS INDICATED THAT HYDRAULIC BUFFER RECOIL SYSTEM COULD ACHIEVE WEIGHT/COST REDUCTIONS

Light



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THE M240B MG BUFFER STORY

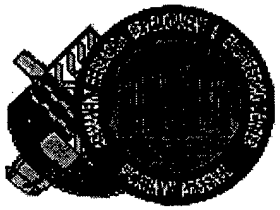


- HYDRAULIC BUFFER MATERIAL CHANGE PROGRAM APPROVED JUNE 1997

- PROGRAM GOALS:

  - REDUCE SYSTEM WEIGHT
  - LOWER WEAPON CYCLIC RATE (IMPROVED CONTROLLABILITY)
  - NO RECEIVER/BUTTSTOCK MODIFICATIONS REQUIRED
  - LOWER SYSTEM COSTS
  - NO DECREASE IN SYSTEM RELIABILITY





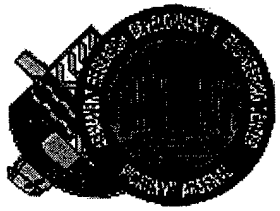
1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY



- **STANDARD M240B SYSTEM PARAMETERS:**
  - GAS-OPERATED WEAPON WITH 3 POSITION GAS REGULATOR
  - NORMAL CYCLIC RATE OF 700-750 SPM (NEW) (G.P. #1)
  - UPON BREAK-IN CYCLIC RATE CLIMBS TO 850-900 SPM
  - HIGH CYCLIC RATE REQUIRES "FLEXMOUNT" TO DAMPEN WEAPON MOTIONS ON M122 TRIPOD
  - FLEXMOUNT ADDS WEIGHT AND COST TO SYSTEM

Light



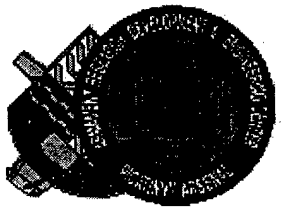
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THE M240B MG BUFFER STORY

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- **HYDRAULIC BUFFER DESIGN APPROACH:**
  - FUNCTION WEAPON RELIABLY AT -50°F TO +160°F WITH EXISTING BARREL/GAS SYSTEM
  - REDUCE CYCLIC RATE TO 600 + 50 SPM
  - ELIMINATE NEED FOR FLEXMOUNT
  - NO MODIFICATIONS TO RECEIVER OR BUTTSTOCK
  - MAINTAIN CURRENT WEAPON'S HIGH RELIABILITY
  - RETROFIT CONVERSION OF FIELDED WEAPONS DOABLE BY UNIT ARMORER

Light



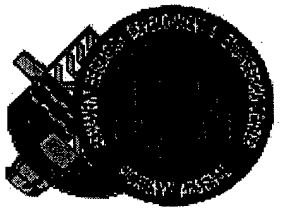
1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY

Close Combat Armaments Center

- **HYDRAULIC BUFFER CHARACTERISTICS IN M240B APPLICATION:**
  - BUFFER IS DASHPOT DESIGN WITH SINGLE PISTON
  - TYPICAL PISTON STROKE IS 0.500 INCH - 0.510 INCH
  - MAXIMUM PISTON STROKE IS 0.571 INCH (CONTACTS BACKPLATE)
  - HYDRAULIC FLUID FILLED
  - SERVICE LIFE: 50,000 CYCLES MINIMUM
  - OPERATING TEMPERATURE RANGE: -50°F TO +160°F

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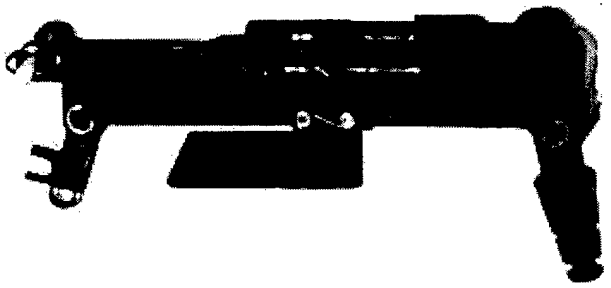


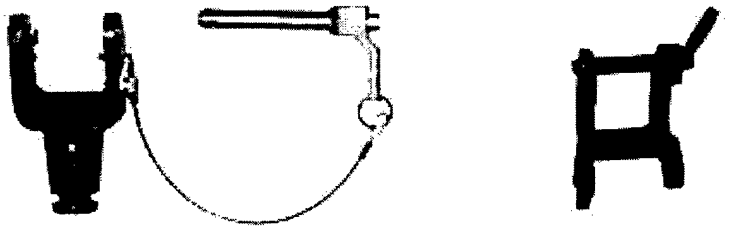
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THE M240B MG BUFFER STORY

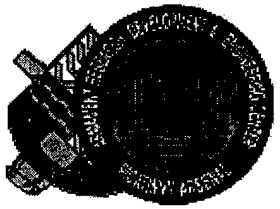
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M240B STD BUFFER COMPONENTS VS. HYDRAULIC BUFFER SYSTEM





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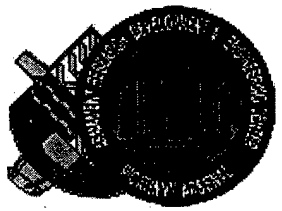
THE M240B MG BUFFER STORY

Close Combat Armaments Center

- **TEST RESULTS (ARDEC)**

CHARACTERISTIC	STANDARD M240B	HYDRAULIC BUFFER M240B
• CYCLIC RATE (SPM)	790-825	630-640
• BELT PULL (AVG-LBS) (REQ - 10.5 LBS MIN)	25	19
• ACCURACY (M.R. -300M)	10.02 IN	6.20 IN
• DISPERSION (300 M)		
EXT. SPREAD X	28.31 IN	12.4 IN
EXT. SPREAD Y	15.06 IN	14.87 IN
• RELIABILITY (MRBF) (15,000 RDS. MIN)	EXCEEDED	EXCEEDED

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1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY



- **WEAPON RELATED CHANGES:**

PART NAME	STANDARD M240B	HYDRAULIC BUFFER M240B
• BACKPLATE/BUFFER ASSEMBLY	1.44 LBS	1.02 LBS
• BUTT SCREW	0.11 LBS	0.04 LBS
TOTAL	**1.55 LBS**	**1.06 LBS**

Light

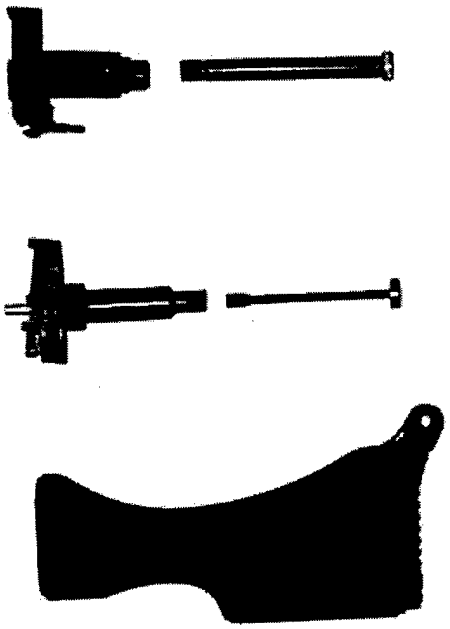
M122 TRIPOD MOUNT RELATED CHANGES:

PART NAME	STANDARD M240B	HYDRAULIC BUFFER M240B
• FLEXMOUNT	4.88 LBS	———
• PINTLE	———	1.38 LBS
• 13MM Q.R. PIN & LANYARD	———	0.34 LBS
• T+E BRACKET ASSEMBLY	———	0.74 LBS
TOTALS	**4.88 LBS**	**2.46 LBS**

