2018 ARMAMENT SYSTEMS FORUM

ARMAMENT SYSTEM RESPONSE TO THE EVOLVING THREAT SPECTRUM

May 7 – 10, 2018

Sheraton Indianapolis Hotel at Keystone Crossing

Indianapolis, IN

NDIA.org/Armament-Forum

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WELCOME TO THE 2018 ARMAMENT SYSTEMS FORUM

Dear Attendees,

Welcome to the 2018 Armament Systems Forum and Technology Firing Demonstration. The Armament Forum continues to confirm partnership of government and with the industrial base to ensure capability and readiness. This event is designed to provide the opportunity to examine aspects of Armament systems and technologies that underpin our military power today and in the future. The theme: “Armament System Response to the Evolving Threat Spectrum” reflects the changing needs for Integrated Armament Systems to counter the evolving nature of the threat and the need for maintaining technological superiority in Armaments design and performance in the face of these threats. The 2018 Forum is focused to provide a vision for the evolving Armament System capability enhancing legacy systems and evolving, maturing, and fielding advanced systems. The importance of platform integration, enabler technologies meeting warfighter objectives is included.

The informative and challenging presentations address ensuring legacy armament enhancements and present a vision for future capability over the course of the next three days. Our speakers are experts in their fields and come together with you to share their insights and discuss challenges to shape opportunities. The agenda reflects participation by Allied International countries. I am sure you will benefit from interacting and networking. Our exhibitors are eager to show innovation and advanced technology, so please take time to visit with them to consider technology applications and benefits.

The Technology Firing Demonstration on Thursday afternoon is always a highlight of this annual event. I want to thank Sal Fanelli and the demo team for their support and participation. In addition, I thank Camp Atterbury for providing the range and safety support so critical in ensuring a successful and safe experience for all participants.

I want to acknowledge and thank the planning committee, and especially the Chairs of the Division Committees – Small Arms Systems- Mr. Brian Berger, GTDS America, LLC, The GARM Industry and Government Leadership Team, and Unconventional and Emerging Technology Armament Systems- Mr. Daniel Hartman, Spectra Technologies, LLC. Without the support of the Armament Team leadership, NDIA staff, and each attendee this event would not offer the vision for Armament Systems evolving capabilities. The 2018 Forum provides value added vision for future Armament Technologies and Systems.

Thank you to the sponsors of this event who have stepped up to provide the support so vital in providing a quality experience for all participants. We appreciate their partnership and urge you to learn more about their capabilities.

Please enjoy the 2018 Armament Systems Forum and Technology Firing Demonstration, and I look forward to speaking with you.

Sincerely,

David Broden
President, Broden Resource Solutions, LLC
NDIA Armament Division Chair

WHO WE ARE

The National Defense Industrial Association is the trusted leader in defense and national security associations. As a 501(c)(3) corporate and individual membership association, NDIA engages thoughtful and innovative leaders to exchange ideas, information, and capabilities that lead to the development of the best policies, practices, products, and technologies to ensure the safety and security of our nation. NDIA's membership embodies the full spectrum of corporate, government, academic, and individual stakeholders who form a vigorous, responsive, and collaborative community in support of defense and national security. For more information, visit **NDIA.org**

SCHEDULE AT A GLANCE

MONDAY, MAY 7

Registration
Suite Tower Lobby
12:00 – 4:30 pm

Plaza Foyer
4:30 – 7:30 pm

Tutorial Sessions
See page 6 for details
1:00 – 5:30 pm

TUESDAY, MAY 8

Registration
Plaza Foyer
7:00 am – 5:00 pm

Networking Breakfast
Plaza Foyer
7:00 – 8:00 am

Poster Sessions
Suite Tower Lobby
8:00 am – 5:00 pm

General Session
Plaza AB
8:00 am – 5:10 pm

Exhibit Hall
8:30 am – 7:00 pm

Awards Ceremony
Plaza AB
10:30 – 11:15 am

Networking Reception
Exhibit Hall
5:15 – 7:00 pm

WEDNESDAY, MAY 9

Registration
Plaza Foyer
7:00 am – 5:00 pm

Networking Breakfast
Plaza Foyer
7:00 – 8:00 am

Concurrent Sessions
See page 13 for details
7:45 am – 5:40 pm

Poster Sessions
Suite Tower Lobby
8:00 am – 5:00 pm

Exhibit Hall
8:30 am – 3:45 pm

THURSDAY, MAY 10

Registration
Plaza Foyer
7:00 – 11:00 am

Networking Breakfast
Plaza Foyer
7:00 – 8:00 am

Concurrent Sessions
See page 19 for details
8:00 – 11:50 am

Technology Firing Demonstration
Camp Atterbury
See page 24 for details
12:00 – 5:30 pm

LEADERSHIP AND COMMITTEES

David Broden
Division Chair

Brian Berger
Small Arms Committee Chair

Daniel Hartman
Unconventional Emerging Technology Armament Systems Committee Chair

Matt Phillips
Guns, Ammunition, Rockets & Missiles Committee Chair

ARMAMENTS DIVISION

WHO WE ARE

The Armaments Division provides the forum for industry, military and government personnel to address the issues necessary to ensure a superior armament system capability today and in the future. The division addresses armament operational needs and requirements, approaches and concepts, system integration, weapons, munitions, fire control and other ancillary equipment, and logistic support. Attention is given to total systems and to technology application and state-of-the-art technology advancements.

EVENT INFORMATION

LOCATION

Sheraton Indianapolis Hotel at Keystone Crossing
8787 Keystone Crossing
Indianapolis, IN 46240

EVENT WEBSITE

NDIA.org/Armament-Forum

EVENT CONTACT

K. Ashley Phayme
Meeting Planner
(703) 247-2540
aphayme@ndia.org

PLANNING COMMITTEE

David Broden
Division Chair

Brian Berger
Small Arms Committee

Daniel Hartman
Unconvential Emerging Technology Armament Systems Committee

Matt Phillips
Guns, Ammunition, Rocket & Missiles Committee

EVENT THEME

Armament System Response To The Evolving Threat Spectrum

ATTIRE

Business attire for civilians or uniform of the day for military personnel.

SURVEY AND PARTICIPANT LIST	A survey and list of attendees (name and organization only) will be emailed to you after the conference. NDIA would appreciate your time in completing the survey to help make our event even more successful in the future.
SPEAKER GIFTS	In lieu of speaker gifts, a donation is being made to the Fisher House Foundation.
HARASSMENT STATEMENT	NDIA is committed to providing a professional environment free from physical, psychological and verbal harassment. NDIA will not tolerate harassment of any kind, including but not limited to harassment based on ethnicity, religion, disability, physical appearance, gender, or sexual orientation. This policy applies to all participants and attendees at NDIA conferences, meetings and events. Harassment includes offensive gestures and verbal comments, deliberate intimidation, stalking, following, inappropriate photography and recording, sustained disruption of talks or other events, inappropriate physical contact, and unwelcome attention. Participants requested to cease harassing behavior are expected to comply immediately, and failure will serve as grounds for revoking access to the NDIA event.

SESSION TRACKS

SMALL ARMS SYSTEMS

Small Arms Technology Which Creates Asymmetric Operational Advantage for Soldiers, Sailors, Airmen, and Marines.

All sessions are Distribution A.

GUNS, AMMUNITION, ROCKETS & MISSILES SYSTEMS

Armament System Modularity and Scalability Enabling Operation Capability Across Expanding Threat Spectrum.

Concurrent sessions offered are Distribution A and D.

UNCONVENTIONAL EMERGING TECHNOLOGY ARMAMENT SYSTEMS

Kinetic to Electromagnetic and Other Defeat Mechanisms on Target. **Sessions offered are Distribution A and D.**

MONDAY, MAY 7	TUESDAY, MAY 8	WEDNESDAY, MAY 9	THURSDAY, MAY 10
TUTORIALS	COMBINED JOINT GENERAL SESSION	SMALL ARMS TRACK GARM TRACK UEA TRACK	SMALL ARMS TRACK GARM TRACK TECHNOLOGY FIRING DEMONSTRATION

AGENDA

MONDAY, MAY 7

12:00 – 4:30 pm

REGISTRATION
SUITE TOWER LOBBY

1:00 – 2:30 pm

TUTORIAL 1:
US Export Controls Over Technology - ITAR And EAR Licensing Rules And Exemptions

METRO SUITE

Johanna Reeves, Esq.
Attorney, Reeves & Dola, LLP

TUTORIAL 2:
Bore Erosion Measurement and Inspection System - Small Caliber (BEMIS-SC) for QC And LAT

CLEARWATER BALLROOM A

Rand W. Hammel
Mechanical Engineering Technician, US Navy NSWC

TUTORIAL 3:
What Gun Gurus Need To Know About 'Accuracy'

CLEARWATER BALLROOM B

Jeff Siewert
Systems Engineer, Arrow Tech Associates, Inc.

2:30 – 4:00 pm

TUTORIAL 4:
Additive Manufacturing-Army Plans for AM Capabilities to Enhance Warfighter Capabilities And Integrate in the Industries Base

METRO SUITE

James L. Zunino
US Army, RDECOM- ARDEC

TUTORIAL 5:
USAF AFRL Armament and Technology 2030 Initiatives

CLEARWATER BALLROOM A

Air Force Research Laboratory

TUTORIAL 6:
Small Caliber Ammunition Intermediate Caliber Panel

CLEARWATER BALLROOM B

See tutorial description for panelist members

4:00 – 5:30 pm

TUTORIAL 7:
Small Caliber Lead Free Primer Panel

METRO SUITE

Steve Faintich
Sr. Director Marketing & Sales, St. Marks Powder
Moderator

Dan Mansfield
Lead Development Engineer, Orbital ATK

Todd Townsend
Small Caliber Project Management Engineer, Maneuver Ammunition Systems

Joel Sandstrom
Vista Outdoors

Jeremy Mills
Manager, Military Programs, Olin Corporation

Lina Norum
Nammo Demil Division

Gustavo Domit
Technical Director, Companhia Brasileira de Cartuchos

TUTORIAL DESCRIPTIONS

TUTORIAL 1

US Export Controls Over Technology - ITAR And EAR Licensing Rules And Exemptions

Ms. Reeves' practice focuses on regulatory compliance under US export controls and the federal firearms laws and regulations. The tutorial will feature a comprehensive overview of US Export Controls over US Technology.

TUTORIAL 2

Bore Erosion Measurement and Inspection System - Small Caliber (BEMIS-SC) for QC & LAT

Drawings are now aligned with current barrel dimensions as a baseline. As new barrels are accepted using the laser-based BEMIS-SC, we can verify and validate the qualities that prove to enhance accuracy. The final aspect of the BEMIS-SC is that every aspect of measurement is recorded providing a historical record of that barrel.

TUTORIAL 3

What Armament System, Weapon, and Ammunition Developers Need to Know About "Accuracy'

Jeff Siewert, will present and in-depth tutorial addressing system performance focused to accuracy and dispersion. The tutorial will cover the difference between accuracy and dispersion, factor influencing short aid long range accuracy, short range dispersion trouble shooting, interior and exterior ballistic dispersion influences, bias vs. random factors in error budgets, and strategies for minimize error. The sources and remedies for achieving desired dispersion are presented with a focus on the needs of System, Weapon, and ammunition developers and manufacturers.

TUTORIAL 4

Additive Manufacturing-Enhancing Warfighter Capabilities

The evolving Additive Manufacturing capabilities offer benefits to government and industry development and manufacturing of armament systems. The tutorial will provide status of Additive Manufacturing, overview multiple application examples, and outline the vision for applying Additive Manufacturing to facilitate development and integrate with production. Additive Manufacturing of electronics, polymers, metals, and energetics will be addressed.

TUTORIAL 5

USAF AFRL Armament and Technology 2030 Initiatives

The USAF Air Force Research Laboratory (AFRL) is developing a vision of technologies and systems for USAF capability in 2030 and beyond. AFRL personnel will describe the Initiative program, overview the technology and system focus, and outline how government, academia, and industry can partner to identify and evolve innovative capabilities. This tutorial will provide an open forum dialogue for flow of ideas, concepts etc.

TUTORIAL 6

Small Caliber Ammunition Intermediate Caliber Panel

Discussion regarding Small Arms Intermediate Calibers. The Committee has defined "Intermediate" to be a caliber between 5.56mm x 45 and 7.62mm x 51 that along with a family of weapons would have better performance (accuracy, lethality, penetration, recoil, etc.) than one or both current cartridges and could be used for both individual and a squad weapons.

Bruce Webb, Director, Specialty Ammunition, NAMMO, Inc.

Moderator

Troy Lawton, USA HQDA

LTC Andrew Lunoff, USA, PM Small Caliber Ammunition, PM MAS

LTC Loyd Beal III, USA, PM SW

LTC Mark Owens, USA, PM for Ammo, Weapons & VAS, USSOCOM

Devin Patterson, Engineer, DHS

Matt Ohlson, Director, Remington Defense, Remington Arms Co., LLC

Gustavo Domit, Technical Director, Companhia Brasileira de Cartuchos

Nick Malkovich, President, MAC, LLC

Jeff Hoffman, Black Hills Ammunition

Russ Oliver, True Velocity

TUTORIAL 7

Small Caliber Lead Free Primer Panel

US Army seeking to remove lead from small caliber primers. Panelists will provide an update on progress made with green primers. USG will address a secondary objective which is to automate primer manufacturing.

TUESDAY, MAY 8

7:00 am – 5:00 pm

REGISTRATION
PLAZA FOYER

7:00 – 8:00 am

NETWORKING BREAKFAST
PLAZA FOYER

8:00 – 8:20 am

WELCOME AND ADMINISTRATIVE ANNOUNCEMENTS
PLAZA AB

David Broden
President, Broden Resource Solutions, LLC
NDIA Armament Division Chair

8:20 – 8:30 am

NDIA WELCOME

Frank Michael
Senior Vice President of Programs and Membership, NDIA

8:30 – 8:45 am

NDIA ENTERPRISE VISION

MG James Boozer, USA (Ret)
Chief of Staff

8:45 – 9:00 am

NDIA POLICY VISION

Col Wesley Hallman, USAF (Ret)
Senior Vice President of Policy, NDIA

9:00 – 9:30 am

NETWORKING BREAK
EXHIBIT HALL

9:30 – 10:00 am

KEYNOTE ADDRESS
Armament Response to the Evolving Threat Spectrum

LTG David Halverson, USA (Ret)
Chairman and Chief Executive Officer, Cypress International

10:00 – 10:30 am

KEYNOTE ADDRESS

Anthony Sebasto
Executive Director of Enterprise and Systems Engineering Center, US Army, ARDEC

10:30 – 11:15 am

AWARDS PRESENTATIONS

Chinn Award Recipient

Presented by: Dan Shea, Phoenix Defense

Richard D. Jones

Curator Emeritus National Firearms Collection

Hathcock Award Recipient

Presented by: Buford Boone

Stephen Toboz, Jr.

Naval Special Warfare Command

Ambrose Award Recipient

Presented by: Brian Berger, GTDS America, LLC

Jim Teetzel

CEO, Wilcox Industries, Corp.

Trifiletti Award Recipient

Presented by: Ralph Tillinghast, ARDEC

Vic Galgano

Professional Service Awards Recipients

Presented by: Brian Berger, GTDS America LLC

John H. Edwards (Retired)

RDECOM-ARDEC, JSSAP

Presented by: David Broden, Broden Resource Solutions

Mark Serben (Retired)

Supervisory Project Manager, US Army RDECOM-ARDEC

11:15 am – 12:30 pm

LUNCHEON

PLAZA FOYER

12:30 – 1:00 pm

ARMY S&T EFFORTS TO MODERNIZE LETHALITY

PLAZA AB

Michael Holthe

Director for Lethality, ASA(ALT)/ODASA Research & Technology

1:00 – 1:30 pm

PEO AMMUNITION VISION

PEO Ammo Today and Vision for the Future

BG Alfred F. Abramson, III (USA)

Commanding General, Program Executive Officer Ammunition

1:30 – 2:00 pm

KEYNOTE ADDRESS

Close Combat Ground Forces - Initiatives and Vision

MG Robert Scales, USA (Ret)

2:00 – 2:30 pm

USN KEYNOTE ADDRESS

Surface Combatant Weapon System Response to the Evolving Threat

John Fiore

Technical Director, NSWCDD - Dahlgren

2:30 – 3:00 pm

NETWORKING BREAK

EXHIBIT HALL

3:00 – 3:45 pm	**USAF KEYNOTE ADDRESS** USAF Armament System Vision Ahead - ARFL 2030 Initiative **Dr. David E. Lambert** Chief Scientist, Munitions Directorate, AFRL, Eglin Air Force Base
3:45 – 4:15 pm	**ADDRESSING THE MORPHING THREAT AND RECENT ACQUISITION REFORM TO RESPOND** **James O'Bryon** President, The O'Bryon Group
4:15 – 4:45 pm	**MODERN TRENDS & DEVELOPMENTS IN GLOBAL ORDNANCE 2017 – 2018** **Dan Shea** General Director, Phoenix Defense
4:45 – 5:15 pm	**NATIONAL ARMAMENT CONSORTIUM** **Butch Burgess** Technology Manager, Department of Defense Ordnance Technology Consortium **Charlie Zisette** Executive Director, National Armaments Consortium
5:15 pm	**CLOSING REMARKS**
5:15 – 7:00 pm	**NETWORKING RECEPTION** EXHIBIT HALL
5:40 – 6:00 pm	**MANDATORY MEETING FOR ALL COMPANIES PARTICIPATING IN THE FIRING DEMONSTRATION**

WEDNESDAY, MAY 9

7:00 am – 5:00 pm	**REGISTRATION** PLAZA FOYER
7:00 – 8:00 am	**NETWORKING BREAKFAST** PLAZA FOYER

7:50 – 8:00 am

ADMINISTRATIVE ANNOUNCEMENTS

Brian Berger
GTDS America LLC
Small Arms Committee Chair

8:00 – 8:20 am

WELCOME

CAPT Mark H. Oesterreich, USN
Commanding Officer, NSWC, Crane

8:20 – 9:40 am

PANEL DISCUSSION: PM SOLDIER WEAPONS (PM SW)

COL Elliott Caggins, Jr. USA
Product Manager, Solider Weapons
Moderator

LTC Loyd Beal III, USA
Product Manager, Crew Served Weapons

LTC Steven Power, USA
Product Manager, Solider Weapons

Gabe Bailey
Sig Sauer M17/M18 Pistol

9:40 – 10:10 am

NETWORKING BREAK

EXHIBIT HALL

10:10 – 11:10 am

PANEL DISCUSSION: PM MANEUVER AMMUNITION SYSTEMS (PM-MAS)

COL Hector Gonzalez, USA
Project Manager, PM-MAS
Moderator

Christopher Seacord
Product Manager, Medium Caliber Ammunition

LTC Andrew Lunoff, USA
Product Manager, Small Caliber Ammunition

Tom Coradeschi
Chief Engineer, PM MAS

11:10 am – 12:10 pm

PANEL DISCUSSION: NATO WEAPONS & SENSORS WORKING GROUP

Dr. Barton Halpern
NATO Weapon and Sensor Group Chairman

Callum Jensen
Land Engineering Agency, DoD - Australia

Dr. Amal Bouamoul
DRDC, Canada

Aldo Sluga
DMO - The Netherlands

Cdr. Jens Tore Moen Alfei
DLO, Land Systems - Norway

Douglas Cohen
System Engineer, PM SW

Dr. David Dye
Scientist, NSWC Crane

Adam Jacob
Engineer, ARDEC

Mark McFadden
Chief, Armament Tech Facility-Supervisory General Engineer, USA, ARDEC, JSSAP

David Long
Navy Technical Warrant Holder, NSWC Crane/ NAVSEA

Wayde Thomka
Director, Technology Managment, Project Manager Soldier Sensors & Lasers

Dr. Mark Thoreson
Engineer/Scientist, NSWC

12:10 – 1:10 pm

NETWORKING LUNCH

EXHIBIT HALL

1:10 – 2:10 pm

PANEL DISCUSSION: PM SOLDIERS SENSORS AND LASERS (PM SSL)

COL Christopher Schneider, USA
Project Manager, Soldier Sensor & Laser
Moderator

Wayde Thomka
Director, Technology Management, Project Manager Soldier Sensors & Lasers

2:10 – 3:10 pm

PANEL DISCUSSION: JOINT SERVICE SMALL ARMS SYNCHRONIZATION TEAM (JSSAST)

Augustine Funcasta
USA, RDECOM-ARDEC, JSSAP
Moderator

COL Kurt "Travis" Thompson, USA
Solider Requirements Division

Christopher Woodburn
Deputy, Maneuver Branch, Capabilities, Development Directorate

Col Enrico Venditti, USAF
Security Forces Center

MSgt Craig LaMudge, USAF
Chief, Weapons and Ordnance Division, HQ USCG: Office of Specialized Capabilities

LCDR Peter Downes, USN
DCNO N9

LTC Mark Owens, USA
PEO SOF Warrior

3:10 – 3:40 pm

NETWORKING BREAK

EXHIBIT HALL

JOINT SERVICE SMALL ARMS PROGRAM (JSSAP) SESSION

Augustine Funcasta
USA, RDECOM-ARDEC, JSSAP
Moderator

3:40 – 4:00 pm

JSSAP Science and Technology Advisory Council

Marc Ritt
ARDEC

4:00 – 4:20 pm

ARDEC Small Caliber Barrel S&T Efforts

Adam Foltz, P.E.
Mech Eng, ARDEC

4:20 – 4:40 pm

Characterization of Machine Gun Barrel Temperature and Stress Conditions Through Correlation of Testing and Modeling Simulation Data

Adam Jacob
Engineer, ARDEC

Dr. Laurie Florio
ARDEC

Adam Foltz
Mech Eng, ARDEC

4:40 – 5:00 pm

Development of Small Caliber Barrel for Enhanced Performance

Ryan Berg
Design Engineer, ARES, Inc.