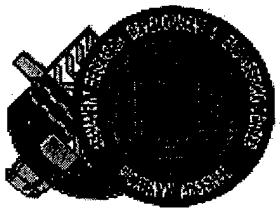
THE M240B MG BUFFER STORY

M240B/M122 TRIPOD RELATED MOUNTING DIFFERENCES

- STANDARD M240B VS. HYDRAULIC BUFFER M240B



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THE M240B MG BUFFER STORY

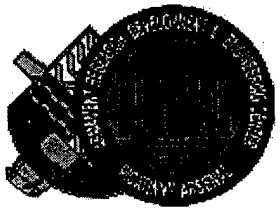
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- **EFFECT ON SYSTEM COST (PRODUCTION)**

ITEM DESCRIPTION	CURRENT M240B PARTS	HYDRAULIC BUFFER M240B PARTS
• BACKPLATE, BUFFER CATCH/ASSY	$172	———
• BACKPLATE/BUFFER CATCH	———	$125
• BUTT SCREW	$ 10	$ 10
• HYDRAULIC BUFFER	———	$ 95
• FLEXMOUNT	$475	———
• PINTLE/13MM PIN	———	$ 85
• T+E BRACKET ASSEMBLY	———	$ 35
TOTALS	**$657**	**$350**

Light

475



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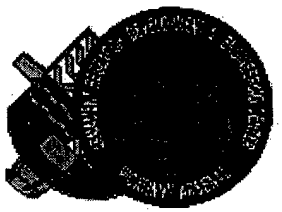
THE M240B MG BUFFER STORY

Close Combat Armaments Center

- **ADVANTAGES OF HYDRAULIC BUFFER SYSTEM:**
  - REDUCTION IN SOLDIER LOAD OF APPROX. 3 LBS.
  - REDUCTION IN CYCLIC RATE (IMPROVED CONTROLLABILITY)
  - MORE ACCURATE/LOWER DISPERSION
  - WEAPON SYSTEM COST REDUCTION OF $300/UNIT (PRODUCTION)
  - NO MODIFICATION OF RECEIVER OR BUTTSTOCK REQUIRED
  - SIMPLE CHANGEOUT OF PARTS TO RETROFIT FIELDED WEAPONS
  - RELIABILITY MAINTAINED

- **DISADVANTAGES OF HYDRAULIC BUFFER SYSTEM:**
  - RETROFIT COSTS OF $350/SYSTEM FOR FIELDED WEAPONS
  - LOWER BELT PULL VALUE

Light



1998 NDIA SMALL ARMS SYSTEM CONFERENCE

THE M240B MG BUFFER STORY



- **PROGRAM STATUS:**

  - SYSTEM IN TESTING MAR-JUN 98 AT ABERDEEN TEST CENTER
  - TEST DATA AVAILABLE - JUL 98
  - PRODUCTION DECISION - 4QFY98
  - AWARD PRODUCTION CONTRACTS - 1QFY99
  - FIRST HARDWARE DELIVERIES - 3QFY99
  - INITIAL FIELDINGS OF NEW SYSTEM - 4QFY99

Light

Rockwell VIPER:

PRECISION INTELLIGENT TARGETING SYSTEM FOR CONVENTIONAL MILITARY AND SPECIAL OPERATIONS FORCES

by Morris Peterson and Donald E. Davis-Ashbury International Group, Inc.

Rockwell Collins Inc., the worlds leader in military global positioning system (GPS) receivers is proud to introduce to the US Armed Forces, and MOU Countries, ***VIPER*** the worlds only design-built fully integrated, multi-purpose binocular laser range finder with a precision on-board digital magnetic compass and inclinometer. The ***VIPER*** is a true ***"Precision Intelligent Targeting System"***, providing conventional military and special operations forces (SOF) with a rugged, advanced technology targeting system that fully supports missions requiring surveillance, ranging, targeting and orientation. ***VIPER*** provides the highest probability of a first round strike, on the digital battlefield. Whether carrying out airborne, land, or maritime missions the ***VIPER*** can provide Warfighters with unfailing high quality performance in the field. All branches of the military share a common necessity for state-of-the-art, high quality e! ro-optic and GPS targeting equipmeni that can stand up to the rigors of current and future global military missions. The Rockwell ***VIPER*** is that device...and more!

PURPOSE BUILT ENGINEERING

As a binocular, the ***VIPER*** has no peer, and represents a new generation of high performance binoculars on the cutting edge of electro-optics technology. Its high quality optics has one of the highest light transmission values and sharpest fields of view in the industry. Two of ***VIPER***'s most advanced technical innovations-a state-of-the-art **totally** eye-safe Class 1-1.55μm diode laser range finder, and a digital magnetic compass with inclinometer have been incorporated into this ergonomically designed binocular. The ***VIPER*** is easy to operate, simply click the right button and display ranges to over 4km's with a total range accuracy of three meters! To obtain an azimuth, click the left button and the azimuth is displayed indicating a compass bearing of 0 to 360° with an accuracy of 10 mils (0.6°). Additionally inclination angles can be measured to ± 35° with an accuracy of 3 mils (0.2°). Distance, azimuth and elevation information is digitally displayed in the field of view by red LED's for a duration of four seconds. The VIPER can provide the user with a total of eight distance and angular measurements, all using just two buttons! A common 6-volt 2CR5 lithium battery powers the VIPER.

PRECISION INTELLIGENT TARGETING

Rockwell has integrated the ***VIPER*** binocular laser range finder with the PLGR+96/AN-PSN/11 (US DoD Precision Lightweight GPS Receiver), developing the first commercially off the shelf (COTS) precision intelligent targeting system. Warfighters, or traditionally trained fire support specialists, from any position on today's digital battlefield are now capable of bringing precision artillery, mortar fire and close air support on hostile positions with extreme accuracy (10 digit grid coordinate and CEP) at ranges out to 4 kilometers. ***VIPER*** provides precision in-direct fire support for the "close-in" infantry fire and maneuver, MOUT and Special Forces operations. The ***VIPER***

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targeting system is also night vision capable, employing the AN-PVS-14 monocular night vision device. The AN-PVS-14 is integrated to the ***VIPER*** by a rugged lightweight night vision interface. This effective combination of night vision and binocular laser range finder has proven to be effective for infantry forces engaging targets at night out to 2 kilometers! When engaging distant targets from OP's Warfighters have the option of employing a sturdy non-magnetic tactical tripod.

Forward Observers and Spotters with the ***VIPER*** can also now measure distances between various points relative to the target (e.g. natural terrain feature, opposing forces positions, and roadways). In a fire support role with the ***VIPER*** the FO can rapidly with a greater degree of precision "call in" and adjust mortar and artillery fire. He can also provide dimensional measurements of parachute drop zones, helicopter landing zones, to include heights of buildings, trees, etc. To protect the FO the ***VIPER*** can be provided with anti-reflective and laser protection filters.

RECONNAISSANCE AND SCOUTING

From concept, the ***VIPER*** was designed as a 3½-pound precision observation instrument. Warfighters benefit from the clear sharp images the ***VIPER*** provides, due to its precision; high quality multi coated optics. The ***VIPER*** has routinely outperformed various military binoculars in terms of light gathering capability under low light, and night conditions. Rugged and dependable, the ***VIPER*** has survived the rigors of long-range reconnaissance patrols in snowbound mountainous environments, and hot arid desert AO's. The ***VIPER*** aids Warfighters to prepare more accurate reconnaissance reports utilizing its highly accurate binocular laser range finder to provide range measurements, and target azimuths by a simple series of button presses. The ***VIPER*** can also be field programmed to display measurements in feet, yards, meters, mils, and or degrees.

SNIPING

The ***VIPER*** could be considered the ultimate military sniper support optic. It combines a number of precision devices into one user friendly instrument, that supports short, intermediate, and long-range sniper missions. The ***VIPER*** provides accurate distance to target information at over 2,000 meters (maximum sniper rifle range), eliminating the most frequent cause of missed sniper shots, errors in judging distance. Range estimation is critical for all snipers, but most especially for SOF snipers that must be capable of delivering a guaranteed neutralizing shot at 600 yards. The ***VIPER*** also displays the angle of engagement when indexing targets up or downhill (plunging fire) to $\pm 35^{o}$. This is critical when snipers engage targets at extreme angles (i.e. high atop multi-story buildings) and over extended ranges. ***VIPER*** comes standard with both an electronic and a "hard" SWISS Mil reticle. This combination provides increased accuracy in placement of the laser, and in the event battery power is lost, range finding can still be performed with the mil reticle. For situations when the target was partially obscured (trees, vegetation, structures, etc.), ***VIPER*** features, **Multiple-Object-**

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Measurement or **MOM**. Instead of following the road many manufactures have taken, where incremental and intermediate ranges are "dialed out" through a process called "gating". **MOM** allows the sniper to view up to the three strongest pulse returns from targets in the line of sight, by simply scrolling through them using the range finder button. This state-of-the-art function was introduced to the sniper community through close collaboration between engineers and international sniping authorities. One of the inherent benefits of the ***VIPER's*** 1.55μm eye safe laser diode technology is the ability to "laze" targets from behind different types of glass, allowing the sniper to remain secreted in his OP.

LAND NAVIGATION

Land navigation is an essential military skill. Recognizing this, built into every ***VIPER*** is a highly accurate Digital Magnetic Compass (DMC). The DMC is so highly regarded it was selected as the electronic compass of choice by the US Army for a military range finder project. The exacting DMC can also be adjusted ± 90° for declination allowing for its use worldwide. To factor out various types of magnetic interference ***VIPER*** uses a simple compensation process that takes less than a minute to perform. Upon completion the ***VIPER*** tells the Warfighter whether the unit is properly calibrated. The ***VIPER*** also assists Warfighters to accurately locate their positions when reading maps, by providing azimuths and **absolute** distances to significant terrain features. With the **relative** measurement features in the ***VIPER*** software, Warfighters can now measure distances between significant terrain features, determine the relative height differences between the features, and when necessary measure the height of each terrain feature individually!

CREW SERVED AND ANTI-ARMOR WEAPON SUPPORT

Due to the range of "heavy" weapon systems available to the Warfighters, the ***VIPER*** can enhance the effectiveness of crew served weapons. Traditional methods of "walking" rounds into a target tends to waste ammunition, increase collateral damage and alerts opposing forces of incoming fire. By employing the ***VIPER***, the crew can "laze" the target, and the weapons operator can adjust the sights for the exact range prior to firing, and when ready, **deliver precise effective fire**. Crew served weapons that are supported include:

- M-60 LMG - M240 - FN/MAG - GPMG - H&K 21E
- M2 .50 Caliber Heavy Machine-gun
- Mk-19 40mm Automatic Grenade Launcher

In an anti-armor weapon support role, the ***VIPER*** can assure the precision placement of shoulder fired ordnance on target. Whether the target is moving or stationary, the ***VIPER*** provide the Warfighter accurate ranges on a wide variety of target types.

AMPHIBIOUS OPERATIONS

Whether conducting small boat, or combatant/scout swimmer operations,

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the ***VIPER*** can support amphibious Warfighters in a waterborne environment. The standard ***VIPER*** is waterproof to a depth of 3 feet and can be optionally waterproofed to a depth of 1 atmosphere for sub-surface operations. The durable shock absorbing rubber cover, sealed over the strong die cast housing helps to insure that the ***VIPER*** performs in harsh and demanding amphibious environments. If the ***VIPER*** is accidentally dropped overboard during an operation, don't worry because it floats!

MAPPING AND INTELLIGENCE GATHERING

The newest role for the ***VIPER*** in the military community is real-time mapping, and recording of geographical information. This unique application for the ***VIPER*** casts it in the role of a field data collector, connected to a ruggedized field computer with specialized GIS software. ***VIPER*** in this configuration provides intelligence personnel the ability to produce real-time maps combined with highly accurate GPS coordinates. ***VIPER*** in this role lends itself to many SOF special surveillance and pre-assault building analysis missions.

FORCE PROTECTION, SECURITY AND THREAT SURVEYS

Warfighters are many times called upon to conduct force protection missions, OOTW security and threat surveys on sensitive installations, embassies, airports and other strategic facilities. Cast in an unconventional, but fitting role the ***VIPER*** is the perfect data collector. By utilizing both **absolute** and **relative** measurement functions, the ***VIPER*** can assist the SOF operator in the preparation of accurate site diagrams, perimeters, defensive fighting positions, exact threat vantage points, CCTV camera views, etc. Until now no such multi-purpose tool existed, and the Warfighter spent many man hours walking the site with a tape measurer, relying on out of date or inaccurate maps or blueprints, or in some cases even guesstimating. This no longer need occur as the ***VIPER*** can support the survey process either as a stand alone instrument, or as part of a GIS mapping system where the entire survey is recorded electronically with digital photographs, and real time notations.

CONCLUSION

As an "Precision Intelligent Targeting System" the ***Rockwell VIPER*** represents the latest advancement in electro-optic technology and combat GPS systems integration. Rockwell's approach to the DoD community is user driven, mission capable and available commercially-off-the-shelf to assist Warfighters TODAY.

For Further Information Contact:

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A Unique Coax Gun Installation

Ken Hoffman

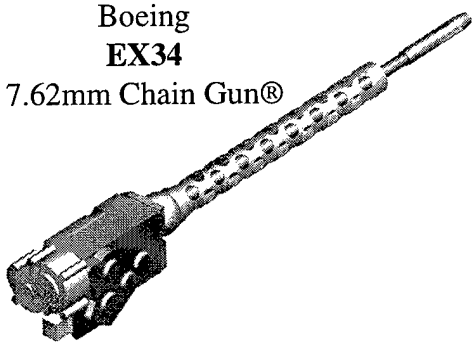
Boeing - Mesa, AZ
Ordnance Engineering

June 17, 1998

BOEING

Introduction

Boeing
EX34
7.62mm Chain Gun®



- Overall Project: Bradley Up-gun
- 3-D CAD Model Layout
- Main Gun Solution Displaces Coax Gun
- Solutions for New Coax Installation
- Details of Selected Coax Solution
- Benefits

BOEING

NDIA Small Arms: "A Unique Coax Gun Installation"
Page 2-6/17/98

Recently, Boeing Ordnance Engineering was tasked to design new armament installation for the Bradley Fighting Vehicle. The objective of this task was to increase the lethality and survivability of the Bradley without modifications to the existing turret structure and with minimal modifications to the supporting systems.

3-D CAD Models of the Bradley A2 turret were obtained from TACOM in IGES format. These models were used to setup a virtual design fixture to develop up-gun installation concepts.

The storage magazine used for the 35/50mm Bushmaster III installation displaced the 7.62mm coax gun. This created a new challenge to relocate a coax gun in the existing turret.

This paper describes a unique installation of the coax gun into the Bradley turret which allows the overall new system to include a 35/50mm Bushmaster III cannon with 22 ready rounds, a 62 round storage magazine for automatic quick upload of the ready magazine, and a 7.62mm coax gun in the existing turret structure of the Bradley.

Bradley Upgun Project



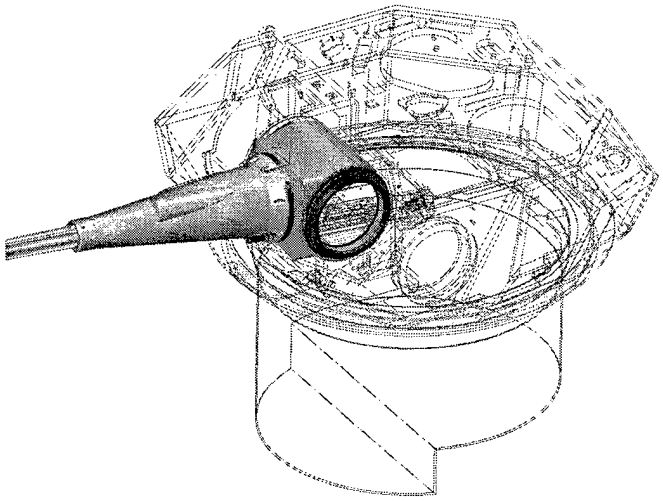
BOEING

The Bradley Up-gun Project

Ground Rules:

- Do Not Alter Existing Bradley Structure
- Minimal Modification to Gun Support Systems
- Elevation Range +35°/-10°