Adam Jacob
Engineer, ARDEC

5:00 – 5:20 pm

Precision Munitions Technology

Christopher Parisi
Project Officer, ARDEC

5:20 – 5:40 pm

Development of Small Arms Blowback Test Methodology

Adam Jacob
Engineer, ARDEC

Douglas Ray
Lead Mathematical Statistician, ARDEC

Arnt Johnsen
Norwegian Defense Research Establishment (FFI)

WEDNESDAY, MAY 9 CONTINUED

GARM TRACK – CLEARWATER BALLROOM AB

7:30 – 7:40 am

ADMINISTRATIVE ANNOUNCEMENTS

7:40 – 8:10 am

DECISIVE LETHALITY ON NGCV

COL Gerald Boston
Deputy Director, NGCV Cross Functional Team

8:10 – 8:40 am

EVOLVING TECHNOLOGY ENABLING CAPABILITY VS. THREAT SPECTRUM

Maria Allende
Acting Chief of the Office of the Director of Technology, RDECOM-ARDEC

8:40 – 9:40 am

PANEL DISCUSSION: ARMAMENT RESPONSE TO EVOLVING THREAT SPECTRUM

David Broden
President, Broden Resource Soultions
Moderator

Dr. Anthony Pezzano
Director, ARDEC Business Interface

Dr. Terrence West
AMRDEC

Michael Holthe
US Army ASAALT

Dr. David Lambert
Chief Scientist, AFRL

9:40 – 10:10 am

NETWORKING BREAK

EXHIBIT HALL

GARM CONCURRENT BREAKOUT SESSIONS

	Distribution A - Clearwater Ballroom A	Distribution D - Clearwater Ballroom B
10:10 – 10:30 am	**Panel Discussion: Ammunition vs. Missiles Application Considerations** Howard Kent CEO, Armor Development Group, LLC *Moderator*	**25mm Non-Energetic Fragmenting Cartridge for Joint Strike Fighter** Rick Wright Sr. Principal Engineer, General Dynamics-OTS
10:30 – 10:50 am	**PGU-47 APHEI-T** James McConkie Mechanical Engineer, NSWC Crane	**40mm x 53 High Exploding Air Burst Ammunition & Weapon Systems** Rick Wright Sr. Principal Engineer, General Dynamics-OTS
10:50 – 11:10 am	**One Basic Technology for Different Multipurpose Tank RD** Danny Schirding IMI Systems LTD	**Tube Launched Range Extended (T-Rex) Munition for a Multi-Role Mission** Michael Donadio Senior Systems Engineer, ARDEC
11:10 – 11:30 am	**Improved 105mm Illuminating Candle** M. Benoit Jolicoeur General Dynamics–OTS, Canada	**Kinetic Defeat of Maneuverable Agile (Group 1) Unmanned Aerial Vehicle Targets Using an Integrated Precision Fire Control Radar, Remote Weapon Station and Small Caliber Munition** Andre Aklian ARDEC
11:30 – 11:50 am	**The Rheinmetall Day Zimmermann Munitions M430A1 ABM Retrofit Program** Brian Sullivan Program Manager, American Rheinmetall Munitions, Inc.	**XM25 Counter Defilade Tactical Engagement (CDTE) System and Complimentary Counter Unmanned Aircraft System Capability** Vince Martinez XM25 Technical Director, Orbital ATK
11: 50 am – 12:10 pm	**Analysis of Large Caliber Ballistic Perf and Base Pressure Gradient** Jeff Siewert Systems Engineer, Arrow Tech Associates, Inc.	**105mm Low Blast Overpressure Muzzle Brake for M119 Towed Howitzer** Alan Ng ARDEC
12:10 – 1:10 pm	**NETWORKING LUNCH** EXHIBIT HALL	
1:10 – 1:30 pm	**The Need for Increased Full-Spectrum Lethality for Light and Medium Vehicles** Warwick Holloway EOS Defense Systems	**Truck Mounted Howitzer** Thomas DeVoe ARDEC

1:30 – 1:50 pm	**Enabling Air to Ground Munitions to Survive Extended Ground Deployment** Howard Kent CEO, Armor Development Group, LLC	**Fragmentation Characterization for Multi-Material Multilayer (M3I) Warhead Cases** John Paul Shebalin Engineer, NSWC Dahlgren Mary Collings Manager, Systems Development and Rapid Fielding Branch E34, NSWC Dahlgren
1:50 – 2:10 pm	**Modernizing Field Artillery Maintenance Equipment to Increase Performance and Reduce Needed Resource** James Brooker Vice President, Engineering, R&D, Otis Technology	**Lightweight Tandem Warhead System for Mout Targets for the Precision Shoulder Launched Munition (PSLM)** David Pfau Engineer, ARDEC
2:10 – 2:30 pm		**M72E8/E10 Law FFE Qualification Effort** Tyler Caudell Engineer, NSWC Crane
2:30 – 2:50 pm		**Electronic Round Counter for 120mm Mortar** Anthony Cannone Mechanical Engineer, ARDEC
2:50 – 3:10 pm	**End of GARM Distribution A Session**	**Enabling Better Mortar Systems Through Accuracy Testing and Modeling** Michael Wright APO, ARDEC
3:10– 3:40 pm	**NETWORKING BREAK** EXHIBIT HALL	
3:40 – 4:00 pm		**Hostile Fire Signatures: Their Measurement and Analysis** Jeffery Cameron Scientist, QuantiTech
4:00 – 4:30 pm		**MK34 Gun Weapon System Capabilities and Recent Improvements** Joe Segar MK160 Project Manager, NSWC Dahlgren Division
4:30 pm	**OBSERVATIONS AND WRAP UP**	

WEDNESDAY, MAY 9 CONTINUED

UEA TRACK – DISTRIBUTION A – METRO SUITE LOWER LEVEL

7:30 – 7:50 am

UEA OBJECTIVES, PURPOSE, CHALLENGES, OPPORTUNITIES

Dan Hartman
Spectra Technologies
UEA Committee Chair

7:50 – 8:00 am

UEA FOCUS TO 2018 ARMAMENT THEME

Evolving Technology and Systems to Shape Armament System Response to Evolving Threat Spectrum

8:00 – 8:40 am

MAJOR DEFENSE ACQUISITION PROGRAMS AND MEETING CHEMICAL, BIOLOGICAL, RADIOLOGICAL, AND NUCLEAR SURVIVABILITY REQUIREMENTS

John Larzelere
JPEO JPM-P MDAP Support-Team Lead, NSWC Dahlgren Division

8:40 – 9:00 am

THE SECURE SUPPLY CHAIN

Henry Newman
Chief Technology Officer, Seagate Government Solutions

9:00 – 9:20 am

ADAPTIVE SENSITIVITY TESTING IN ARMAMENTS:

A Case Study

Zachary Krogstad
Mechanical Engineer, Armament Research, Development & Engineering Center

Nick Tashjian
Quality Engineer, Armament Research, Development & Engineering Center

9:20 – 9:40 am

THE STUNSTICK NEUROSCRAMBLER LESS-LETHAL WEAPON SYSTEM

Directed Energy That Works

Fred Pearson

Pearson Industries

9:40 – 10:10 am

NETWORKING BREAK

EXHIBIT HALL

10:10 – 10:40 am	**MULTI-CALIBER WEAPON** **A Survival Weapon Incorporating New Technology** Richard "Rex" Hayes Liberty Consulting Solutions
10:40 – 11:00 am	**SCI-FI TODAY:** **Forward Deployed 3-D Unitized Polymer and Metal Fabrication Shops** Howard Kent CEO, Armor Development Group, LLC
11:00 – 11:20 am	**ANALYSIS OF LOW DENSITY, LOW VELOCITY, LESS THAN LETHAL PROJECTILES** Kenneth Hohnecker Mechanical Engineer, ARDEC
11:20 – 11:40 am	**MICRO-LASER IGNITION** Gregory Burke SME, Pictanny Arsenal, US Army
11:40 am – 12:10 pm	**GUNS, BULLETS, FIRE CONTROL AND ARTIFICAL INTELLIGENCE** Ralph Tillinghast Lab Director, Collaboration Innovation Lab, ARDEC
12:10 – 1:10 pm	**NETWORKING LUNCH** EXHIBIT HALL

UEA TRACK – DISTRIBUTION D – AUTHORIZED DEPARTMENT OF DEFENSE AND US DOD CONTRACTORS ONLY

1:10 – 1:30 pm	**UNCONVENTIONAL AND EMERGING TECHNOLOGY ARMAMENT SYSTEMS VISION FOR EVOLVING EMERGING CAPABILITIES FROM DEVELOPMENT TO FIELDING** Dan Hartman Spectra Technologies *UEA Committee Chair*
1:30 – 2:00 pm	**US ARMY EM GUN TECHNOLOGY AND SYSTEM STATUS** Josiah Fay Mechanical Engineer, ARDEC

2:00 – 2:30 pm

US ARMY DIRECTED ENERGY VISION

Dr. Craig Robin
Sr. Research Scientist, AMRDEC

2:30 – 3:00 pm

USAF DIRECTED ENERGY VISION

Dr. Diana Loree
Acting Chief Scientist, AFRL

3:10 – 3:40 pm

NETWORKING BREAK

EXHIBIT HALL

3:40 – 4:10 pm

INDUSTRY DIRECTED ENERGY VISION

Matt Straup
Northrop Grumman

4:10 – 4:40 pm

HYPERSONIC WEAPONS

Dr. Richard P. Hallion
President, Hallion Associates

4:40 – 5:45 pm

PANEL DISCUSSION:

Unconventional and Emerging Technology Armament Systems Focus, Vision, Enabling Response to Evolving Threat Spectrum – From Concept to Technology and Integrated Systems Readiness

Dr. Anthony Pezzano
Director, ARDEC Business Interface, ARDEC

Michael Holthe
US Army ASAALT

Dr. David Lambert
Chief Scientist, Munitions Directorate, AFRL

Dr. Craig Robin
Sr. Research Scientist, AMRDEC

Dr. Diana Loree
Acting Chief Scientist, AFRL

Matt Straup
Northrop Grumman

Dr. Richard P. Hallion
President, Hallion Associates

Josiah Fay
Mechanical Engineer, ARDEC

5:45 pm

OBSERVATIONS AND WRAP UP

THURSDAY, MAY 10

7:00 – 11:00 am

REGISTRATION

PLAZA FOYER

7:00 – 8:00 am

NETWORKING BREAKFAST

PLAZA FOYER

12:00 – 4:30 pm

TECHNOLOGY FIRING DEMONSTRATION

12:00 pm – Pickup box lunch prior to boarding bus
12:30 pm – Buses depart for Camp Atterbury
4:30 pm – Buses depart for Sheraton Hotel after Technology Firing Demonstration

SMALL ARMS TRACK PLAZA AB

CONCURRENT BREAKOUT SESSIONS

Plaza A

SESSION 1: AMMUNITION

Bruce Webb
Director, Specialty Ammunition, NAMMO, Inc.
Moderator

8:00 – 8:10 am

Announcements

Brian Berger
GTDS America LLC
Small Arms Committee Chair

8:10 – 8:30 am

Multiplex Small Arms Cartridge Technology

Christopher Parisi
ARDEC

8:30 – 8:50 am

Improving Bullet Pull- FEA and Empirical Studies

Daniel Meierhofer
Orbital ATK

8:50 – 9:10 am

A Wild Ride- 9mm MK217 SMAW Spotting Cartridge

Jay Bell
MAST/Brass Extrusion Labs Ltd.

Plaza B

SESSION 2: TARGET ACQUISITION – FIRE CONTROL PANEL

Robert Guarasi
Wilcox Industries Corporation
Moderator

Terence Rice
RDECOM-ARDEC, JSSAP
Moderator

Announcements

Robert Guarasi
Wilcox Industries Corporation
Moderator

Panel Discussion

Robert Guarasi
Wilcox Industries Corporation
Moderator

Government Panelists:

COL Elliott Caggins, USA
PM Soldier Weapons

COL Chris Schneider, USA
PM SSL

Ross Towers
ARDEC Fire Control

Darren Ward
ARDEC Fire Control

Dr. Mark Thoreson
NSWC Crane

Greg Petty
NSWC Crane

Dean Kissinger
CERDEC NVESD

9:10 – 9:20 am

NETWORKING BREAK
PLAZA FOYER

CONTINUED

SESSION 1: AMMUNITION
PLAZA A

9:20 – 9:40 am

Design, Modeling and Simulation, and Testing of a Lightweight Cartridge Case

Raymond Chaplin
ARDEC

9:40 – 10:00 am

Contributions Of Variables To Velocity Deviations In Small Caliber Ammunition

Connie Lusto
ARDEC

David Stubler
Orbital ATK

10:00 – 10:20 am

Preparation Technique for High Liquid Content Energetics in Sensitivity Testing, and Thin Layer Propagation Testing Overview for Energetics Process Hazards Evaluation

Daniel Mansfield
Chemical Engineer, Orbital ATK

10:20 – 10:40 am

High Performance Propellants Using Thin Film Energetics; Thin Film Primer Technology

Professor Kevin Coffey
Spectrum Materials Science

SESSION 2: TARGET ACQUISITION – FIRE CONTROL
PLAZA B

Panel Discussion (Continued)

Robert Guarasi
Wilcox Industries Corporation
Moderator

Industry Panelists:

Robert Guarasi
Wilcox Industries Corporation

Bryan Bockmon
Aim-Lock, Inc.

Tony Bacarella
DRS EOIS

Lennart Ljungfelt
Aimpoint

Bill Schorr
L3 Brashear

Matthew Warnick
American Rheinmetall Munitions

End Session 2

SESSION 1 CONTINUES
PLAZA A

10:40 – 11:00 am

Inductive Heating to Dry Environmentally Safe Case Mouth Waterproofing

Andy Bowman
Orbital ATK

Wilfredo Ramos
Orbital ATK

SESSION 3: WEAPONS B
PLAZA B

David Long
Navy Technical Warrant Holder, NSWC Crane/ NAVSEA
Moderator

Cryo Accurizing

Pete Paulin
CEO, 300 Below, Inc.

11:00 – 11:20 am

Contributing Factors to Proper Tracer Performance

Thomas Gmyrek
ARDEC

Kaleb Luna
Orbital ATK LCAAP

International Collaborative in Stabilized Small Arms Testing and Evaluation

Dr. Mark Thoreson
NSWC Crane

Ian Campbell
NSWC Crane

11:20 – 11:40 am

Multi-Spectral Small Arms Signature Characterization

Dr. David Dye
NSWC Crane

Dr. Mark Thoreson
NSWC Crane

Cooperative Barrel Erosion Study of 5.56mm Ball and Lead-Free Ammunition

Matt Wolff
Vista Outdoor/Federal Cartridge Company

Joel Sandstrom
Vista Outdoor/Federal Cartridge Company

Paul Furrier
Vista Outdoor/Federal Cartridge Company

Justin Pierce
Vista Outdoor/Federal Cartridge Company

11:40 am – 12:00 pm

The Next Advancement for the Battle Proven M240 Weapon System

Robert Landies
Ohio Ordnance Works

Mid-Length vs. Carbine Length Gas System on 14.5-Inch Upper Receiver Group Test

Andrew Zirkelbach
NSWC Crane

12:00 pm

CLOSING REMARKS

Brian Berger
GTDS America LLC
Small Arms Committee Chair

THURSDAY, MAY 10 CONTINUED

GARM TRACK – CLEARWATER BALLROOM AB

FIRE CONTROL SESSION – DISTRIBUTION D – AUTHORIZED DEPARTMENT OF DEFENSE AND US DOD CONTRACTORS ONLY

8:00 – 8:10 am

ANNOUNCEMENTS

8:10 – 8:30 am

THE FIRE CONTROL KILL CHAIN

Ralph Tillinghast
Lab Director, Collaboration Innovation Lab, ARDEC

8:30 – 8:50 am

ARDEC AND NATO SOFTWARE FOR FIRE CONTROL SYSTEMS

Andre Sowa
US Army REDCOM ARDEC

Jason Fonner
US Army REDCOM ARDEC

8:50 – 9:10 am

HELMET DISPLAY AND TRACKER SYSTEM FOR US NAVY MH-60S MULTI-MISSION HELICOPTERS

Caleb Michel
NSWC Crane

9:10 – 9:45 am

NETWORKING BREAK
PLAZA FOYER

9:45 – 10:05 am

ELECTROCHEMICAL RIFLING OF LARGE CALIBER CANNONS

Christopher Humiston
Mechanical Engineer, RDECOM ARDEC, Benet Laboratories

GPS DENIED GUIDANCE SESSION – DISTRIBUTION D – AUTHORIZED DEPARTMENT OF DEFENSE AND US DOD CONTRACTORS ONLY

10:05 – 11:00 am

GPS DENIED PANEL (SMALL BUSINESSES & USG)

Moderator: TBD

Brad Clawson
Director Technical Programs,
NAVSYS Corporation

Hamish Malin
NSWC - Dahlgren

Tony Opperman
Orbital Research

Anthony Corcella

11:00 – 11:20 am

GUIDED ADVANCED TACTICAL ROCKET (GATR) WEAPON SYSTEM

Dr. Tom Ting
Director of Advanced Technology, Orbital ATK

11:20 – 11:40 am

GPS DENIED/DEGRADED NAVIGATION

Fred Lisy
President, Orbital Research

TECHNOLOGY FIRING DEMONSTRATION

12:00 pm

PICKUP BOX LUNCH PRIOR TO BOARDING BUS

12:30 pm

BUSES DEPART FOR CAMP ATTERBURY

2:00 pm

ARRIVE AT DEMONSTRATION SITE—CAMP ATTERBURY

2:15 pm

SAFETY BRIEFING ONSITE

2:30 pm

DEMONSTRATING COMPANIES BRIEF TECHNOLOGY INITIATIVES

3:00 pm

FIRING DEMONSTRATIONS

3:30 pm

ATTENDEE FIRING PARTICIPATION

4:30 pm

BUSES DEPART FOR HOTEL

5:30 pm

ARRIVE AT HOTEL

THANK YOU TO OUR SUPPORTING SPONSOR

Orbital ATK

POSTER SESSIONS

TUESDAY AND WEDNESDAY

Suite Tower Lobby
8:00 am – 5:00 pm

ABSTRACT TITLE	AUTHOR	TRACK
ARDEC Terminal Performance Model - an unclassified damage model for use by industry	Gavin McFarland	Small Arms
The Effects of Stratified Wind Profiles in Direct Fire Ballistics	Tomas Bober	Small Arms
Analysis of Low Density, Low Velocity, Less-Than- Lethal Projectiles	Kenneth Hohnecker	UEA
Contribution of Variables to Velocity Deviations in Small Caliber Ammunition	Connie Lusto	Small Arms
Modeling Ballistic Events Using Explicit Finite Element Analysis	Michael Cataldi	Small Arms
Micro-Laser Ignition	Gregory Burke	UEA
External Ammunition Sealants and Bullet Pull Strength	Harry Arnon	Small Arms
High Velocity Armor Piercing Ammunition Technology Enablers for Evolving Threats	Howard D. Kent	Small Arms

BIOGRAPHIES

LTG DAVID D. HALVERSON, USA (RET)

CEO
Cypress International, Inc.