3-D Solid Modelling
Bradley A2 Model from TACOM



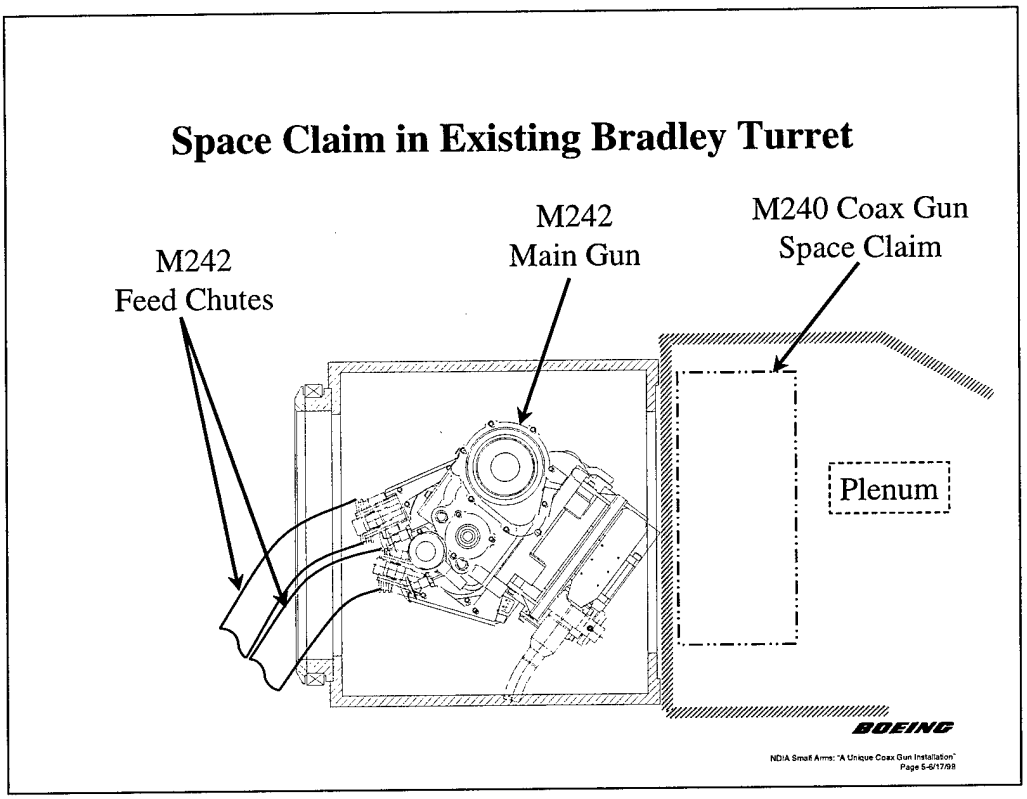
BOEING

Boeing obtained 3-D CAD models of the Bradley A2 turret structure and system assemblies that are near the main gun space claim.

These models were used to construct a 3-D design fixture in Unigraphics.

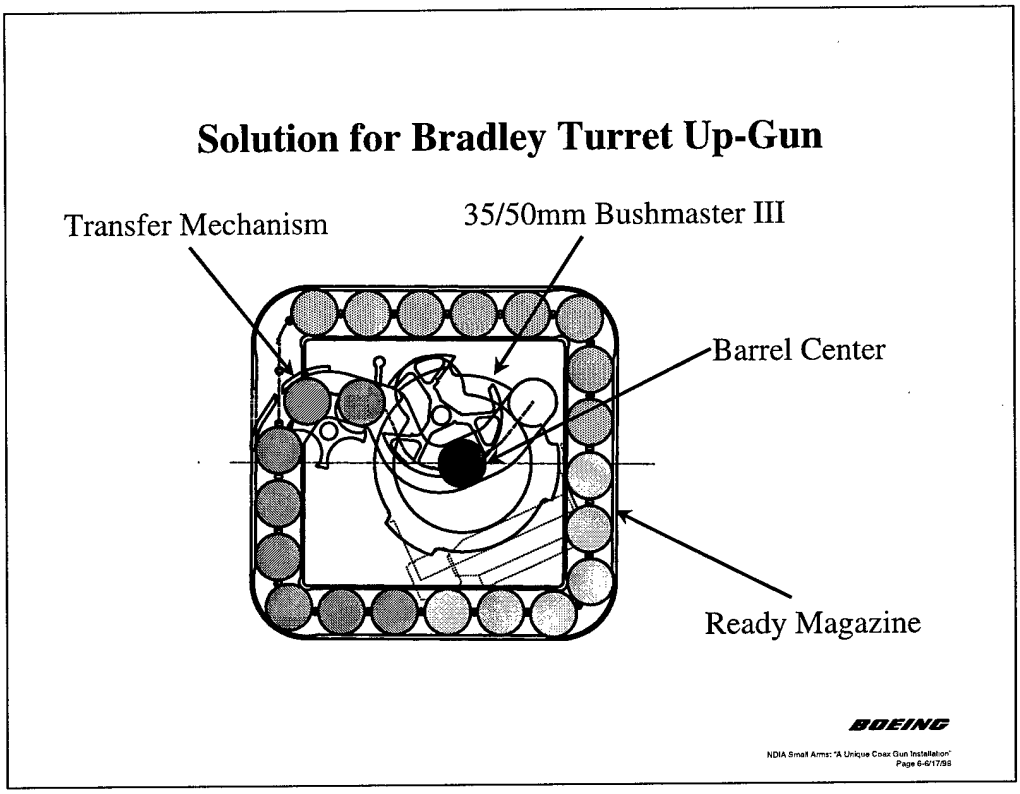
This fixture was used to layout and design potential concepts for main gun and coax gun installation. This method was very effective in investigating the effects of various concepts on Bradley sub-systems relative to space claim.

This method was proven successful when the 35/50mm Bushmaster III installation, which was designed using the turret model, was fabricated, installed, and fired out of an A2 Bradley.



The existing Bradley turret uses the M242 Bushmaster Cannon as the main armament. This gun is configured as a dual link fed gun. The gun is fed using flexible feed chutes (2) coming through the left trunion bearing. These feed chutes bring ammo from a magazine located on the turret basket floor. Spent cases are ejected forward and used links are ejected through the right trunnion bearing into the plenum chamber.

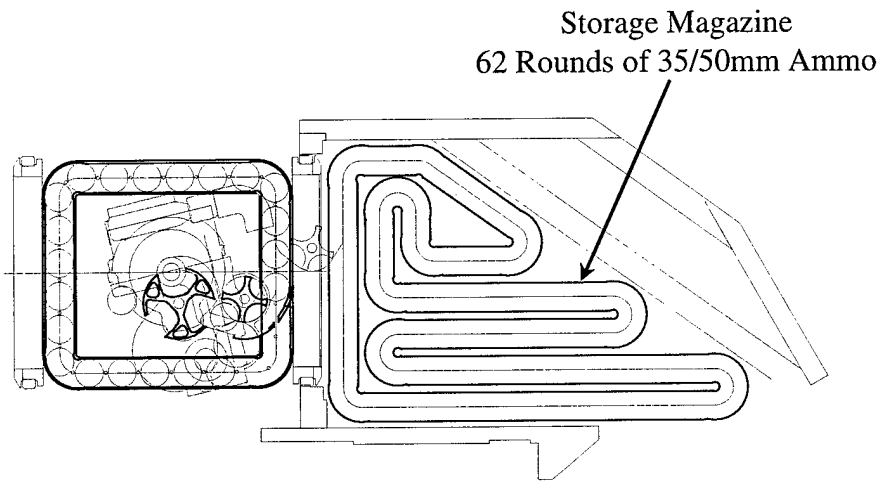
The coax gun is located in the plenum chamber and it's mount is fixed to the elevation rotor. The coax gun is fed using flexible feed chute which brings ammunition from magazines located in the crew compartment next to the commander. The feed is routed through an armor plate into the plenum chamber and up to the coax gun. The spent cases and used links are ejected into the plenum chamber.



After investigating many alternatives, a concept was chosen which best met the objectives of the task. A 35/50mm Bushmaster III gun is configured with a single linkless feeder. The gun is fed using a linear linkless ("chain ladder") magazine which wraps around Bushmaster III gun inside of the elevation rotor. A new elevation rotor is required but the turret structure itself is not altered to accommodate the new rotor.

This system provides a ready magazine capacity of 22 rounds of 35/50mm ammunition and a feed selection capability which permits the use of multiple types of ammunition. The new design also accommodates first round select, giving the gunner the selected nature of ammunition with the first round fired after a feed select. This system meets all design goals and ground rules set forth for the task.

Space Claim in Up-Gun Bradley Turret with 35/50mm Bushmaster III



• Storage Magazine Displaces M240 Coax Installation

BOEING

NDIA Small Arms: "A Unique Coax Gun Installation"
Page 7 6/17/98

The next phase of the design was to determine feasible concepts for uploading the ready magazine. The method of uploading must be automatic ("hands off") and reasonably quick. Several concepts were investigated. One of the most favorable concepts uses the plenum chamber to house a linear linkless storage magazine. To upload the ready magazine, the elevation rotor is brought to horizontal. The two magazines are coupled together and the storage magazine feeds the ready magazine through the right trunion bearing. The same method is used to download the ready magazine into the storage magazine.

The storage magazine's most significant effect to the current system is that it displaces the coax weapon. This creates the necessity to investigate a new installation concept for the coax gun.

Proposed Solutions for Coax Installation

- Two options considered:
  - External to turret
  - Internal to turret
- Must be integral to the 35/50mm Bushmaster III
- Must not displace existing turret structure

BOEING

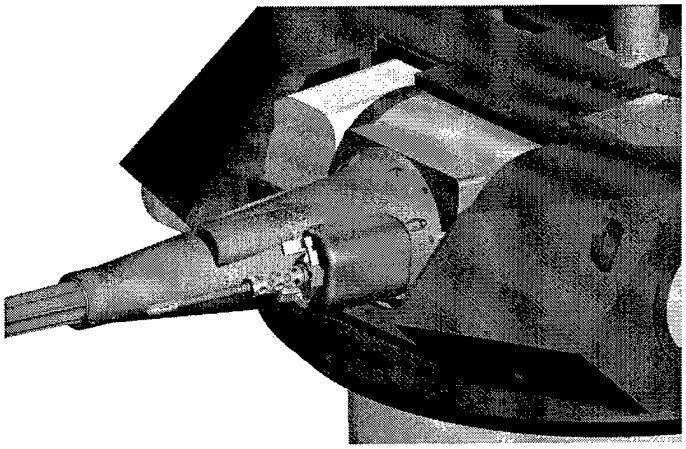
At the onset of the task to integrate a coax gun into the 35/50mm Bradley turret up-gun concept, the following goals were set forth:

1. The coax gun must be integral to the 35/50mm Bushmaster III. This approach will lead to the most efficient use of available volume. Existing weapon structure can be used to support the coax. Inclusion of coax into 35/50mm Bushmaster III space maximizes space use.
2. The installation must not displace existing turret structure.
3. Minimal effect on existing turret systems.

Two options were considered:

1. A gun and mount that was outside of the turret and thus remote from the crew.
2. A gun and mount that was inside of the turret with direct access by the crew.

External Mount Solution



BOEING

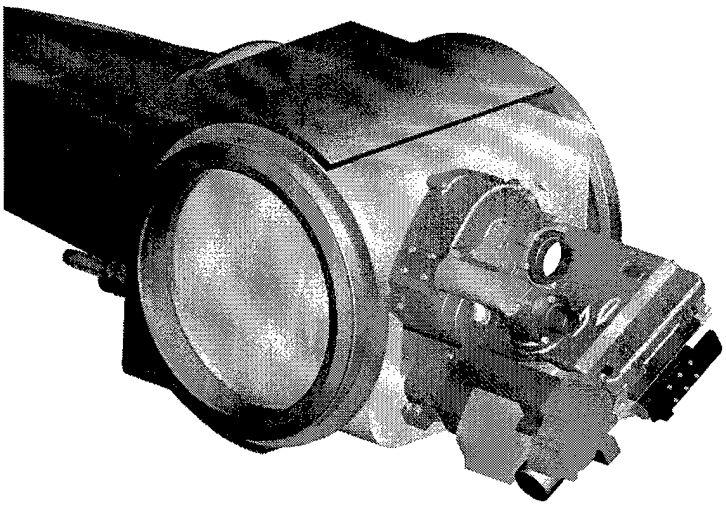
NDIA Small Arms: "A Unique Coax Gun Installation"
Page 9-6/17/98

This approach is to mount the coax gun external to the turret. The EX34 can be mounted directly to the integral mount of the Bushmaster III. An armored access door encloses the gun, making it easily accessible.

This concept requires no additional modifications to the Bradley turret.

A feed chute would run from a magazine located inside of the turret through the Bushmaster III mount plate and integral mount to the coax gun. Links and spent cases would be ejected through a door in the bottom of the access panel.

Internal Mount Solution



BOEING

This approach mounts the coax gun inside the elevation rotor and inside of the ready magazine. Because the gun would now be directly in the crew department, the EX34 7.62mm Chain Gun® is ideal because it has a very low gun gas output.

By mounting the EX34 integrally with the Bushmaster III, maximum space use efficiency can be achieved.

The internal mount configuration does interfere with the existing elevation drive mechanism in the Bradley turret. A redesign of the elevation drive would be necessary to facilitate the internal coax installation.

Decision: Internal Mount Solution

Criteria	External	Internal
Effect on turret systems	None	Low
Access During Mission	Poor	Excellent
Vulnerability	Moderate	Low
Effect on Elevation Balance	Negative	Positive
Upload/Download	Remote	Direct
Design Complexity	Moderate	Low

BOEING

Effect on turret systems: The Internal Mount solution does interfere with a member of the existing turret elevation drive mechanism.

Access During Mission: The External Mount is a remote system with no access under armor. The Internal Mount gives direct access for all functions to the gunner from inside of the turret.

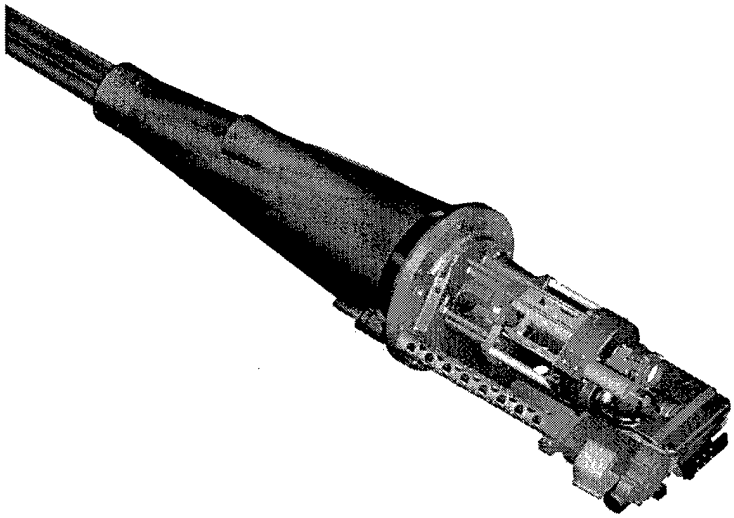
Vulnerability: Obviously, the External Mount is more vulnerable to small arms fire and artillery shrapnel.

Effect on Elevation Balance: The elevating mass is front-heavy on the 35/50mm Bushmaster III installation. This requires a heavy equilabrator to compensate. The External Mount adds to this problem, whereas the Internal Mount helps the problem.

Upload/Download: For obvious reasons the upload/download task is much simpler on the Internal Mount than on the External Mount.

Design Complexity: Adding the Internal Mount to the 35/50mm Bushmaster III Up-Gun concept adds only 5 new parts to the system, four of which are quite simple. The External Mount adds approximately 15 parts to the system.