LTG David D. Halverson, USA (Ret) became the Chief Executive Officer of Cypress International, Inc. in Alexandria, VA in October 2017. In January 2018, he became the Chairman and Chief Executive Officer.

He grew up in Babbitt, MN, and graduated from the US Military Academy with a Bachelor of Science Degree. He attended the US Naval Postgraduate School in Monterey, CA, where he was awarded a Master of Science degree in Operations Research and Systems Analysis. He graduated from the Kenan-Flagler Business School's Executive Development Program at the University of NC.

Dave's last active duty assignment was the Army Assistant Chief of Staff for Installation Management, where he transformed the business approach to the global installation management and programmed the $19B annual energy, general services, force protection, construction and quality of life programs for over 154 installations in the Total Army. He has served in various staff and leadership positions including command at every level from Battery to Post Command to the Commanding General of Army Installation Management Command. He has served in Continental America, Europe, Korea, Panama, and South West Asia. His staff positions, focused on program development, testing, concept and requirement development, strategic planning, cost-benefit and risk analysis, with assignments as the Senior Military Analyst in the Joint Wargaming and Policy Division of the US Southern Command in Panama, joint requirements and Army budget development in positions such as the Commander in Chief Team Chief in the Office of the Chief of Staff of the Army, Program, Analysis, and Evaluation Directorate. He was the Central Command J3, Chief of Plans, and planned, coordinated, and executed war plans for Operation Enduring Freedom and Operation Iraqi Freedom after 9-11. He deployed as the Deputy Commanding General (Support) for the 4th Infantry Division for OIF 5/7. After his deployment, he assumed duties on the Army Staff, as the Director of Operations, Readiness, and Mobilization, G-3 and then became the Director of Force Development, G-8, where he developed the RDT&E investment, modernization and equipping programs for the Army totaling $200B across the POM. He transformed the training and modernization as the Commanding General of Army Fires Center of Excellence and Fort Sill, Oklahoma, where the Air Defense and Field Artillery merged under one post. Dave served as the Deputy Commanding General, Army Training and Doctrine Command where the newest doctrine and concepts were developed, along with leader development, training and learning models programs were revamped.

CAPTAIN MARK H. OESTERREICH, USN

Commanding Officer
NSWC, Crane

Captain Mark H. Oesterreich assumed command of the Naval Surface Warfare Center, Crane Division (NSWC Crane) in July of 2017. NSWC Crane delivers innovative solutions and readiness to the Nation and its Warfighters through application of its technical capabilities.

A native of South Holland, Illinois, Captain Oesterreich received his commission from the United States Naval Academy in May 1991, graduating with a Bachelor of Science degree in Naval Architecture. He completed the nuclear training pipeline and served aboard USS ARCHERFISH (SSN 678), completing his qualification in Submarines.

Captain Oesterreich attended the Naval Postgraduate School earning a Master of Science degree and Professional Engineer's degree in Mechanical Engineering as well as certification as a Professional Engineer in Mechanical Engineering. Following his graduate studies, he completed the Submarine Officer Advanced Course and served aboard USS OHIO (SSBN-726G) as Engineering Officer until his transfer to the Engineering Duty Officer Community in January of 2003.

Captain Oesterreich next served at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility as the Deputy Project Superintendent for the Refueling Overhaul and Conversion of USS MICHIGAN (SSGN-727).

In November of 2007 he reported to the Director, Fleet Readiness Division (N43), on the Staff of the Chief of Naval Operations (OPNAV) as a Ship and Submarine Readiness Action Officer responsible for Carrier Maintenance Requirements and Fleet Maintenance Requirement Integration. Captain Oesterreich then assumed responsibility as Chief Engineering Officer aboard USS RONALD REAGAN (CVN-76) in December of 2007 completing two deployments in support of Operation Enduring Freedom.

In June of 2010 he reported to the staff of Commander Naval Air Forces Pacific as the Carrier Force Maintenance Officer. Following selection for Captain, he reported to Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility where he served as the Business and Strategic Planning Officer and Production Resources Officer.

In July of 2014 Captain Oesterreich reported to the staff of Commander Naval Air Forces, Atlantic for duty as the Assistant Chief of Staff for Ship Maintenance and Material. One year later he was transferred to the same position at Commander Naval Air Forces Pacific Fleet.

Captain Oesterreich's service decorations include the Legion of Merit, Meritorious Service Medal and various personal, campaign, service, and operational awards.

ANTHONY J. SEBASTO

Executive Director of Enterprise and Systems Engineering Center, US Army ARDEC
ARDEC, Munitions Engineering & Technology Center.

Anthony J. Sebasto was appointed to the Senior Executive Service and named Executive Director for Enterprise and System Integration Center, US Army Armaments Research, Development and Engineering Center effective June 28.

His appointment was announced on June 19 by the Assistant Secretary of the Army for Manpower and Reserve Affairs. Sebasto, currently Senior Associate for Munitions at the Munition Engineering and Technology Center, began his civil service at Picatinny Arsenal in 1983.

He served in a variety of engineering and management positions in support of the research, development and production of small, medium, and large caliber weapon systems for ground and air combat platforms and for the individual soldier.

"I have to thank my many mentors that helped guide me throughout my career, my family for their love and support, and to the entire Picatinny community, both government and private sector, that I have had the honor of working with in achieving many accomplishments in support of the warfighters" said Sebasto.

A graduate of the University of Delaware with a bachelor's degree in mechanical engineering, Sebasto received a master's degree in management from the Florida Institute of Technology. Sebasto is also a graduate of the Senior Executive Program at Harvard University's John F. Kennedy School of Government. He is a member of the Army Acquisition Corp and certified in Engineering, Science and Technology Management, as well as in Program Management.

Sebasto serves as the lead for subterranean/megacities materiel solutions for the US Army Research, Development and Engineering Command.

In his new job, Sebasto will be responsible for guiding and measuring the progress of large, complex integrated product development teams assigned to all services and armament acquisition programs of the Office of the Secretary of Defense.

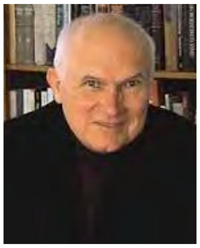
BG ALFRED F. ABRAMSON III, USA

Program Executive Officer Ammunition, Commanding General
Picatinny Arsenal, New Jersey

Brigadier General Alfred F. Abramson III became the Program Executive Officer Ammunition and the Commanding General, Picatinny Arsenal on December 29, 2017, leading the mission to develop and procure conventional and leap-ahead munitions to increase the Warfighter's combat power. Prior to this, BG Abramson served as the Deputy Program Executive Officer Ammunition and Senior Commander Picatinny Arsenal.

BG Abramson was commissioned a Second Lieutenant in the Chemical Corps after graduating from VA State University where he received a Bachelor of Science degree in Chemistry. BG Abramson served in a variety of positions overseas as well as the contiguous United States to include: Battalion Chemical Officer, 6-37th Field Artillery; Smoke Platoon Leader, 172nd Chemical Company; Company Commander, 266th Quartermaster Battalion; Chemical Staff Officer, Project Manager's Office for NBC Defense; Aide-De-Camp, Soldier Biological Chemical Command; Assistant Product Manager, NBC Point Detection; Program Executive Office Liaison Officer, Coalition Forces Land Component Command; Assistant Product Manager, NBC Reconnaissance Systems; Budget Team Chief, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology); Joint Product Manager, Biological Detection Systems; Military Assistant to the Under Secretary of the Army; Joint Project Manager for NBC Contamination Avoidance; Executive Officer for the Principle Military Deputy Assistant Secretary of the Army (Acquisition Logistics, and Technology); and previously served as the Deputy, Joint Program Executive Officer for Chemical and Biological Defense.

His civilian education includes a Master's degree in Chemistry from Johns Hopkins University, a Master's degree in National Security and Strategic Studies from the Naval War College, and a Master's degree in Strategic Studies from the Army War College. His military education includes the Chemical Officer Basic and Advanced Courses, the Combined Arms and Services Staff School, Command and General Staff College, the Advanced Program Management Course, the Senior Service College and Senior Leaders Course.



ROBERT SCALES

Retired MG Robert Scales currently serves as a FOX News Channel (FNC) military analyst. He is president of Colgen, Inc., a consulting firm specializing in issues relating to land power, war gaming and strategic leadership and is one of America's best known and most respected authorities on land warfare. Dr. Scales served over thirty years in the Army commanding two units in Vietnam and winning the Silver Star for action during the battles around Dong Ap Bia (Hamburger Hill) during the summer of 1969. Subsequently, he served in command and staff positions in the United States, Germany, and Korea and ended his military career as Commandant of the United States Army War College. In 1995 he created the Army After Next program which was the Army's first attempt to build a strategic game and operational concept for future land warfare. He has written and lectured on warfare to academic, government, military, and business groups in the United States, Australia, Asia, the Middle East, Europe, and South America. He is the author of two books on military history: Certain Victory, the official account of the Army in the Gulf War and Firepower in Limited War, a history of the evolution of firepower doctrine since the end of the Korean War. In addition, he is an authority on contemporary and future warfare. He was the only serving officer to have written books subsequently selected for inclusion in the official reading lists of three services.

JOHN G. FIORE

Technical Director
NSWCDD

Mr. John G. Fiore is the Technical Director for the Naval Surface Warfare Center, Dahlgren Division (NSWCDD), Dahlgren, VA. He was appointed to the position in July 2016 and has been in the SES since September 2014. In his current role, he is responsible for Dahlgren's technical excellence in executing research, development, test and evaluation, analysis, systems engineering, integration, and certification of complex naval combat, sensor, weapon, and strategic systems associated with surface warfare as well as homeland defense and force protection.

Mr. Fiore was previously the Director for Above Water Sensors in the Program Executive Office for Integrated Warfare Systems (PEO IWS). In this capacity he oversaw the planning, development, acquisition, testing, and sustaining of cost-effective warfare systems for US Navy surface ships and submarines. Additionally, Mr. Fiore was the Chief Technology Officer for PEO IWS. He spearheaded the constantly-evolving transition of new naval capabilities and technologies into more than 150 Programs of Record.

Mr. Fiore began his career at the Naval Surface Warfare Center Philadelphia Division (NSWCPD) in Philadelphia, PA., where he held a series of progressively challenging positions culminating in his assignment as the first Deputy Program Manager for Smartship in 1998. After leaving NSWCPD, Mr. Fiore held key leadership positions at the National Geospatial Intelligence Agency (NGA) as Deputy Program Manager for Imagery Continuity of Operations (ICOOP), the US Navy's Office of Technology Development Support as the Chief Engineer for an advanced airborne intelligence, surveillance, reconnaissance, and targeting sensor, and as the acting Deputy Program Executive at the Aegis Ballistic Missile Defense (BMD) organization where he shared responsibility with the Program Executive for oversight of all Aegis BMD programs.

DR. DAVID E. LAMBERT

Chief Scientist
Munitions Directorate, Air Force Research Laboratory, AFRL, Eglin Air Force Base

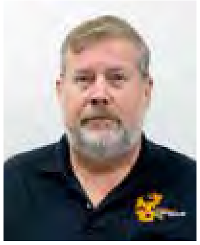
Dr. David E. Lambert is a scientific senior executive currently serving as the Chief Scientist, Munitions Directorate, Air Force Research Laboratory (AFRL/RW), Eglin Air Force Base, FL. He serves as the principal scientific and technical advisor to the director and is the primary authority for the technical content of the directorate's science and technology portfolio. The Munitions Directorate consists of a staff of more than 600 military, civilian and contracted professionals pursuing the discovery, development and integration of affordable conventional air-launched weapon technologies for the US Air Force.

Dr. Lambert has served over 32years in DoD civil service in a variety of technical positions. He earned his Bachelors of Science from Florida State University (FSU) and Masters and PhD from the University of Florida (UF). In 2011 he was recognized as an AFRL Fellow and has earned honors as Distinguished Alumnus from FSU Mechanical Engineering Dept, Distinguished Alumnus lecturer from UF Mechanical and Aerospace Engineering Dept, and Leroy Collins Distinguished Graduate from Northwest Florida State College.

JAMES O'BRYON

CEO
The O'Bryon Group

James O'Bryon has over 40 years of technical experience serving with the DoD including 15 years as Deputy Assistant Secretary of Defense (Live Fire Testing), as well as, currently, the CEO of The O'Bryon Group. Prior to his work at the Pentagon, he served as Chief, Combat Survivability in AMSAA, Aberdeen, MD as well as a mathematician at the Ballistics Research Laboratories (now ARL) for over 10 years on aeroballistics and fire-and-forget weapons. He has testified before the Congress several times testifying on Weapons Acquisition, Test and Evaluation, Directed Energy Systems, and Aviation Security, He has a mathematics degree from The King's College, and graduate degrees from George Washington University and MIT in Systems Analysis and Electrical Engineering respectively. He retired from the Pentagon shortly after the 9/11 attack and formed The O'Bryon Group which contracts with DoD, DHS, IDA, SURVICE Engineering, CSC and other defense-related organizations. Since his retirement from OSD, he has taught over 60 short courses on Live Fire Testing to DoD and industry partners across America. He is also a National Board Member of NDIA and served 21 years as Chair of the T&E Division. Jim has also worked as a radio announcer and talk show host at radio stations in Indiana and Maryland, written 2 books and has also released 4 music albums. He is currently listed in Who's Who in the World.



DAN SHEA

General Director
Phoenix Defense

E. Daniel Shea is a US Army veteran (Combat Engineers) and for over 40 years in the defense industry has been heavily involved in military small arms and defense contracting. Dan is a certified government expert on small arms, and a Master Armorer certified as an armorer instructor on the following weapon systems: M16 series, AK47 series, M203, GP25, M249/MK46, M240, M60 series, M2HB, NSV, PKM, DShK, KPVT, RPG7, Carl Gustav M3 84mm, AGS-17/BGA-30, MK19, M134 Minigun, most shoulder-fired or tripod-mounted weapon systems, as well as most suppressor systems. Dan designed and implemented the 1997 and 1999 Suppressor trials using cutting-edge equipment to quantify the sound results. Due to this extensive experience, he is frequently contracted to supervise MILSPEC testing of new weapons systems.

Dan is the National Defense Industrial Association's 2017 Colonel George M. Chinn Awardee and has been on the NDIA Steering Committee since the early 1990s, as well as being the Editor-in-Chief and Technical Editor of Small Arms Defense Journal, Small Arms Review, the old Machine Gun News and many technical books on firearms, and has written over 1100 technical articles on firearms. For almost 40 years, he was the founder and General Manager of the now closed Long Mountain Outfitters, is currently the General Director of Phoenix Defense, an armorer training and weapons supply company.

Dan's licensing includes manufacturing, importing and exporting of firearms including machine guns, silencers, and destructive devices, as well as international arms brokering. He has been to over 80 countries actively dealing in arms and munitions and studying historical weapons and current threats.