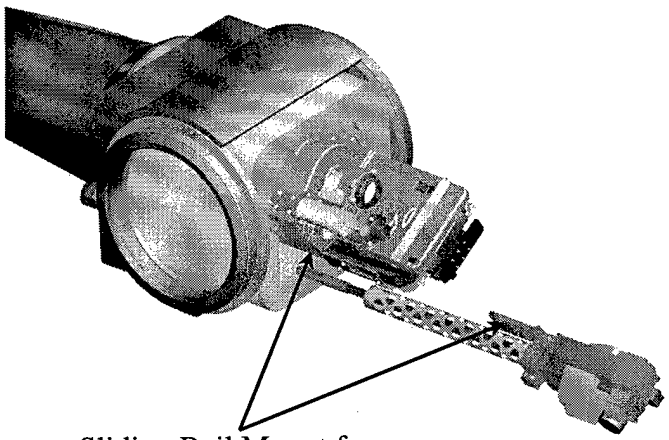
Integrated To Bushmaster III



BOEING

The Internal Mount 7.62 Coax gun is integral to the 35/50mm Bushmaster III. Very little additional volume is consumed by adding the 7.62 gun to the system.

Easy Removal of Coax From Installation



Sliding Rail Mount for
Quick Installation/Removal

BOEING

The coax gun mount uses a rail which mates with a support bracket located on the 35/50mm Bushmaster III receiver.

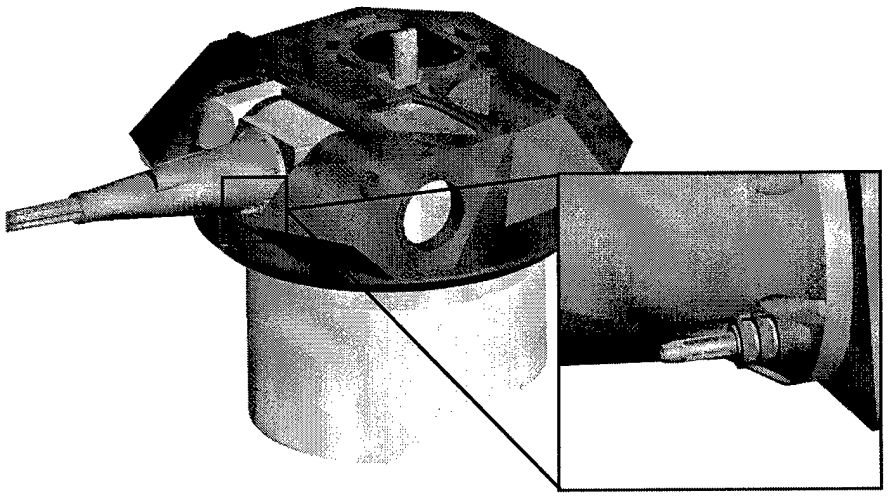
Installation of the coax gun is accomplished by simply aligning the coax gun from within the turret and inserting it forward. The front end of the barrel is guided through the inside of the wrap-around magazine and through the bore-sight mechanism. As the gun move forward the rail on the coax gun mount engages the mating rail on the Bushmaster III receiver. The coax gun is then pushed forward until it latches into its locked position.

Removal is accomplished by reaching under the coax gun to pull the mount-release pin and the sliding the gun aft while holding the mount-release pin out. The gun is then pulled aft until the barrel is clear of the wrap-around magazine.

No tools are required to install or remove the gun and the task is easily accomplished by one crew member.

Bore-sighting accuracy is assured since the sliding rail mount for the coax gun is fixed directly to the main gun.

Bore-sight Adjustment Outside of Turret

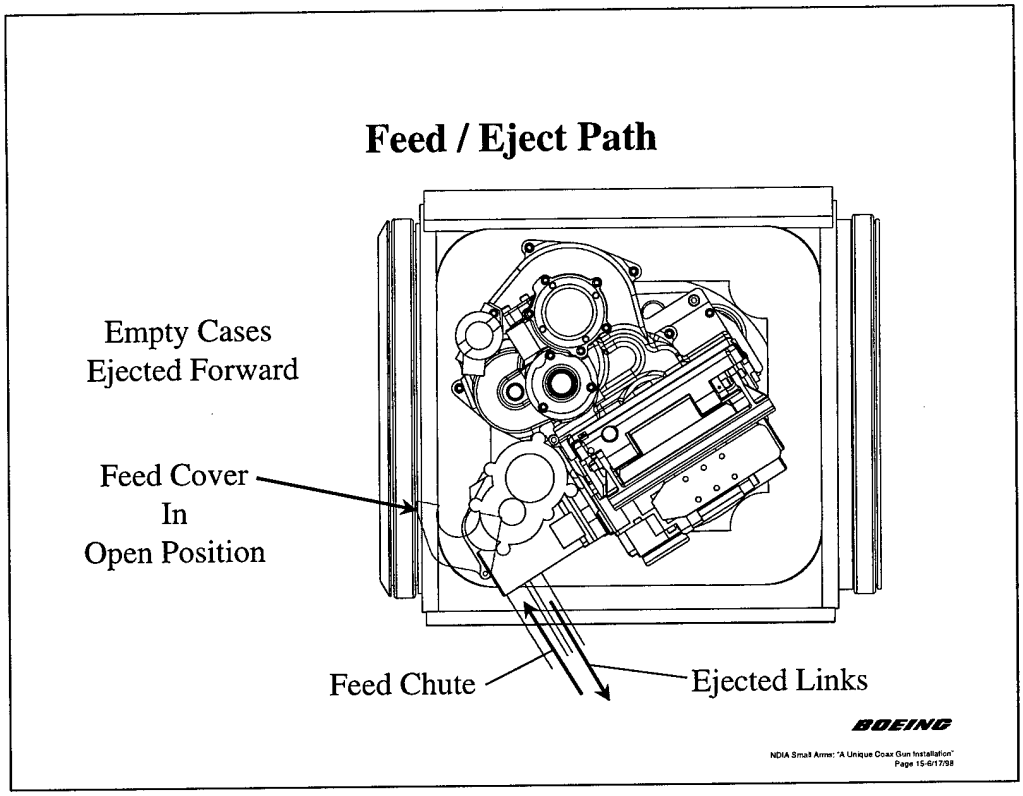


BOEING

A bore-sight mechanism is contained in the coax gun forward mount housing. This housing is integral to the 35/50mm Bushmaster III integral mount. Two hex nuts are accessible from outside of the turret. These hex nuts provide adjustment of the coax guns aiming point in the vertical and horizontal planes.

The mechanism is spring-loaded and self-locking so that on person can easily use the bore-sight and adjust the aiming point at the same time. This reduces the bore-sight task to a simple task for one crew member.

Since the bore-sight mechanism is fixed to the main gun, their will be a very good repeatability of the bore-sight of the gun from one install/removal to the next.



The incoming feed and ejected links come into and leave the gun parallel to each other. The EX-34 is oriented such that the feed path is coming up to the bottom of the gun at about 30° from vertical. This is a versatile position as it allows the feed chute and ejected links to be routed virtually anywhere desired.

The empty cases can be ejected inside of the turret or they can be routed forward through the magazine and mount plate and ejected out the front of the turret.