SAVE THE DATE

9TH ANNUAL INTEGRATED AIR AND MISSILE DEFENSE SYMPOSIUM

July 12, 2018

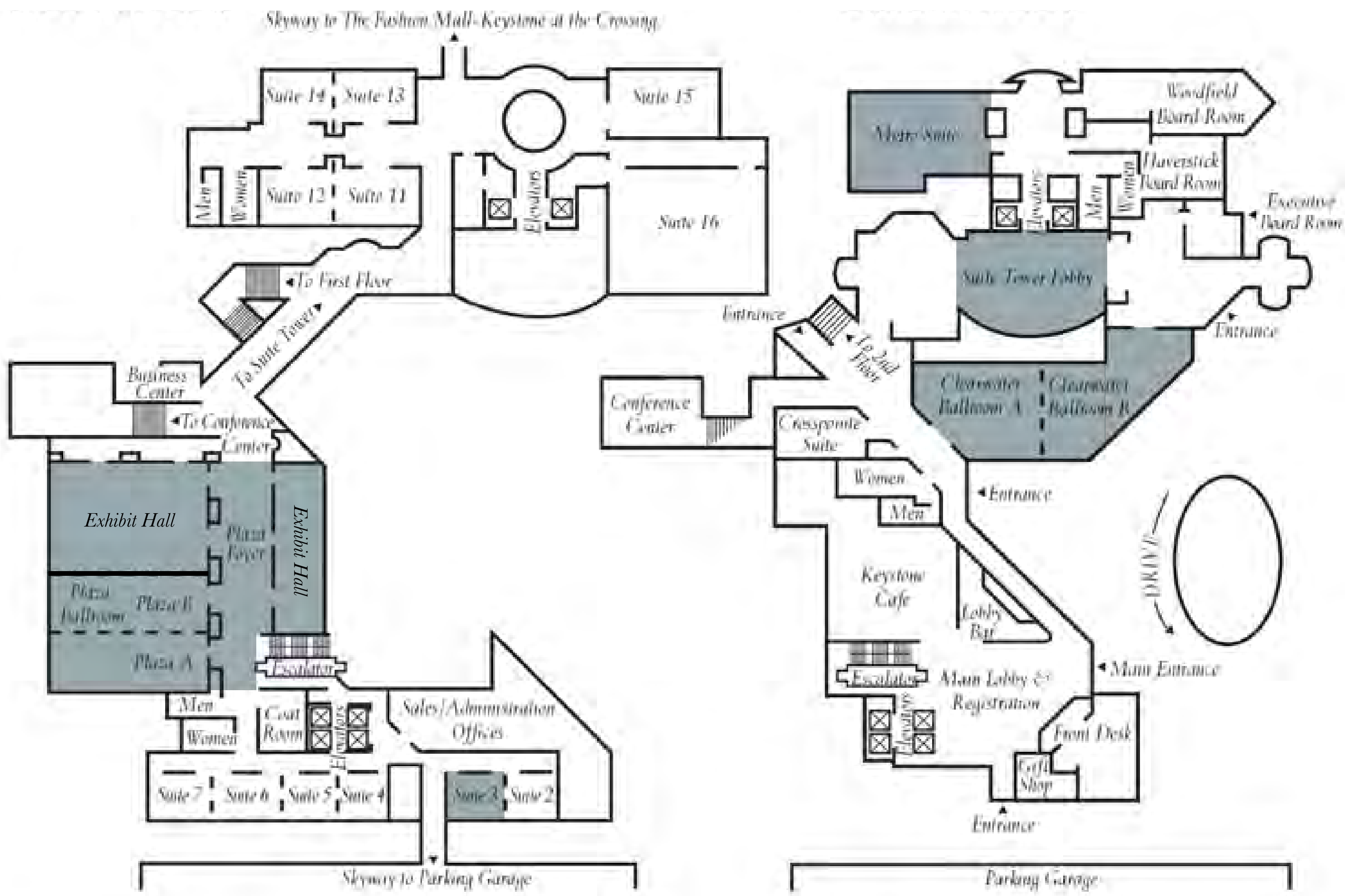
The Johns Hopkins University Applied Physics Laboratory

Laurel, MD

NDIA.org/IAMD18

VENUE MAP

2^{ND} FLOOR **GROUND FLOOR**



SAVE THE DATE

INTERNATIONAL EXPLOSIVES SAFETY SYMPOSIUM & EXPOSITION

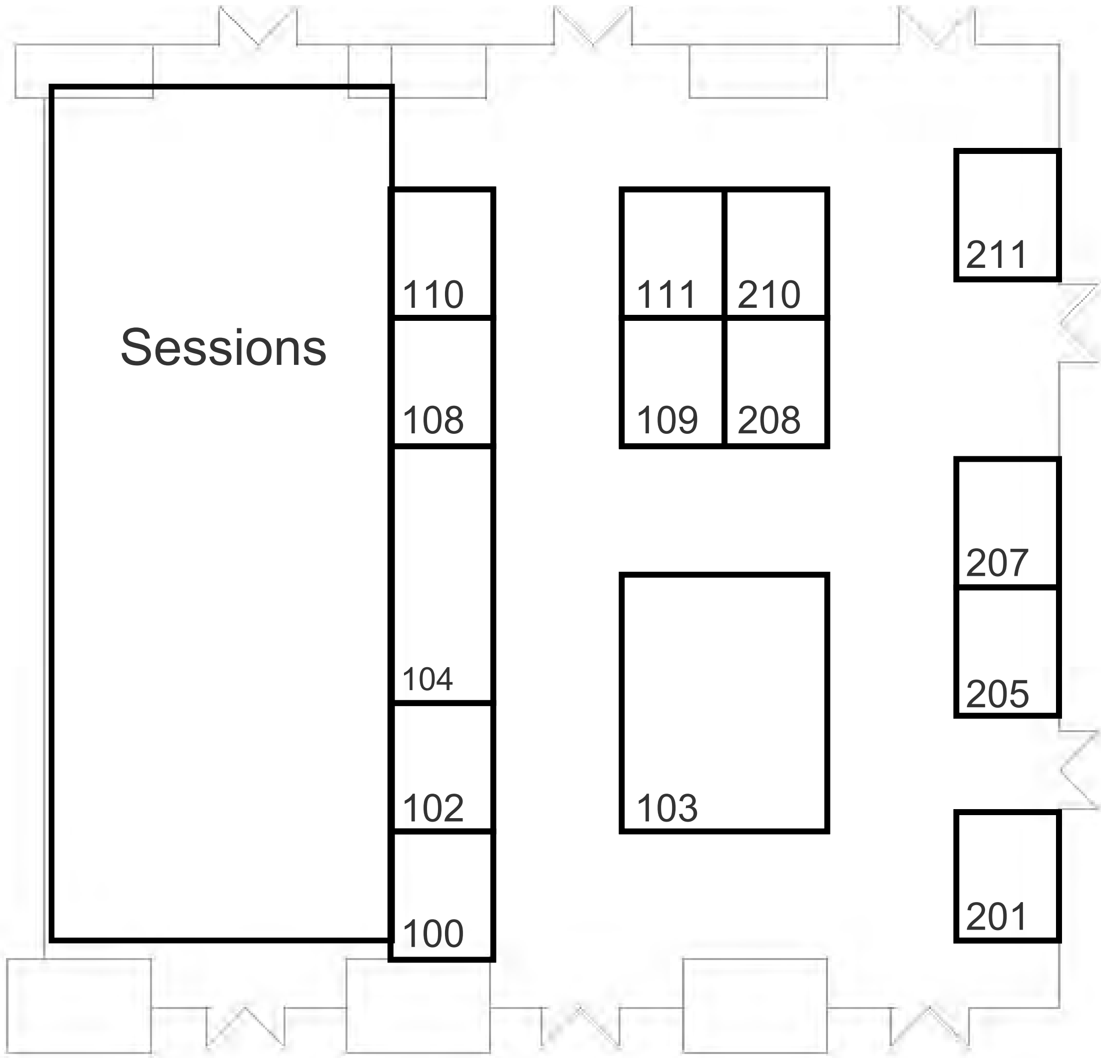
August 6 – 9, 2018

Sheraton San Diego Hotel & Marina

San Diego, CA

NDIA.org/Intl-Explosives-Safety

EXHIBITOR MAP



ENTRANCE

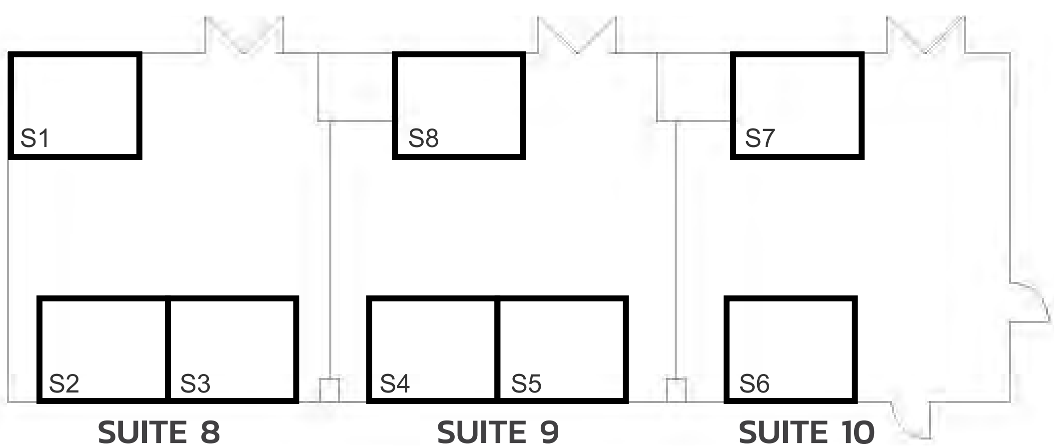


EXHIBIT HALL HOURS

TUESDAY, MAY 8
8:30 am – 7:00 pm

WEDNESDAY, MAY 9
8:30 am – 3:45 pm

EXHIBITORS BY COMPANY

As of 4/26/18

Company	Booth
Aimpoint Inc	110
ARDEC	S5
Arrow Tech Associates	102
Barrett	207
CBC	210
Detroit Gun Works	S1
FN America, LLC	S3
General Dynamics - OTS	103
Glock, Inc	111
Heckler & Koch Defense	208
Kistler Instrument Corp	109
Lancer Systems	205
LINSUN INDUSTRIAL GROUP	100
National Armaments Consortium	104
NDIA Chapters	S6
Orbital ATK	211
Secubit	108
Small Arms Defense Journal	S4
Sturm, Ruger	201
Textron Systems	S8
U.S. Army RDECOM	S5
USAF AFRL	S2
Wilcox Industries	S7

EXHIBITORS

AIMPOINT INC. 110

For over 40 years, Aimpoint has been the world leader in design and manufacture of electronic red-dot sighting systems. Soldier tested and combat proven – don't settle for anything less.

ARDEC S5

Based at Picatinny Arsenal, NJ and Aberdeen Proving Ground, MD (respectively), the Armament RDE Center (ARDEC) and Army Research Laboratory (ARL) provide critical research and underpinning technologies that support armament developments for Soldier weapons, ground combat vehicles, aircraft, mortars, and field artillery. ARDEC and ARL pursue this mission through interactions and collaboration with partners in government, industry, and academia and through a robust internal research and development capability.

ARROW TECH ASSOCIATES 102

Arrow Tech Associates is a small Non traditional contractor located in South Burlington VT specializing in ammunition design including exterior, interior ballistics, trajectory simulation and reconstruction, test data analysis, structural analysis and design (interior balloting, case chamber interaction, sabot design), Guidance, Navigation and Control, Hardware in the Loop (HIL) Development, Truth Modeling (Firing Tables and Fire Control) along with Technical and Program Management.

BARRETT 207

Headquartered in Tennessee, Barrett is the world leader in large-caliber rifle design and manufacturing. Our products are used by law enforcement agencies, the United States military and more than 73 State Department approved countries in the world. It's one thing to manufacture guns, and another to live and breathe them. Whether we're carefully assembling our latest rifle or increasing the velocity and precision of the ammunition itself - we're always working for absolute perfection.

CBC 210

CBC is one of the largest ammunition manufacturers in the world, focused on the production of small and medium calibers, since 1926. Its wide range of products is exported to over 130 countries and attends to the needs of military, law enforcement and commercial markets. CBC offers the most comprehensive range of handgun and rifle cartridges in the industry, including complete families of military calibers such as 5.56x45mm, 7.62x51mm, 12.7x99mm (.50), 20mm, 30mm and 40mm.

DETROIT GUN WORKS S1

Detroit Gun Works (DGW) is a world-class contract manufacturer of precision engineered Weapons components. DGW manufactures quality machined parts for Weapons OEM's and Military Defense Contractors. DGW is ISO 9001 certified; an 07 Federal Firearms Licensee; and maintains an SOT to manufacture Class III components.

FN AMERICA, LLC S3

The World's Most Battle-Proven Firearms™ - FN America, LLC is a wholly-owned subsidiary of FN Herstal, S.A. and is a leader in the development and manufacturing of high quality, reliable firearms for military, law enforcement and consumers in the US Headquartered in McLean, VA with manufacturing operations in Columbia, SC, FN is passionately committed to providing its customers with a portfolio of products, training and support services that enhance their performance and safeguard their lives. For more information, visit www.fnamerica.com.

GENERAL DYNAMICS – OTS 103

General Dynamics Ordnance and Tactical Systems manufactures large-, medium- and small-caliber direct and indirect-fire munitions; and is a leader in the development and production of lightweight tactical vehicles, weapons and armament systems. The company also produces propellants and non-lethal and force-protection products. More information about General Dynamics Ordnance and Tactical Systems is available online at www.gd-ots.com.

GLOCK, INC. 111

GLOCK is a leading global manufacturer of firearms. GLOCK's polymer-based pistols revolutionized the firearms industry, making GLOCK pistols a favorite among military and LE agencies worldwide. In 2016, GLOCK celebrates its 30th Anniversary in the US Renowned for featuring three safeties, GLOCK pistols offer users confidence they can rely on.

HECKLER & KOCH DEFENSE 208

HECKLER & KOCH is the world's premier small arms systems company and a major supplier to the commercial market, global military and federal law enforcement agencies. An innovative leader in design and manufacturing, HECKLER & KOCH provides technologically advanced firearms, logistical support, training and specialized services with the highest standards of innovation and reliability.

KISTLER INSTRUMENT CORP 109

Kistler will exhibit its full line of piezoelectric sensors including dynamic ballistic pressure sensors for various ballistics applications, along with high g accelerometers for recoil, high vibration and shock applications. The 6217A ballistics pressure sensor in a high sensitivity 2000 bar (30 kpsi) measuring range is our featured product; an ideal sensor for mortars, grenade launchers, flare guns, side air bag and more. We will have a new ballistics analyzer with complete software demos.

LANCER SYSTEMS 205

Lancer Systems is a material and engineering company. Applying our expertise in advanced polymers and lightweight component designs, Lancer created the L5 and L7 Advanced Warfighter Magazines. These hybrid magazines comes in either translucent or opaque. Complete weapon systems are available along with carbon fiber handguards and other accessories that meet the needs of today's most discerning shooters. For more information, please visit www.lancer-systems.com or call 610.973.2600

LINSUN INDUSTRIAL GROUP 100

Visit Linsun Industrial Group and see demonstrations of the worlds only bioremediating SMARTWASHER from Chemfree. Experience the health, safety and environmental benefits with no VOC's, nonhazardous, non-flammable, never dump, parts-washing fluid. Smartwashers are designed to preform harsh military weapons cleaning applications. All the Smartwasher process components are available in the DOD NSN system and on GSA Advantage, and GPC's are accepted. Protection and procurement made easy.

NATIONAL ARMAMENTS CONSORTIUM 104

Since 2000, the National Armaments Consortium (NAC) has served as the Department of Defense Ordnance Technology Consortium's (DOTC) industry partner. Our robust, transparent, and unique collaboration approach, once considered a novel and unrealistic concept, has evolved into a well-established process through which our DoD stakeholders acquire the innovative Armament technologies needed to maintain US technological superiority.

NDIA CHAPTERS S6

Indiana, Iowa, Great Lakes and Michigan

ORBITAL ATK 211

As a global leader in aerospace and defense technologies, Orbital ATK designs, builds and delivers space, defense and aviation-related systems to customers around the world both as a prime contractor and as a merchant supplier. Our main products include launch vehicles and related propulsion systems; satellites and associated components and services; composite aerospace structures; tactical missiles, subsystems and defense electronics; and precision weapons, armament systems and ammunition.

SECUBIT 108

Secubit's solution combines three integrated technological components: The revolutionary WeaponLogic Smart Counter, a powerful handheld Reader and a centralized Dashboard and analytics system. Together, they provide a comprehensive new analytical approach for effective weapon management and maintenance. Monitor Weapon AND Operator. Waterproof. Battery life of 10 years Future integration with NETT Warrior, Real -Time Track weapon performance Rugged MIL-STD-810G compliant mobile reader

SMALL ARMS DEFENSE JOURNAL S4

Chipotle Publishing, LLC is home to Small Arms Defense Journal, Small Arms Review, and www.SmallArmsReview.com. Distributed at defense trade shows worldwide, Small Arms Defense Journal is a bimonthly publication that focuses on small arms, accessories, soldier gear, new products, industry news, and defense trade show reviews. Small Arms Review is a 10 issue publication. Our purpose is to provide a forum for all Class 3 interests, as well as any aspect of the military small arms industry.

STURM, RUGER 201

Sturm, Ruger & Co., Inc. is one of the nation's leading manufacturers of rugged, reliable firearms for the commercial sporting market, military and law enforcement. As a full-line manufacturer of American-made firearms, Ruger offers consumers over 400 variations of more than 30 product lines. For more than 60 years, Ruger has been a model of corporate and community responsibility. Our motto, "Arms Makers for Responsible Citizens®," echoes our commitment to these principles.

TEXTRON SYSTEMS S8

Textron Systems' businesses develop and integrate products, services and support for aerospace and defense customers, as well as civil and commercial customers including those in law enforcement, security, border patrol and critical infrastructure protection around the globe. Harnessing agility and a broad base of expertise, Textron Systems' innovative businesses design, manufacture, field and support comprehensive solutions that expand customer capabilities and deliver value.

U.S. ARMY RDECOM S5

Based at Picatinny Arsenal, NJ and Aberdeen Proving Ground, MD (respectively), the Armament RDE Center (ARDEC) and Army Research Laboratory (ARL) provide critical research and underpinning technologies that support armament developments for Soldier weapons, ground combat vehicles, aircraft, mortars, and field artillery. ARDEC and ARL pursue this mission through interactions and collaboration with partners in government, industry, and academia and through a robust internal research and development capability.

USAF AFRL S2

WILCOX INDUSTRIES S7

Wilcox is an industry leader in the design and manufacture of high quality tactical equipment for use by military and law enforcement in the United States. Making tactical products that have a reputation for quality and toughness is what Wilcox is committed to. Wilcox works toward finding solutions to the technology shortfalls that military and law enforcement encounter. With over 35 years of experience in manufacturing Wilcox has become known as a proven performer.

NOTES

SAVE THE DATE

WARHEADS AND BALLISTICS CLASSIFIED SYMPOSIUM

July 30 - August 2, 2018

Naval Postgraduate School

Monterey, CA

NDIA.org/WarheadsBallistics18

Always a Step Ahead
ARDEC
ARMAMENTS

2018 NDIA Armament Systems Forum

Presented by:
Mr. Anthony Sebasto, SES
Executive Director
Enterprise and Systems Engineering Center
RDECOM ARDEC

UNPARALLELED COMMITMENT & SOLUTIONS
Act like someone's life depends on what we do.

U.S. ARMY

U.S. ARMY RDECOM

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER

U.S. ARMY RDECOM

Alignment to Army Modernization Strategy

ARDEC

Long Range Precision Fires

Next Gen Combat Vehicle

Future Vertical Lift

Network

Air & Missile Defense

Soldier Lethality

- Armaments are central to the Army's Modernization Strategy focus
- RDECOM-ARDEC's portfolio is fully aligned to the Modernization Priorities, either directly or as enablers
- The key to innovation is collaboration between:
  - Government entities
  - Businesses
  - Non-traditional contractors
  - Academia

Modular Handgun System (MAR 18)

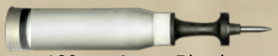
XM1152/XM1153 9MM Ball & Special Purpose Cartridge (MAR 18)

M3 MAAWS (OCT 15)

M104 Non-Lethal Grenade (SEP 16)

XM395 120mm High-Explosive Guided (APR 16)

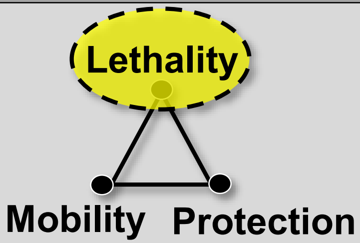
M1156 PGK (DEC 15)



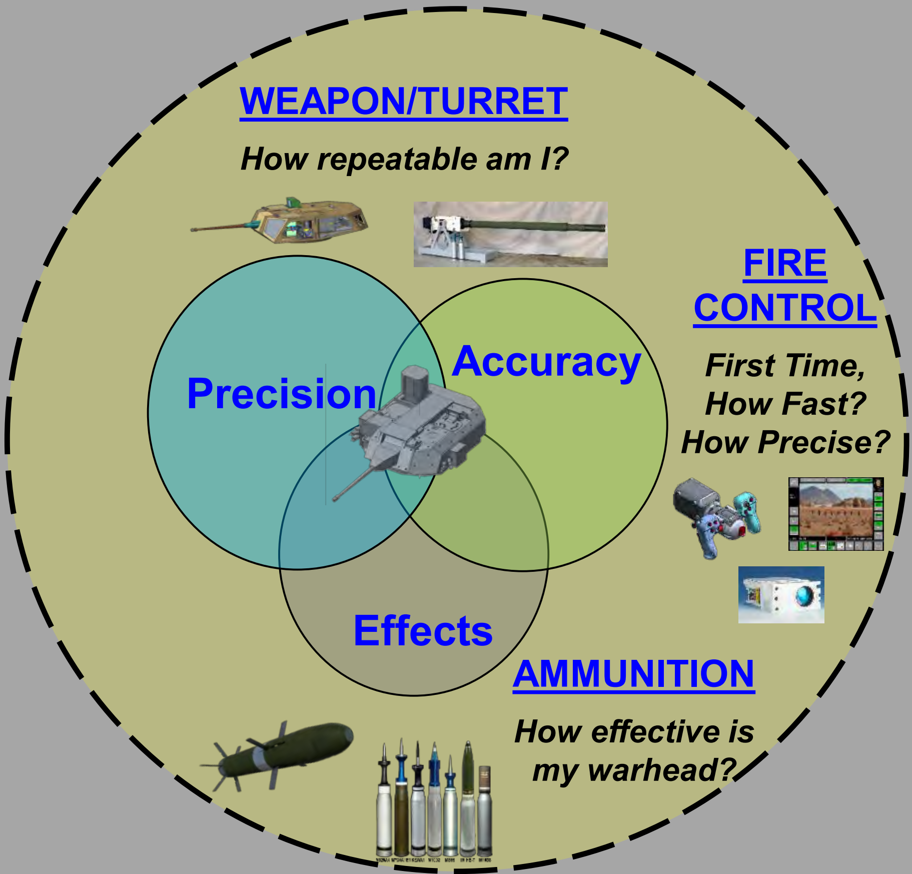
120mm Armor Piercing w/ Tracer (MAY 16)

Our Community has enabled the fielding of 262 new Ammunitions, Weapons and Equipment since 9/11

COMBAT ARMAMENT SYSTEMS



The Armament System is central to all Combat Platforms in order to Eliminate Threats/Targets.



Combat Platform Integration

Threats/Targets

U.S. ARMY RDECOM

ARMAMENT STRESSING THREATS

ARDEC

NEXT GENERATION COMBAT VEHICLE

- GROUND VEHICLES
- ROCKET, ARTILLERY, MISSILES (RAM)
- SMALL ARMS/SHOULDER FIRED
- EXPLOSIVE HAZARDS
- OBSTACLES/BARRIER/ TUNNELS

FUTURE VERTICAL LIFT

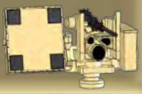
- INTEGRATED AIR DEFENSE (IADS)
- ROCKET, ARTILLERY, MISSILES (RAM)
- SMALL ARMS/SHOULDER

NETWORK

- ELECTRONIC WARFARE (EW)
- CYBER (OFFENSIVE)

AIR AND MISSILE DEFENSE

- INTEGRATED AIR DEFENSE (IADS)
- ROCKET, ARTILLERY, MISSILES (RAM)
- AIR SYSTEMS
- UNMANNED SYSTEMS (AERIAL)



SOLDIER LETHALITY

- SOLDIER PERSONAL PROTECTION EQUIPMENT
- SMALL ARMS/SHOULDER FIRED
- HAND GRENADES
- UNMANNED SYSTEMS
- EXPLOSIVE HAZARDS
- OBSTACLES/ BARRIERS/TUNNELS

LONG RANGE PRECISION FIRES

- INTEGRATED AIR DEFENSE SYSTEMS (IADS)
- ROCKETS, ARTILLERY, MORTARS (RAM)
- MISSILES

TOP ARMAMENT NEEDS

- Higher pressure/lower wear weapon technologies across all platforms
- Extended range projectile technologies
- Novel warhead materials
- Power sources for indirect fire precision munitions
- Artificial intelligence enabled weapon fire control that reduces engagement time from target acquisition to trigger pull
- Advanced small caliber ammunition
- Drone defeat munitions fired from fielded systems
- Lightweight, high strength materials to armament guns and mounts
- Novel recoil mitigation approaches to facilitate greater lethality on lighter platforms, both manned and unmanned

ENABLING*

(ACROSS ALL CFTS)

- SENSORS
- DENIAL/DECEPTION
- CHEMICAL, BIOLOGICAL, RADIOLOGICAL, NUCLEAR (CBRN)
- ELECTRONIC WARFARE (EW)
- CYBER OFFENSIVE

KEY TAKEAWAYS

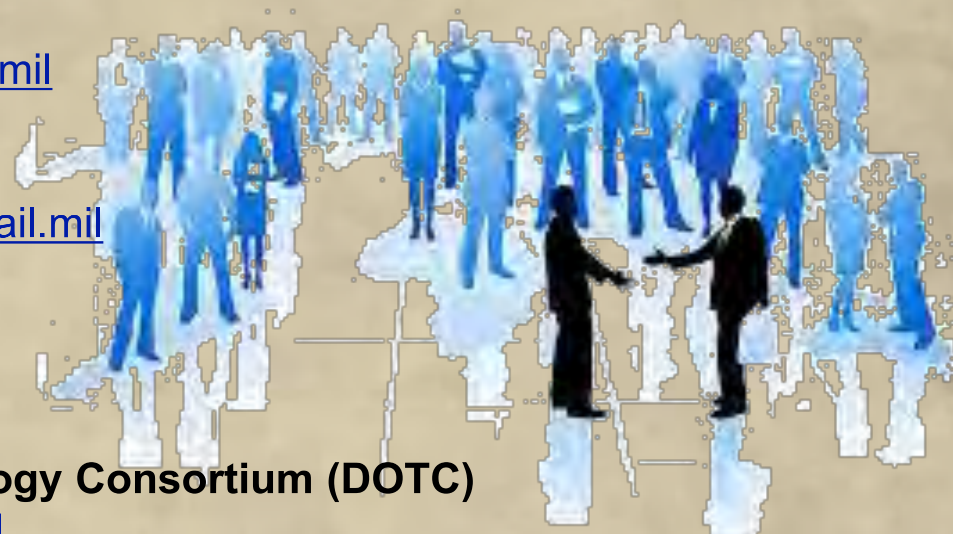
- Armaments are central to all Combat
- Need to combine threat based with capability based planning
- To gain back overmatch, we must focus on the threat early in the development of capabilities
- Through teaming, the armaments community will continue to win the Army's wars as we have done for many years

U.S. ARMY RDECOM

Teaming with ARDEC

ARDEC

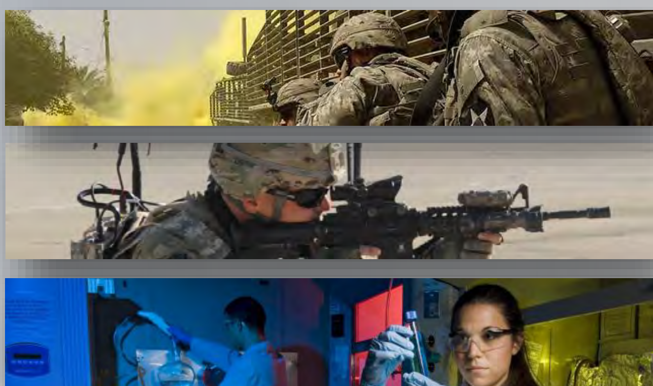
- **Science & Technology**
  POC: Joseph Pelino, joseph.pelino.civ@mail.mil
- **Cooperative R&D Agreements (CRADAs)/Patent Licenses/Testing Services/Engineering Services**
  POC: Timothy Ryan, timothy.s.ryan.civ@mail.mil
- **IR&D Technical Interchange**
  POC: Timothy Ryan, timothy.s.ryan.civ@mail.mil
- **Small Business Innovation Research**
  POC: Sheila Speroni, sheila.c.speroni.civ@mail.mil
- **International Cooperation**
  POC: Lu Ting, lu.c.ting.civ@mail.mil
- **Department of Defense Ordnance Technology Consortium (DOTC)**
  POC: Don Geiss, donald.a.geiss.civ@mail.mil



…..Continued Dialog to Leverage Collaboration Opportunities

Army Science & Technology

The Army Science & Technology Program



Michael Holthe
Director for Lethality
Office of the Deputy Assistant Secretary of the Army
Research and Technology

8 May 2018

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DESIGN • DEVELOP • DELIVER • DOMINATE
SOLDIERS AS THE DECISIVE EDGE

Army Modernization Priorities

SECRETARY OF THE ARMY
WASHINGTON

29 SEP 2017

MEMORANDUM FOR THE DEPUTY UNDER SECRETARY OF THE ARMY

SUBJECT: Science and Technology Portfolio Realignment

1. The August 2017 senior leader review of the Fiscal Year 19-23 Program Objective Memorandum determined that the investment portfolio does not fully support the Army's new modernization priorities:

   a. Precision Fires

   b. Next Generation Combat Vehicle (NGCV)

   c. Future Vertical Lift (FVL)

   d. Network/Command, Control, Communications and Intelligence (C3I)

   e. Air and Missile Defense (AMD)

   f. Soldier Lethality

2. To maximize effectiveness for the Warfighter, the Army must immediately review the fiscal year 2018 (FY18) and FY19 investments to ensure the investments align with the new priorities—realigning what can be changed in the investment portfolio for FY18 budget and FY19 program to better support the six modernization priorities.

3. Roadmaps and metrics will be developed for the evaluation of the investment portfolio to allow for reallocating resources when a program does not deliver the needed outcome.

4. I expect the Army Staff and Secretariat, to include the organizations to whom a copy of this memorandum has been furnished, to support this important endeavor.

5. The Deputy Under Secretary of the Army will oversee these efforts and will provide bi-weekly updates to the Under Secretary of the Army and Vice Chief of Staff of the Army.

Ryan D. McCarthy

Ryan D. McCarthy
Acting

DISTRIBUTION:
(see next page)

Army S&T Investments by Priority

PB19 - $13.7B (FY19-23)

Management Support
Classified; Technical Information Activities
$116M, 1%

Maturation
Technology Maturation Initiatives; Manufacturing Technology

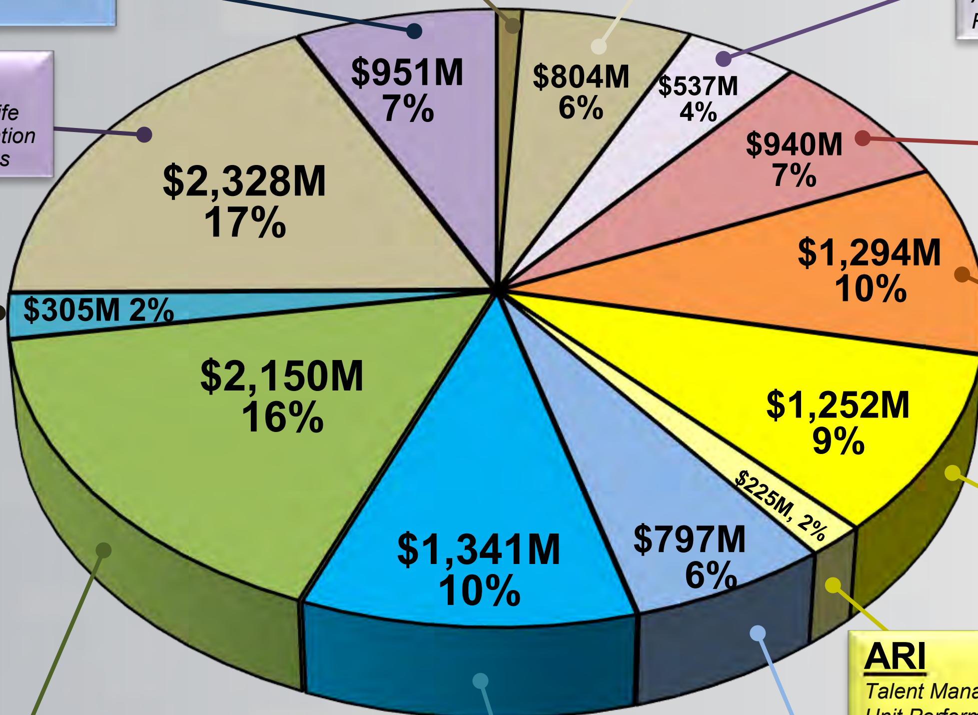
Air and Missile Defense
Smaller & Cheaper Missiles
High Energy Lasers
Gun Based C-Tactical & Small UAS
Advanced Seekers
Advanced Energetics & Propulsion
Radars

HPCMP
High Performance Modernization Program (DoD)

Basic Research
Materials Science; Medical/Life Sciences; Quantum / Information Science; Autonomy; Networks

Long Range Precison Fires
Propulsion for Extended Range Missiles
Extended Range Cannon Artillery
Enhanced Guidance / Navigation for Weapons
Advanced Energetics
Advanced Warheads for Cluster Munitions
Radars

Enabling
Anti-Tamper
Atmospheric Modeling
Logistics Planning R&D
Structural Hardening
Breaching Technologies
Components
Maneuver in Complex Environments



Network/C3I
Tactical Communications
Mission Command
Cyber Electromagnetic Activities
Assured Position, Navigation & Timing
Persistent ISR

Soldier/Lethality
Soldier & Squad Weapons
Training
Soldier Protective Equip
Situational Awareness
Physical/Cognitive Performance
Prolonged Field Medical Care

ARI
Talent Management
Unit Performance and Cohesion
Integrated Assessments

Next Generation Combat Vehicle
Next Gen Combat Vehicles Design
Vehicle Protection Against Advanced Threats
Advanced Power Generation and Distribution
AI, Robotics and Autonomy for Logistics & Combat Ops
Advanced Energetics & Direct Fire Weapons Systems

Future Vertical Lift
Platform Development and Demonstration
Next Generation Unmanned Aircraft System Technologies
Aviation Protection / Aircraft Survivability
Situational Awareness
Integrated Mission Systems
Advanced Power Systems

Medical
Combat Casualty Care, Infectious Disease mitigation, clinical/rehabilitative medicine

Army Investments	FY19-23
BA1	$2,328M
BA2	$4,767M
BA3	$5,290M
BA4	$522M
BA7	$301M

BA6 $155M, Procurement $350M

Version: 26 Jan 2018

Long Range Precision Fires

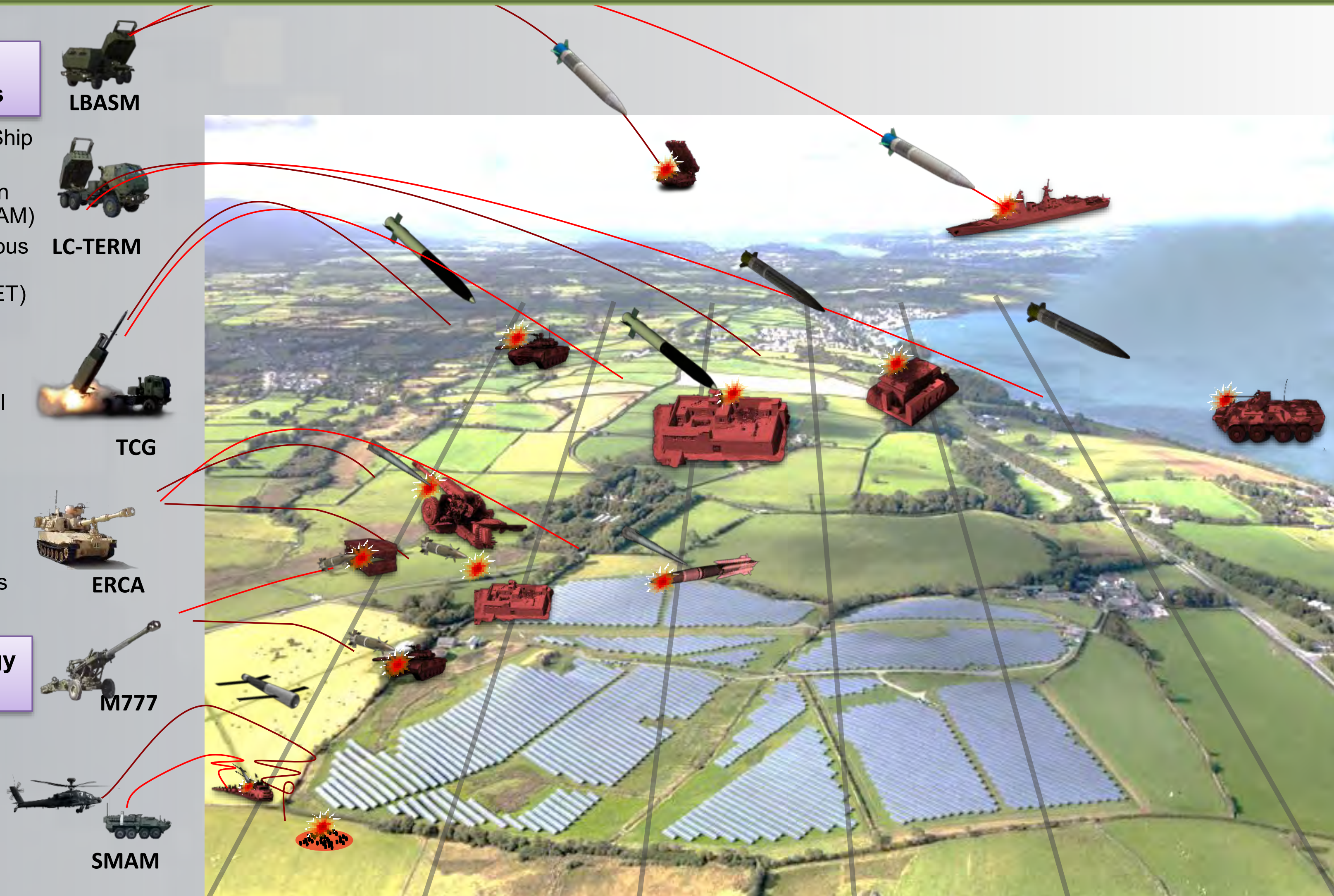
Goal: Provide extended range allowing an increased capability to support maneuver and counter enemy long-range systems.

Technology Demonstrations

- Land-Based Anti- Ship Missile (LBASM)
- Single Multi-mission Attack Missile (SMAM)
- Multiple Simultaneous Engagement Technologies (MSET)
- Extended Range Cannon Artillery (ERCA)
- Low Cost – Tactical Extended Range Missile
- Cluster Munition Replacement Technologies
- Long Range Maneuverable Fires (LRMF)

Critical Technology Areas

- Extend Range
- Expand Coverage
- Enable Cross-domain Maneuver



Land-Based Anti-Ship Missile (LBASM)

Payoff:

- Cross-domain Fires: enables Multi- domain Battle through the projection of power from land into the maritime domain
- Tier One CNA16 Capability Gap 501343 (High Risk): capability to engage, & defeat surface targets located in littoral waters up to 499km range
- Tier One CNA16 Capability Gap 550083 (Extremely High Risk): capability to destroy enemy air defenses

Purpose:

- Adapt Army and Marine Corps HIMARS and MLRS rocket and artillery systems to provide a Defeat of Enemy Air Defense (DEAD) capability against land- and maritime-based targets

Products:

- Development and demonstration of appropriate sensor, datalink, and payload component technologies for engaging and defeating land- and maritime-based ADA
- Integration of these component technologies into prototype missile hardware and demonstration of this hardware in a relevant flight environment
- Provides evidence for the feasibility of adapting existing Army and Marine Corps GMLRS and HIMARS systems for offensive anti-ship warfare
- Provides a basis for cost-capability trades for an objective system

Next Generation Combat Vehicle

Goal: Provide an experimental Prototype in FY 20 for Soldier evaluation.