Features and Benefits

- Simple Design
- Easy Installation and Removal
  - no tools required
- Easy Bore-Sighting Procedure
  - only one crew member required
  - bore-sight is accurate and repeatable
- Efficient use of valuable space inside of turret
- Easy access to coax weapon in turret
- Facilitates Upgrade of Main Weapon

BOEING

Summary

Successful Integration: 7.62 with Up-Gun Concept

Adds to Viability of 35/50mm As Practical Up-Gun

Integral Main Gun/Coax Gun Concept

Other Main Guns/Applications To Be Considered

BOEING

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Team and Technology

STRIKER 40mm SacoDefense incorporated

Computing Devices Canada

Celsius
BOFORS CARL GUSTAF

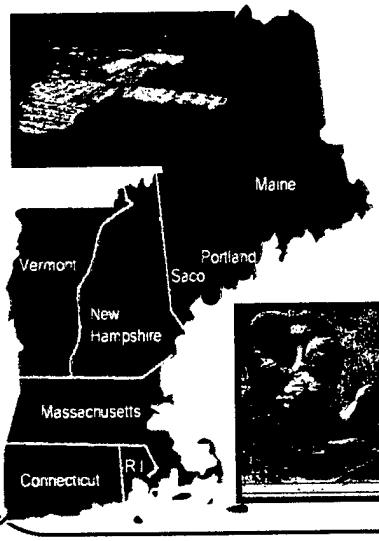


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Saco Defense

SacoDefense incorporated

- Established in 1813
- Primary Producer of DOD's Crew Served Weapons since 1962
- DOD's MK19 and .50 Cal Producer
- 400 Employees





SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

CDC

Computing Devices Canada

- $350M Annual Turnover
- Over 1000 employees
- Core Technologies
  - Vehicle Electronics
  - Flat Panel Displays
  - Fire Control
  - Data Communications
  - Surveillance Systems
  - Software
- Vertically Integrated
- Technology



- CDC Manufactures
  - Fire Control for
    - M1 (A1-A3) & Challenger Tanks
    - Bradley Fighting Vehicles
  - Avionics
    - F14
    - Orison

SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

Bofors

Celsius BOFORS CARL GUSTAF

- Established in 1646
- 4000 Employees



- Products
  - AT-4 / Carl Gustaf
  - AC130 Gun Ship Weapon
  - CV 90

SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

Crew Served Weapons

Maxim & Gatling Gun

Spanish-American War
World War I

.50cal Browning

WWII

Somalia & Gulf Wars
1968-1992

MK19 Bursting Munitions

2000

STRIKER
40mm AGL
Air-Bursting
Programmable
Ammunition &
Weapon

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The Weapon

Computing Devices Canada

SacoDefense incorporated

- Lethal
- Smart
- Precise
- Portable
- Cost Effective



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Company Funded Development

*Use of **Computer Modeling** in Design/Development allowed Saco to explore various designs and find the **OPTIMUM** **Crew-Served Weapon Design***

Team Formed with State Department Approval 1995

BOFORS Fields "3P" Air-Burst 40mm Ammunition to Sweden 1993-1995

Alpha Prototype Development 1993-94

CDC Develops Initial LVS Brassboard 1991-1993

Gun Brass Board R&D 1990-1991

SACO Commissions Gene Stonier 1988

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Development & Testing



Ready for IOT&E

Gun-Sight-Ammunition System Integration 1997

Production Designs Verified 1997-1998

Air-Bursting Ammunition Tested 1996

Customer Focus Groups 1996-1997 MANPRINT Focus

Testing 1994-1998

Cookoff

Accuracy & Dispersion

Beta Weapon Prototype Development 1994-96

Endurance

Ammunition Compatibility

Reliability

Extreme Hot & Cold

Sand & Dust

Safety

ATF

BRING US CHALLENGES... ...WE RETURN SOLUTIONS

ARMAMENT TECHNOLOGY FACILITY
COMMERCIAL: 309-794-4ATF
DSN 880-4ATF

SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

Packed with Technology

Computer Processor
Range Finder & Sensors

Ammunition Programming

Optimized Rate of Fire

Low Dispersion Weapon





Light, Low Recoil Weapon

Lightweight Gun Action Technology

Quick Slew Mount

Fine Adjust

SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

Soldier Display

Electronic Range Card

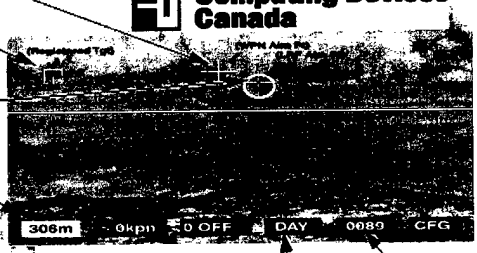
Adjusted Aim Point

Predesignates Targets

Software

Laser Aim Pointer

Range





Soldier Controls

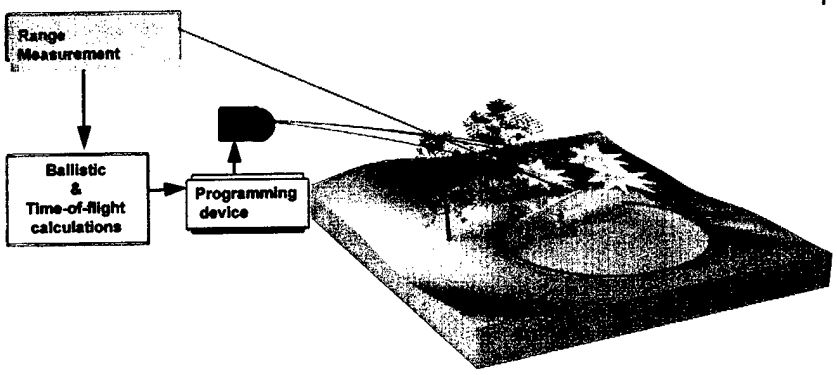
LRF Trigger
Weapon Trigger
Mouse (Toggle)

Day / Night

Azimuth

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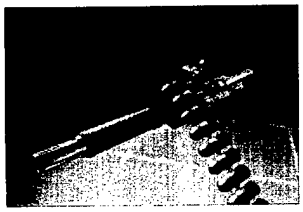
Principle of Air Bursting Ammunition



SacoDefense incorporated Celsius BOFORS CARL GUSTAF Computing Devices Canada

Weapon Design

- **Stability & Low Weight**
  - Recoiling Mass / Total Gun Mass
  - Internal Hydraulic Soft Mount
- **Fires Current DOD and NATO Inventory Ammunition**
- **Built to fire new BOFORS "Programmable" 40mm Ammunition**
- **Embedded Controls**
  - Built for "Soldiers"
- **8 Key Safety Features**
- **Closed Bolt Firing**
  - In Bore Fuzing
  - Lower dispersion

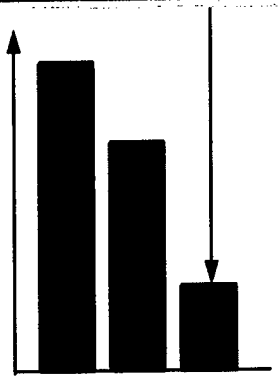




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Low Recoil Energy

* Low Recoil Energy = Easy Mounting on Mobility Platforms
* Lower Recoil Energy = Improved Accuracy





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Gun Facts

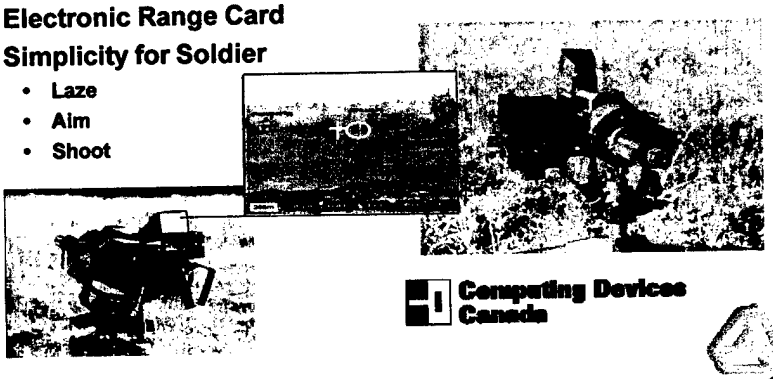
	STRIKER	MK19
Weight	37 lb.	76 lb.
Barrel Removed	31 lbs	
Rate of Fire	250-300 rpm	325-375 rpm
Length	34.6 in	44.29 in
Quick Detach Barrel	20 in	
Width	7.7 in	8.89
Height	7.7 in	8.19 in
Charge Pull	**55 lbs**	**99 lbs**
% Gun/Recoil Mass	55%	22%



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Video Sighting Basics

- **Day/night camera + computer + display**
- **Synchronized Precision electronic mount**
- **Automatic Aimpoint offset**
- **Electronic Range Card**
- **Simplicity for Soldier**
  - **Laze**
  - **Aim**
  - **Shoot**