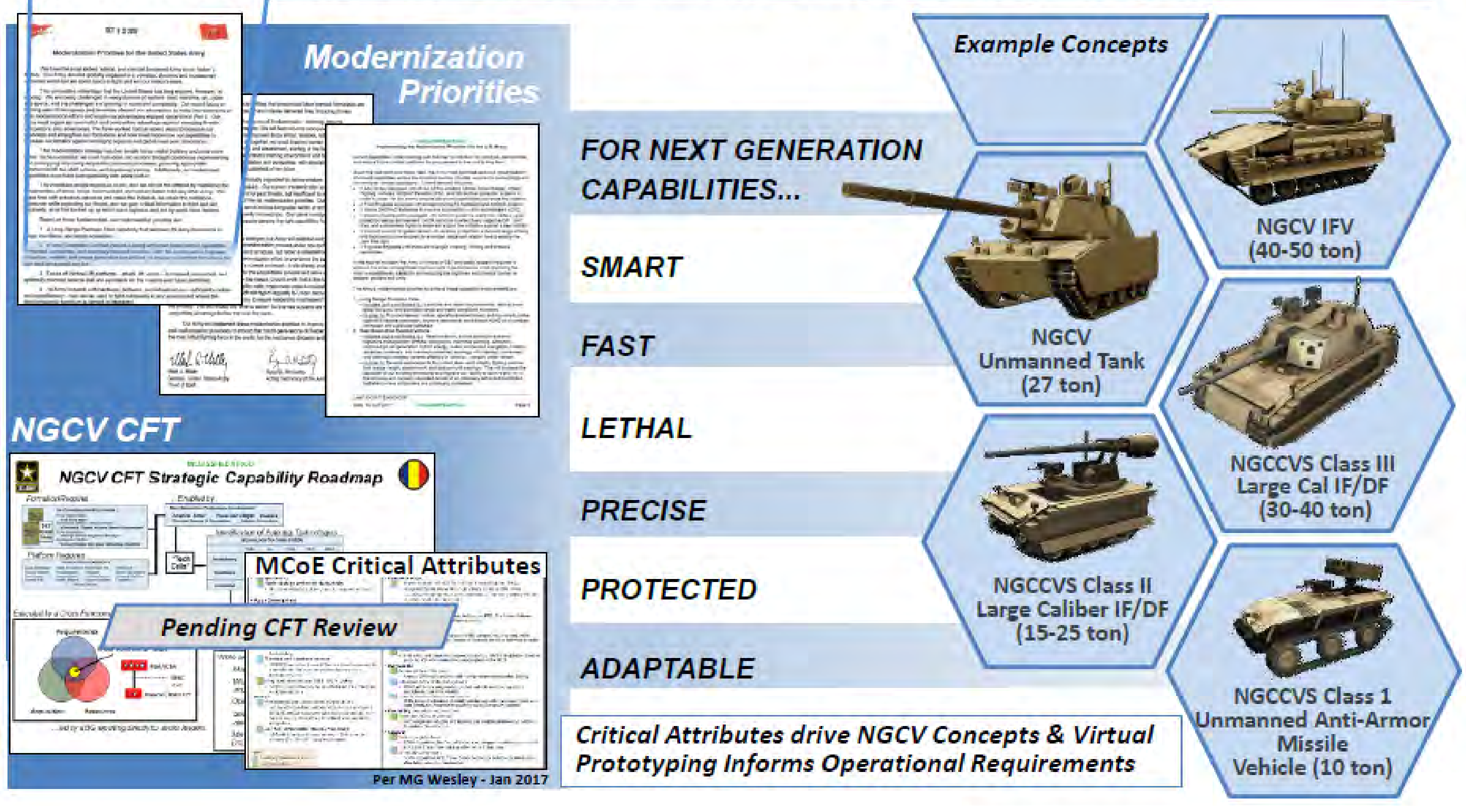
Technology Demonstrations

- Combat Vehicle Robotics (CoVeR)
- Robotics for Engineer Operations
- Ground System Active Defense (GSAD)
- Advanced Powertrain Demonstrator
- Advanced Lethality & Accuracy System for Medium Caliber (ALAS-MC)
- Extended Line of Sight (ELoS)

Critical Technology Areas

- Maneuver Robotics and Autonomous Systems
- Directed Energy & Energetics
- Power Generation & Management
- Advanced Armor
- Vehicle Protection Suites

"A Next Generation Combat Vehicle - along with other close combat capabilities in ***manned, unmanned, and optionally-manned*** *variants - with the most* ***modern firepower, protection, mobility, and power generation capabilities****, to ensure our combat formations can fight and win against any foe."*



Ground System Active Defense

Multi-Threat Domain and Changing Operational Environment

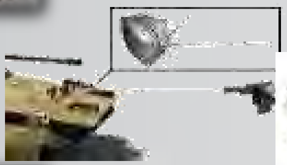
Hard-Kill

Soft-Kill

Active Blast Defeat

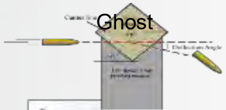
Active Physical & Electronic Defeat

Active Interior Technology



Multi-Spectral Laser Protection

Top Protection



Ghost

Blink

Adaptive Armor

Active Survivability Subsystems and Effectors

Develop active survivability subsystems and effectors which sense, track and respond to neutralize threat prior to terminal effects. System leverages common architecture to provide threat defeat redundancy and layered survivability to optimize protection with reduced weights.

Pre-shot Detection/ Revenge Kill

Active Physical, Electronic Defeat; Mechanical Ctr Measures; Adaptive Interior Protection, Adaptive Armor

Future Vertical Lift

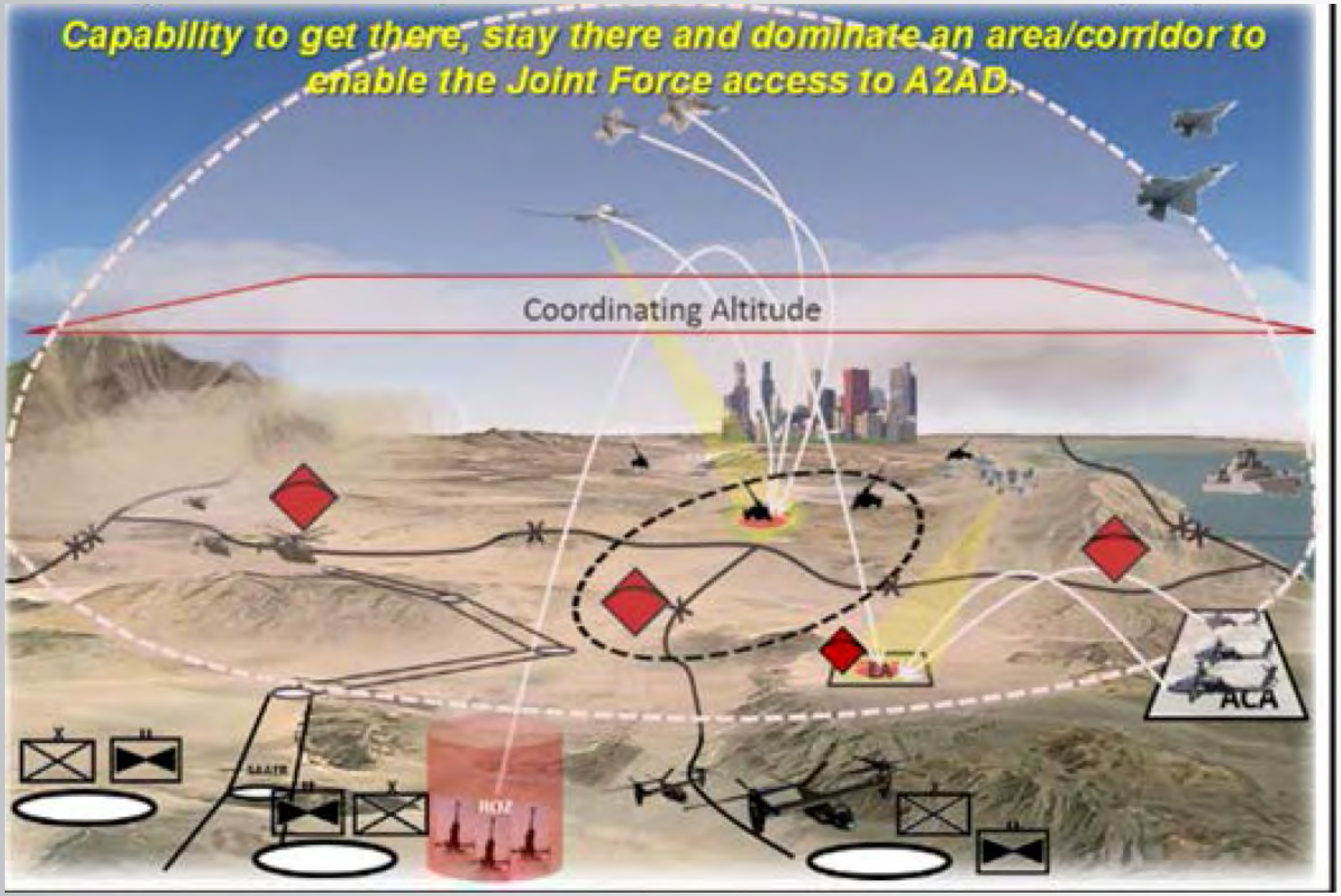
Goal: Close selected Army capability gaps and rapidly deliver 5th Gen rotorcraft to the Army.

Technology Demonstrations

- Joint Multi-Role Technology Demonstrator
- Degraded Visual Environment-Mitigation
- Next Generation Tactical UAS Tech Demonstrator
- Alternative Concept Engine
- Next Gen Rotorcraft Transmission
- Integrated Mission Equipment
- Modular Missile Technology
- Multi-Role Small Guided Missile
- Advanced Rotorcraft Armaments Protection System

Critical Technology Areas

- Expanded Reach & Protection during Movement of Forces
- Increased payload, maneuverability and performance
- Manned-Unmanned Teaming



Next Generation Tactical UAS

Purpose:

- Develop and demonstrate transformational air vehicle technologies that overcome key barriers to enable the Future Tactical UAS performance, survivability, and reliability requirements and operational capabilities

Products:

- Informed Requirements for FTUAS, including new concepts of operations
- Wingman concepts for FVL manned systems
- Enhanced survivability enabling operations in highly contested environments
- System-level SWAP allocation
- Informed Model Performance Specifications (MPS) used as basis for solicitation of FTUAS aircraft; provides quantifiable metrics for technical evaluation of proposals

Payoff:

- A refined set of technologically feasible and affordable capabilities that enable Future UAS requirements in POR EMD phase
- Operational parity with manned fleet enabling advanced manned unmanned teaming (MUM-T)
- Government-owned decision support tools and data readily available to support future acquisitions and product upgrades

Network/C3I

Goal: Provide Soldier with assured communications in contested environments through situationally-aware, intelligent network, and autonomously routing of information over resilient communications link.

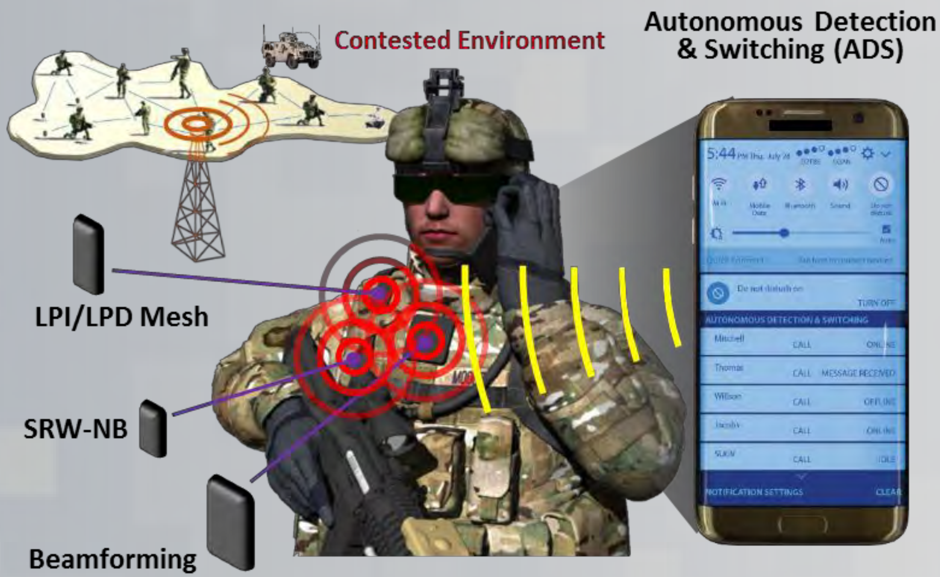
Technology Demonstrations

- Modular RF
- Non-Traditional Waveforms
- Protected SATCOM
- WGS Interference Cancellation
- Spectrum Obfuscation
- Next Gen HF
- Every Receiver a Sensor
- Robust Grey C3I
- Integrated Demos with NGCV, Soldier Lethality, FVL, AMD, and LRPF

Critical Technology Areas

- Tactical Network/Comms
- CEMA/EW/Cyber
- Mission Command/Command Posts
- A-PNT
- Persistent ISR

Modular RF Communications



Purpose:

- Enable connectivity in contested and congested environments by applying modular radio frequency (RF) and networking techniques, to adapt and continue operation under interference signals

Products:

- A system architecture for modular RF networks to be integrated with a single user device
- Autonomous networking to provide agile detection and switching amongst available network connections to maintain network resiliency in congested and contested environments
- Soldier Radio Waveform (SRW) on a modular module to integrate within an automated network
- Distributed, dismounted beamforming for communications through RF interference
- Low Probability of Interception and Detection (LPI/LPD) techniques that support communications in contested and congested environments

Payoff:

- The ability to operate in congested, and contested environments, and automatically adapt and respond to dynamically changing situations without user input
- Elimination of single point of failure when operating as a mobile protected network with assured and resilient communications at the tactical edge
- Common user interface with seamless incorporation of new and additional network capabilities through open architecture design

Air and Missile Defense

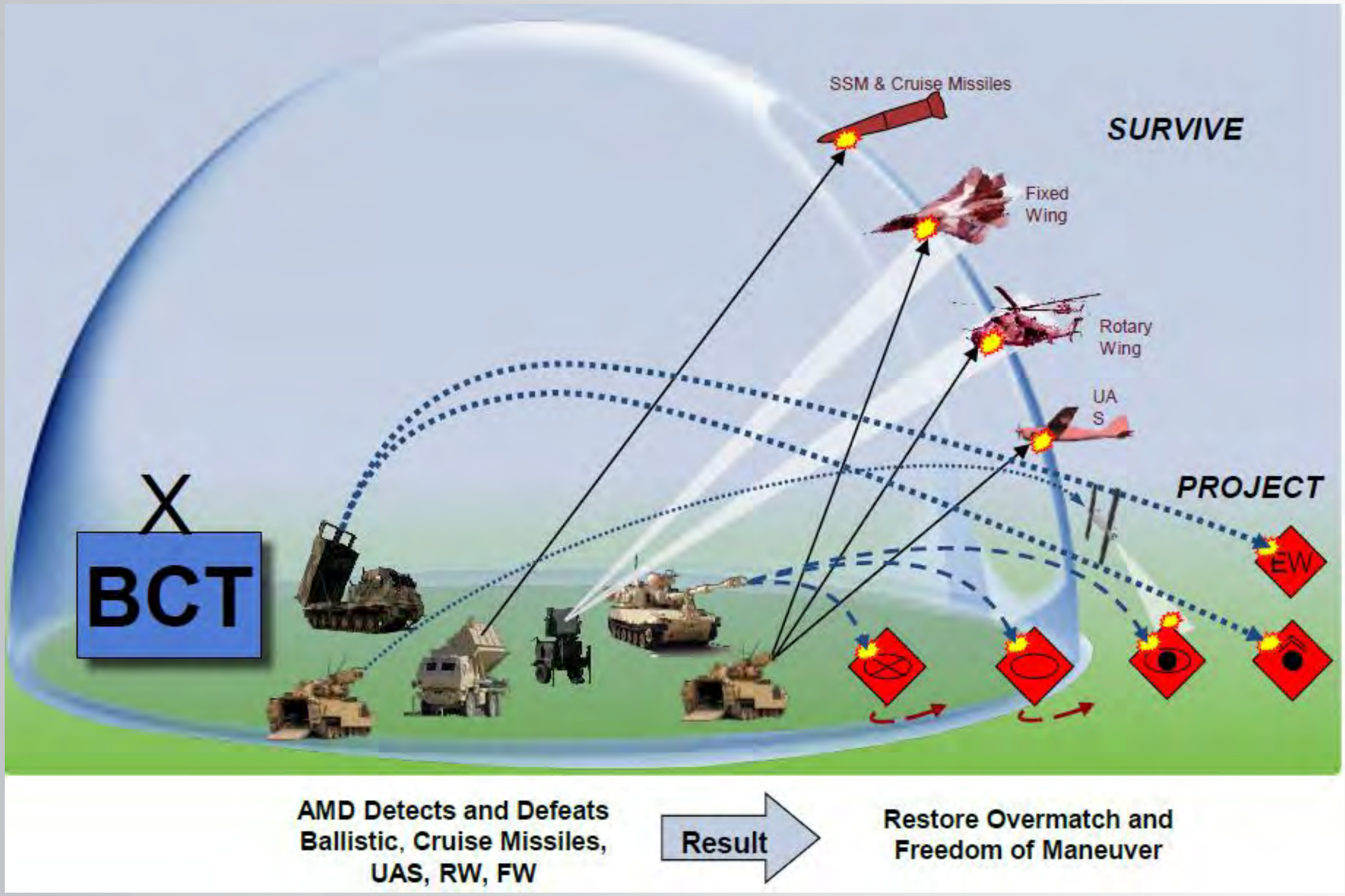
Goal: Provide capability to defend against enemy air attack at extended range.

Technology Demonstrations

- Low Cost Extended Range Air Defense (LowER AD)
- Maneuver AD Technologies (MADT)
- Ballistic Low Altitude Drone Engagement (BLADE)
- Accurate Rapid Controlled Hybrid Effects Round (ARCHER)
- High Energy Laser Tactical Vehicle Demonstrator (HEL TVD)
- Multi-Mission High Energy Laser (MMHEL)
- Unconventional Countermeasures & Survivability

Critical Technology Areas

- Mobile and Survivable Maneuver Short Range Air Defense (M-SHORAD)
- Counter UAS
- Operate within a Contested Environment



Technology Maturation Initiative: Multi-Mission High Energy Laser (MMHEL)

Purpose: Integrate and demonstrate a High Energy Laser (HEL) weapon system that can maneuver with operational forces to counter rocket, artillery and mortar (RAM), Unmanned Aerial Systems (UAS), intelligence, surveillance and reconnaissance (ISR), rotary and fixed wing Maneuver Short Range Air Defense (M-SHORAD) threats.

Multi-Mission High Energy Laser Platform

Successful 10kW HEL Demonstrations: Defeated UAS and Light Mortar in Flight

Products:

- 50kW-class Risk Reduction Demo on High Energy Laser Mobile Test Truck (FY18)
- TRL 7 MMHEL 50kW-class system demonstration (FY21)

This effort leverages Army S&T investments in the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD) effort as well as High Energy Laser Joint Technology Office investments in solid state laser development and advanced beam control systems.

Soldier Lethality

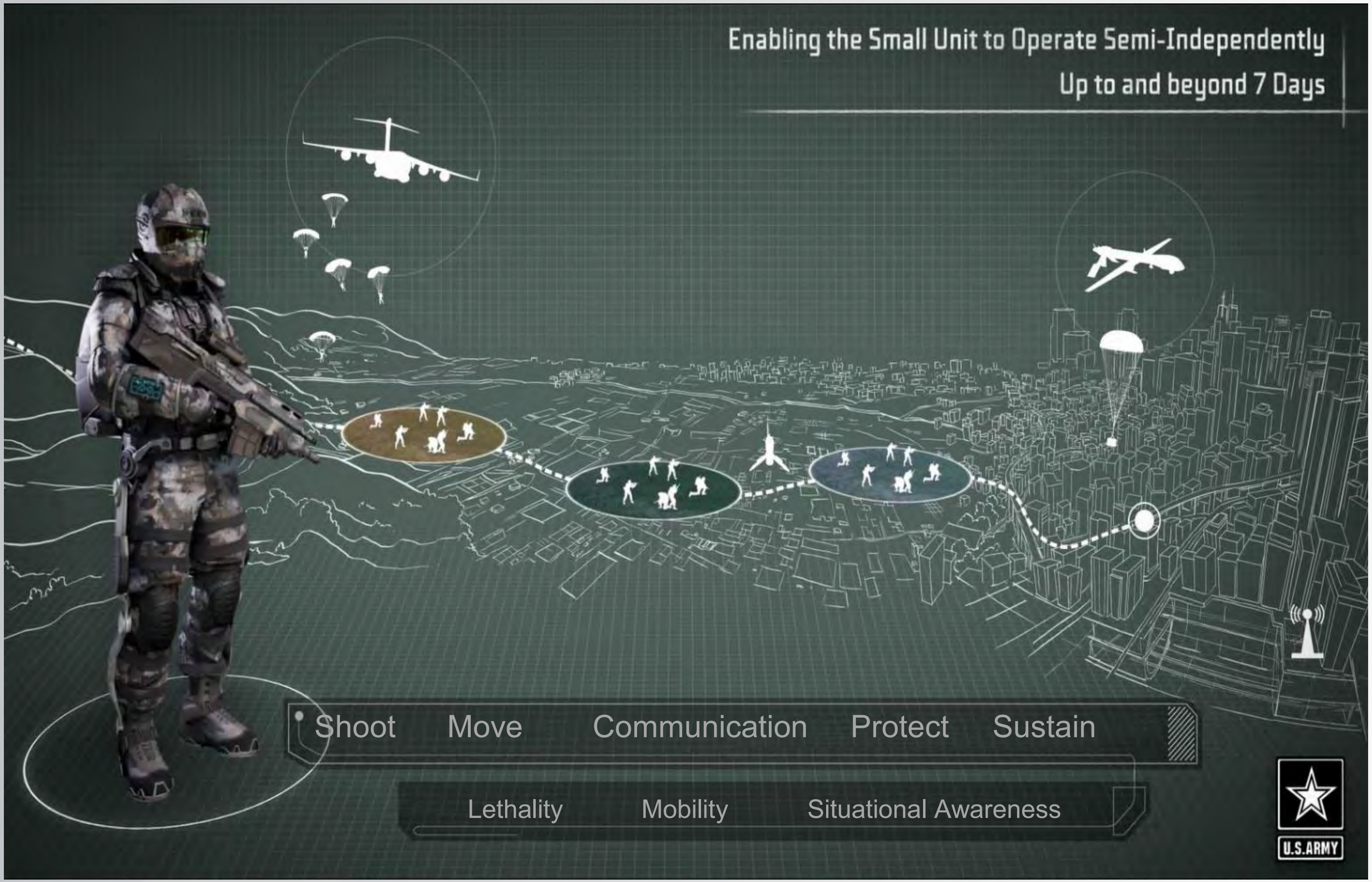
Goal: Improve Soldier and small unit performance, reduce surprise, increase protection, and enhance lethality in close combat on an intensely lethal and distributed battlefield and within complex, urban terrains.

Technology Demonstrations

- Next Gen Squad Weapons Technology
- Next Generation Family of Ammunition
- Soldier Signature Management
- Extreme Austere Environmental Protection
- Integrated Headborne Systems
- Body Armor
- Common Synthetic Environment
- Exoskeleton Systems

Critical Technology Areas

- Next Generation Squad Weapons and Ammunition
- Enhanced Body Armor
- Improved Soldier and Small Unit Performance
- Reduce the Soldier's Load and Increase Bearing Capacity



Next Generation Squad Weapons Technology

Integrated Automatic Rifle

Purpose:

- Provide critical weapon integrated technologies for Next Generation Squad Automatic Rifle (NGSAR – M249 replacement), leveraging LSAT, FAST, 6.5mm CT Carbine, and SAAC study results
- Develop weapon technologies to enable higher pressures
- Provide for fire control integration (SCOPE program)

Product:

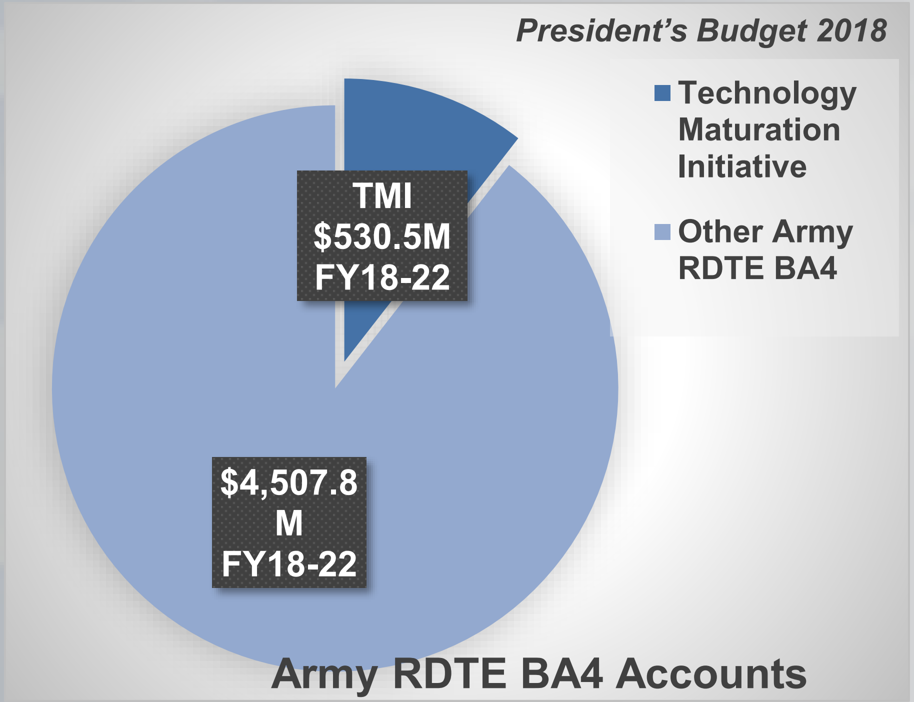
- Demonstration of Weapon/Cartridge for Automatic Rifle (TRL 6)
- Optimized Cartridge Configuration – weight/size vs. lethality
- 75-100 KSI Case Telescoped (CT) Cartridge
- Mid-Caliber (6.8mm) Projectiles (TRL 5/6)
- High Pressure Chamber lightweight materials
- High Pressure Barrel lightweight materials and processes
- Muzzle Device – recoil and signature reduction
- Integrated E/M Trigger and Intelligent Rail - interfaces for SCOPE
- TDP for weapon, ammunition, and fire control interface

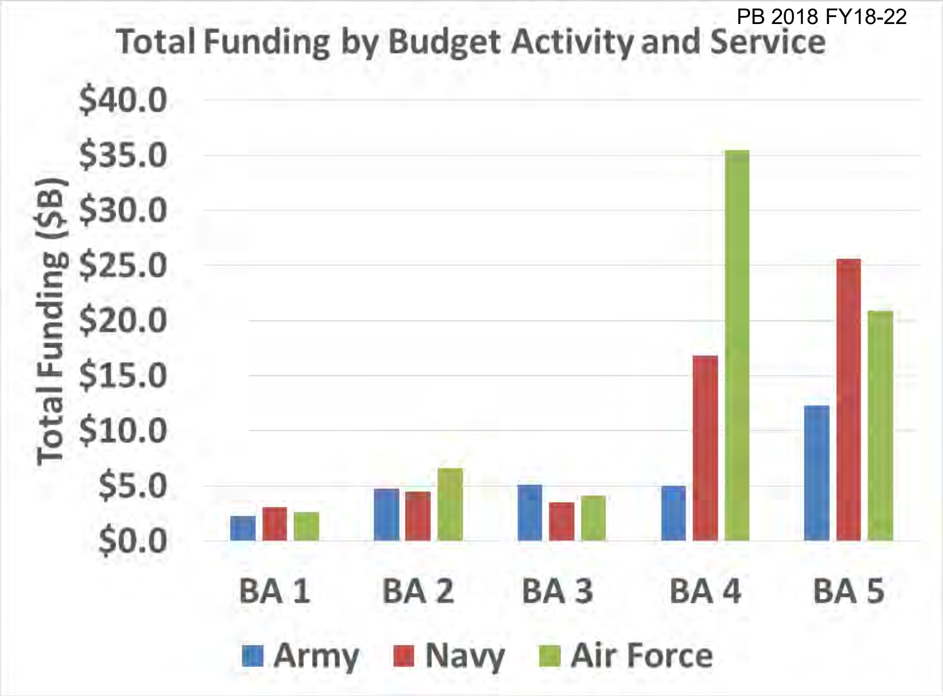
Payoff:

- Meets critical threshold values for Next Gen Squad Automatic Rifle (NGSAR) CDD and entrance criteria for MS-B, transition to PEO Soldier/PM Soldier Weapons
- Provides a TRL 6 platform and growth for NGSAR and future squad weapons by providing the next generation cartridge (carbine, SDMR, etc.)

Army BA 4 Technology Maturation Initiative

- Experimental and Early Developmental prototyping to inform emerging Army requirements and/or prepare S&T products for integration into future systems
- Only Army BA 4 investment not tied to a Program of Record (PoR)
  - Experimental Prototyping for future Army capabilities for which there is no PoR
  - Early developmental prototyping in partnership with Acquisition to inform and provide basis for emerging and objective requirements
- TMI oversight by 2-star Technology Maturation Executive Steering Group





Army Educational Outreach Program (AEOP)
– *part of a holistic strategy to address workforce needs*

Vision: A diverse, agile, highly competent STEM talent pool, representative of our nation's demographics to supply Army workforce initiatives

Mission: Offer students and teachers a collaborative, cohesive, portfolio of Army-sponsored STEM programs that effectively engage, inspire, and attract the next generation of STEM talent through K-through college programs and expose them to DoD STEM careers

Priorities:

- STEM Literate Citizenry: broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industrial Base (DIB)
- STEM Savvy Educators: support and empower educators with unique Army Research and Technology resources
- Develop and implement a cohesive, coordinated, and sustainable STEM education outreach centralized infrastructure across the Army

The Army has a holistic approach to STEM capabilities

AEOP serves to broaden the future talent pool

AEOP Impacts
-FY17 unless otherwise noted

32,947
Students

2,307
Teachers

83%
Alumni reported that AEOP mentors helped influence academic career decisions

485
Universities or Colleges

92
HBCU's or MSI's

3,467
K-12 schools

FY17 included evaluation of AEOP on 21st century workforce skills

15
Strategic Partner Organizations Serving Underserved Youth

42%
of the apprentices in FY17 included students from underserved populations

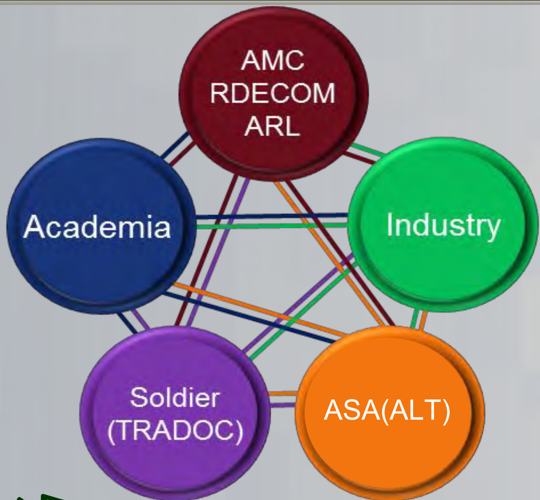
FY17 AEOP Alumni Leadership Counsel Developed

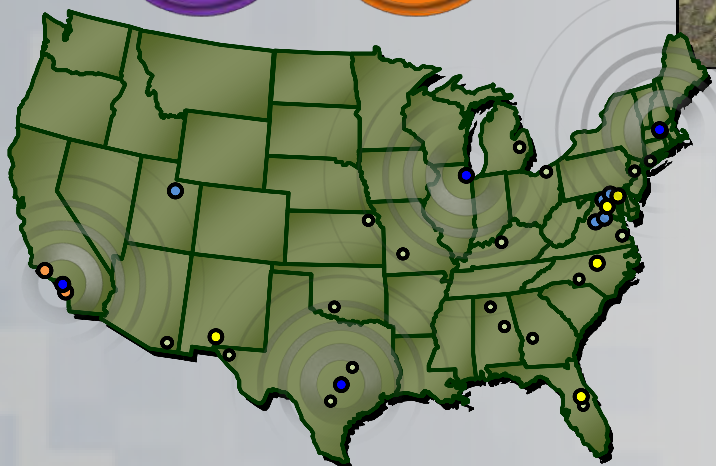
95%
FY16 Alumni stated AEOP contributed to growth in STEM knowledge

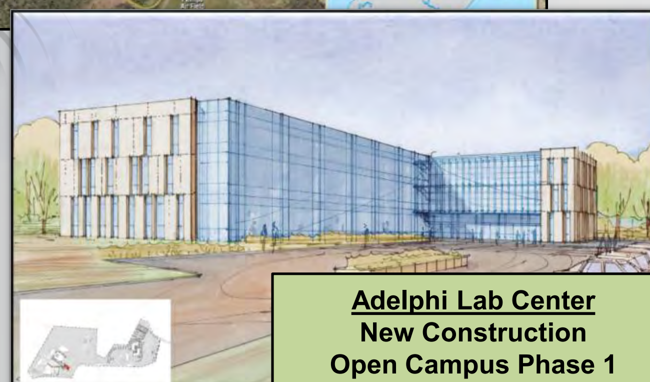
Comprehensive program evaluations and assessments can be found at www.usaeop.com/impacts

As of 28 Feb 2018

Open Campus







Adelphi Lab Center
New Construction
Open Campus Phase 1
Opening 2020

Collaborations focused on Army-specific challenges of mutual importance to all partners

Partners from Army, Industry and Academia engage in research with shared access to people, infrastructure and resources

"…a role model to the broader defense research enterprise"

- Defense Science Board (DSB) Task Force on Defense Research Enterprise Assessment, January 2017

Summary

- Army Science and Technology works to Enhance Current Systems and Enable Future Systems
- In PB 2019 Army S&T resources are aligned to support the Army's Modernization Priorities
- Open Campus is continuing to expand opportunities for collaboration

DATA IS POTENTIAL

Seagate Supply Chain Standards and Operational Systems

Government Solutions | Henry Newman | May 9 2018

SEAGATE

Supply Chain Standards and Results

Agenda

1. SUPPLY CHAIN REQUIREMENTS AND STANDARDS

2. SEAGATE APPROACH

Supply Chain Requirements and Standards

DoD, NIST, FBI, ISO, O-TTPS

Requirements for Information Relating to Supply Chain Risk

DoD Directive States

What is supply chain risk?

DoD has clear definitions of risk

We see both direct and indirect risk every day that could impact the performance of national systems

https://www.acq.osd.mil/dpap/dars/dfars/html/current/239_73.htm

FBI on Supply Chain

Recommendations

**Federal agencies should develop a Supply Chain Risk Management (SCRM) strategy.
It should include:**

Known and emerging threats

Vulnerabilities

Organizational impacts

The teams must be multi-disciplined and address SCRM, security, procurement, contract and administrative law, audit and finance, and facilities management

https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-161.pdf

Supply Chain Risk Management Practices for Federal Information Systems and Organizations

NIST Has a Whole Document on Supply Chain

NIST has standards for ICT (Information and communications technology) that encompass all of Federal Government and contractors and is what DoD standards are based on NIST view 3 areas as critical

Integrity

Resilience

Quality

https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-161.pdf

ISO Standards 28000:2007

Review of What is in the ISO Standards for Supply Chain

1.

Establish, implement, maintain and improve a security management system

2.

Assure conformance with stated security management policy

3.

Demonstrate such conformance to others

4.

Seek certification/ registration of its security management system by an Accredited third party Certification Body; or make a self-determination and self-declaration of conformance with ISO 28000:2007

Companies doing business in the USA or Europe are going to be required being moving to follow supply chain standards

https://www.iso.org/standard/44641.html

ISO/IEC 20243-1:2018 Information Technology Mitigating Maliciously Tainted and Counterfeit Products

ISO Standard

ISO also has a standard for mitigating maliciously tainted and counterfeit products.

Similar standards and regulation to NIST

Using counterfeit products has significant security risks

For computer products counterfeit has multiple meanings

- Complete reengineered products
- Products that might have been previously used in other systems and recycled

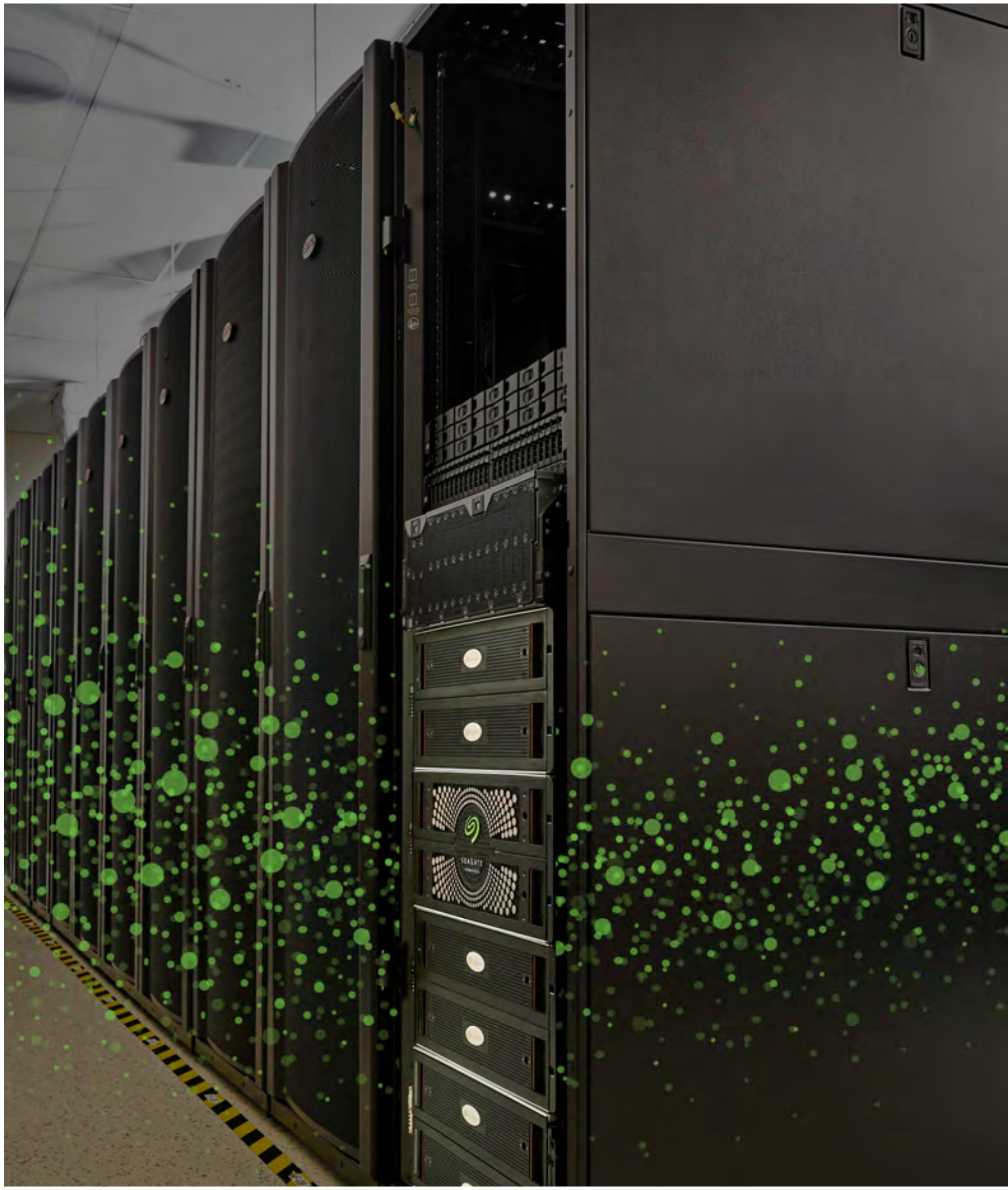
What is the Aim of the O-TTPS

Open Trusted Technology Provider™ Standard

OpenGroup has a clear definition called O-TTPS (Open Trusted Technology Provider Standard) for OEM and sub contractors

- Very high cost in complex systems given audit required of sub-contractors
- Demonstration of conformance through this independent, voluntary O-TTPS Certification Program process provides formal recognition of an organization’s conformance to this industry standard.

https://ottps-cert.opengroup.org/



What Problem in the Market Does it Solve?