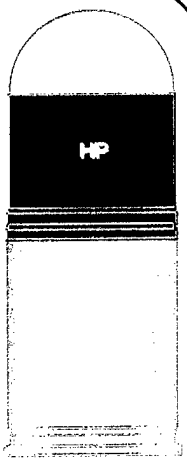


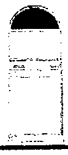
Computing Devices Canada

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HP Round Features

■ Prefragmented	-	large footprint & high lethality
■ Time fuse	-	electronic, for air burst
■ Point Detonating	-	mechanical
■ Self Destruct	-	electronic
■ Safe & arm device	-	mechanical STANAG distances apply
■ Tracer	-	w/wo (IR Tracer Option)
■ Propulsion system	-	off the-shelf highly accurate - low muzzle velocity dispersion
■ Ballistics	-	compatible with M430
■ HEDP Version	- +	penetration> M430 behind armor effect





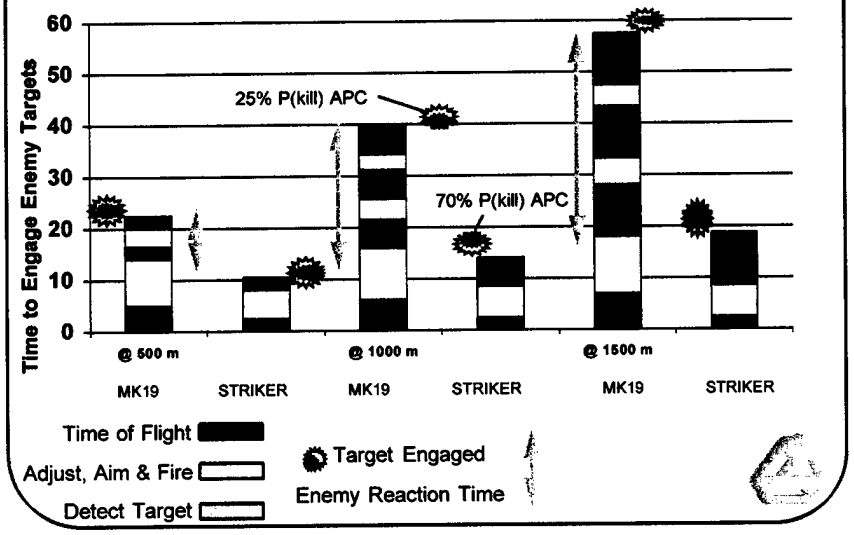
Multi Spectral Screening "Smoke"

- Will use BOFORS Fuze
- MultSpectral Screen
- Air Burst = Good Screen Material Dispersion
- Other

The HP round leverages "3P" Fuse Technology

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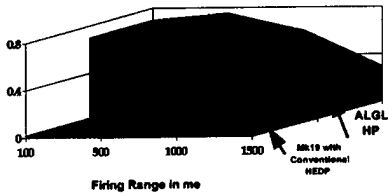
First Burst Destruction



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System comparison

$P_{incapacitation/hit}$

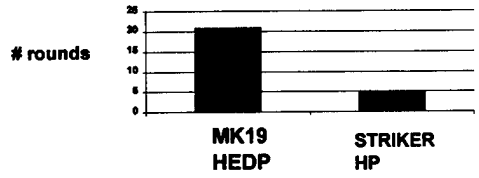


5 Round Burst

Target 10 Standing Soldiers (10 x 20m) area

$P_{incapacitation/hit}$

Mission cost



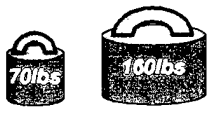


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Weapon Pay-off

Simplicity
Smart Technology
+ Precision

More Firepower with Lighter Loads





More Mission Capability
More Stowage for Fuel, Water, Food
Effective Destruction of Enemy
Better Survivability

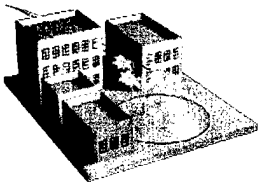
= 75% less ammo/mission
= 60% less gun weight
= 1000% Operational Improvement



More Engagements / minute

Lower Costs



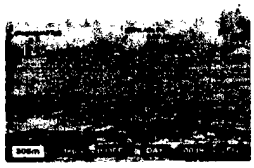


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Advanced Weapon & Fire-Control Technology

- **Gun Technology**
  - Lightweight
  - Ready Soldier Controls
  - Recoil Reductions
  - Embedded Fuzing
- **Fire Control**
  - Aids Target Detection
  - Adjusted Aim Point
  - Sets Fuze





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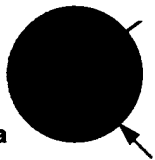
Celsius

BOFORS CARL GUSTAF

Air-Bursting Fuse Technology

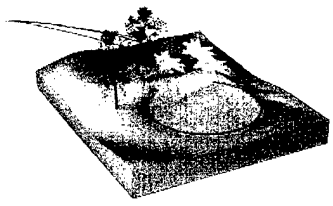


Low Dispersion Propulsion System



Lethality Area of one round 8 vs 100 m²

HP Air Burst Footprint

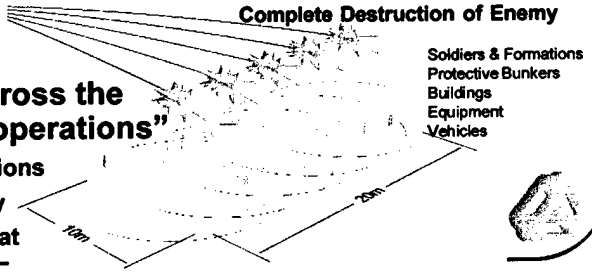


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Weapon Missions

- **Firepower for light & mobile units**
- **Protection of Critical Personnel and Mobility Assets**

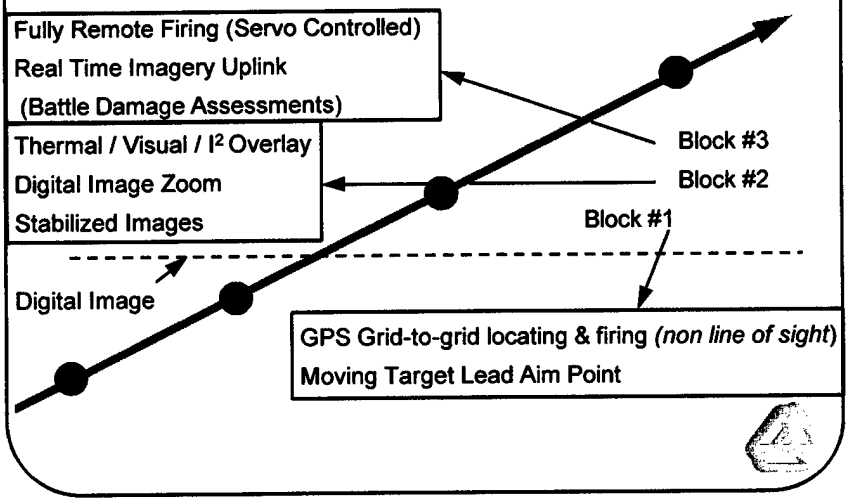




- **Effective across the "spectrum of operations"**
  - **Special Missions**
  - **Low Intensity**
  - **Heavy Combat**

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Technological Growth



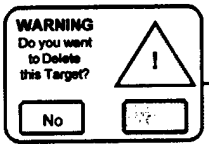
SacoDefense Incorporated | Celsius BOFORS CARL GUSTAF | Computing Devices Canada

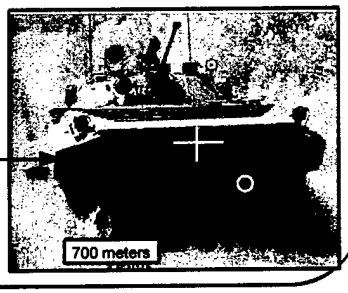
Summary

- **Significant Industry Team Investment**
- **3 New Technologies Vastly Enhance**
  - Lethality & Effectiveness
  - Friendly Survivability
  - Target Detection Capability
  - Mission Capability
  - Mission Flexibility

STRIKER 40mm

Smart Weaponry for Warriors





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