In the US, CC certification is mandated as a procurement prerequisite for defense and intelligence community use as per Committee on National Security Systems (CNSS) Policy #11.

CNSS(Committee on National Security Systems) Policy#11 requires CC certification for all IA (Information Assurance) and IA-enabled devices.

Committee on National Security Systems

CNSS Policy No. 11
10 June 2013

NATIONAL POLICY GOVERNING THE ACQUISITION OF INFORMATION ASSURANCE (IA) AND IA-ENABLED INFORMATION TECHNOLOGY PRODUCTS

FOREWORD

1. The attached policy supersedes National Security Telecommunications and Information System Security Policy (NSTISSP) No. 11, "National Policy Governing the Acquisition of Information Assurance (IA) and IA-Enabled Information Technology (IT) Products," dated January 2000 and revised in June 2003. CNSSP No. 11 clarifies the required evaluation processes applicable to Commercial-Off-The-Shelf (COTS) and Government-Off-The-Shelf (GOTS) IA and IA-enabled IT products that are used on U.S. National Security Systems (NSS) to protect the information therein.

a. The National Security Agency (NSA) and the National Institute for Standards and Technology (NIST) established the National Information Assurance Partnership (NIAP) program to implement and administer a process governing the testing and evaluation of COTS IA and IA-enabled IT products. The Director, NSA is responsible for implementing the NIAP as it applies to NSS to include approving processes for the evaluation of COTS products when they are to be used to protect information on NSS.

b. The Director, NSA, as the National Manager for NSS, is also directly responsible for establishing standards and criteria that GOTS IA and IT products must meet before they are used to protect NSS and the information therein.

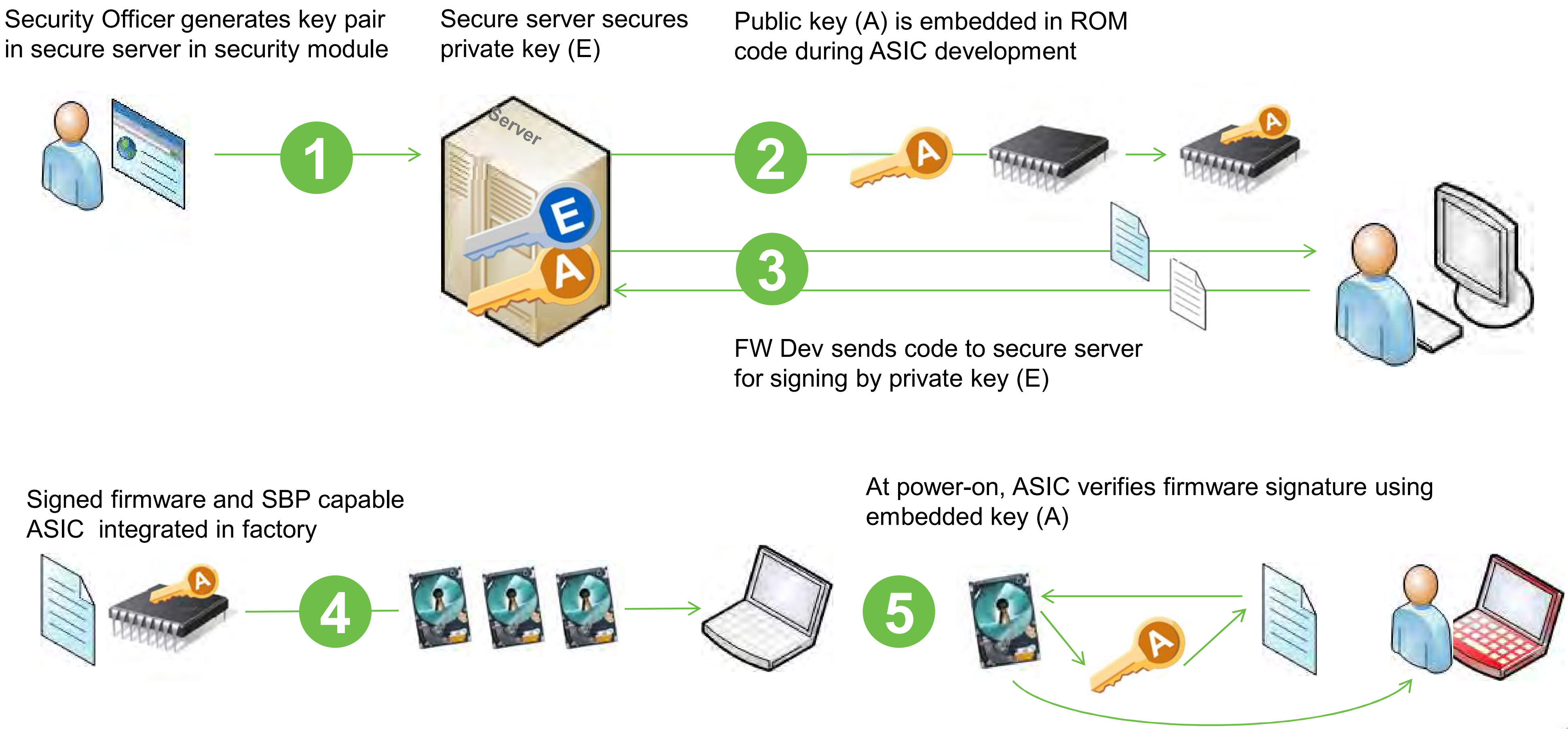
2. Additional copies of this policy may be obtained by contacting the Secretariat or at the CNSS website: www.cnss.gov.

CNSSP#11 Note all CNSSP policies have been removed from https://www.cnss.gov/CNSS/issuances/Policies.cfm

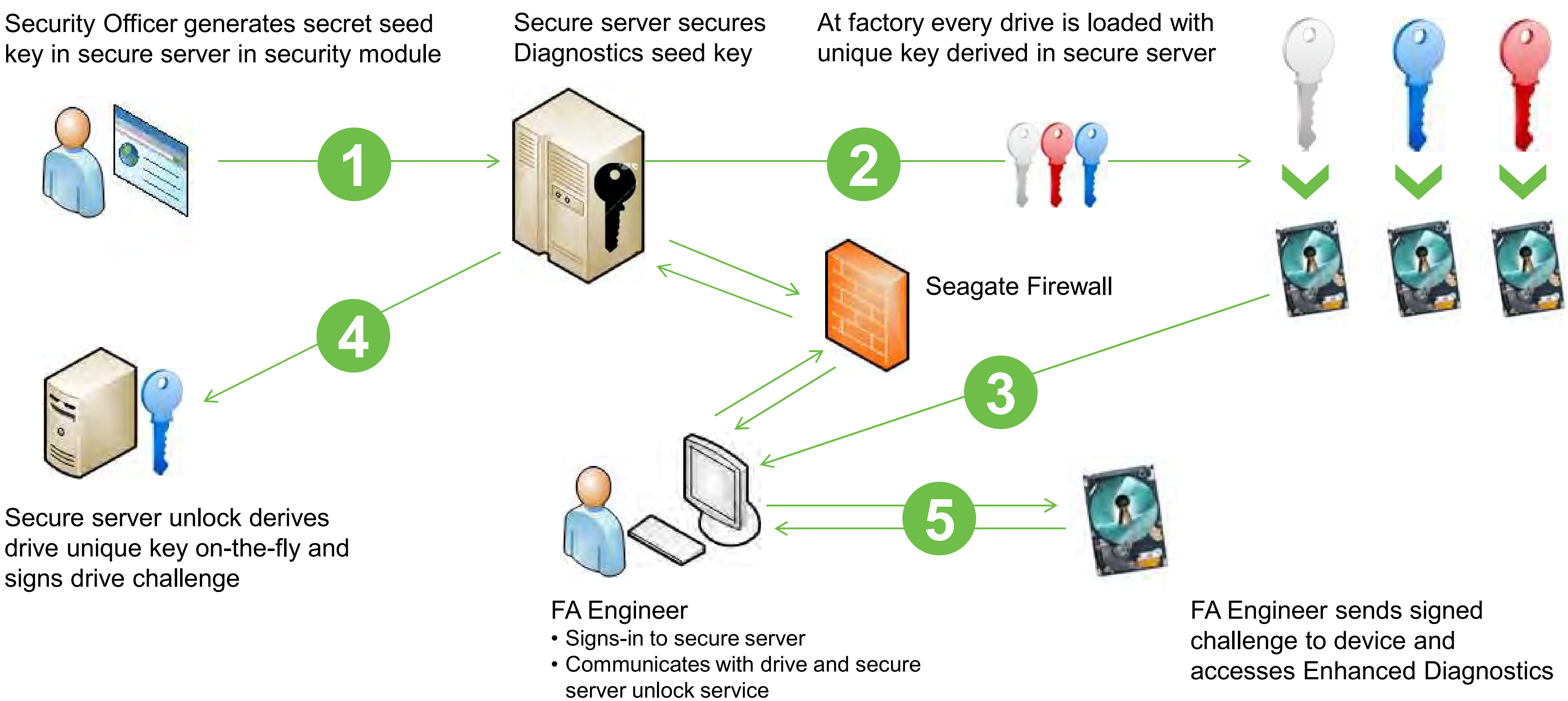
Seagate Approach to Supply Chain

Firmware, Common Criteria, FIPS

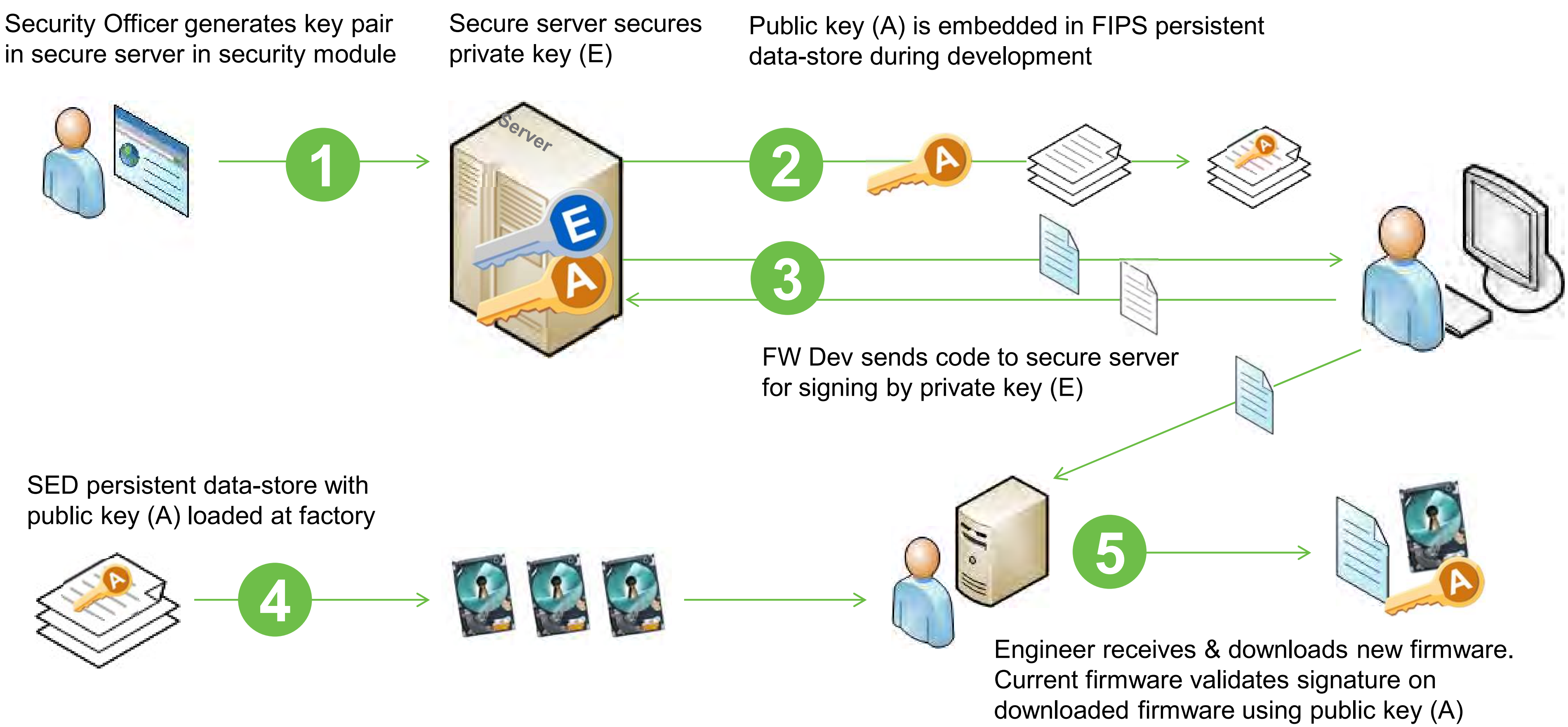
Secure Boot Process 2



Diagnostics Command & Cross Segment FW Download Access



Authenticated Firmware Download



Supply Chain and 3rd Parties

The Need for Product, Component, and Services Security

salesforce.com CEO Marc Benioff says, "We're in the early stages of a data science revolution, and executives of every type of business need to address the disruption and get serious about cybersecurity. **This clearly applies to our digital products**…."There is no finish line when it comes to cybersecurity."

Heightened Awareness & Sensitivity to Cybersecurity and Tainted Products

Customer Requirements

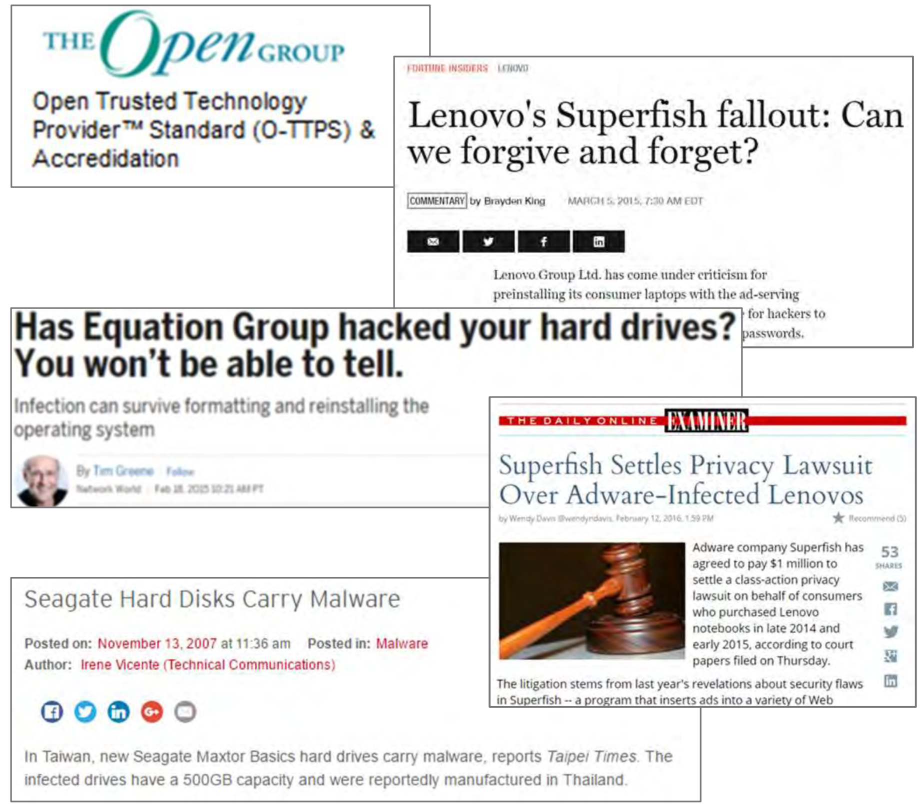
Brand Impact

Counterfeit Products

Standards & Certification Requirements

Origin, Authenticity, Chain of Custody

⇒ Attestable Product Security is now a stewardship requirement


THE Open GROUP

Open Trusted Technology Provider™ Standard (O-TTPS) & Accredidation

Lenovo's Superfish fallout: Can we forgive and forget?

Lenovo Group Ltd. has come under criticism for preinstalling its consumer laptops with the ad-serving

Has Equation Group hacked your hard drives? You won't be able to tell.

Infection can survive formatting and reinstalling the operating system

THE DAILY ONLINE EXAMINER

Superfish Settles Privacy Lawsuit Over Adware-Infected Lenovos

Adware company Superfish has agreed to pay $1 million to settle a class-action privacy lawsuit on behalf of consumers who purchased Lenovo notebooks in late 2014 and early 2015, according to court papers filed on Thursday.

The litigation stems from last year's revelations about security flaws in Superfish -- a program that inserts ads into a variety of Web

Seagate Hard Disks Carry Malware

Posted on: November 13, 2007 at 11:36 am Posted in: Malware

Author: Irene Vicente (Technical Communications)

In Taiwan, new Seagate Maxtor Basics hard drives carry malware, reports *Taipei Times*. The infected drives have a 500GB capacity and were reportedly manufactured in Thailand.

Common Criteria Certified Product Portfolio

Overview

What:

Common Criteria (CC) is an internationally recognized standard (ISO/IEC 15408) for assessing security functionality of information assurance (IA) and IA-enabled products.

How:

A CC certification assures buyers that the process of specification, implementation and evaluation of any certified security product was conducted and proven in a thorough and standard manner.

Why:

CC certification is required for access to US and EU government markets. It can also be used as a competitive differentiator when marketing to non-government markets like finance, critical infrastructure and health care.

Expanding Threats Landscape and Seagate’s Continued Value Add

Seagate

Manufacturing

Supply Chain

Infrastructure

Product Development

Customer Warehouse(s) / Hubs

Customer Data Centers

Rouge Implants in Factory, Rogue Seagate Insider, Supply Chain Attack

Warehouse Attack

- Counterfeiting, Tampering of FW
- Unauthorized FW Update, Undetected Access

Smash and Grab

- Unauthorized Access to or Altering of User Data
- Key Material Compromise/Leakage

End of Life / Decommissioning

- Data exfiltration

✓ **Rogue Firmware Detection Service**

✓ **Attestation Service** (in development)

✓ **ISE, SED & FIPS configs. with Seagate Cloud Key Mgmt. Solution**

Thank You

SEAGATE

DAHLGREN

NAVAL SURFACE WARFARE CENTER · DAHLGREN DIVISION

NDIA Armaments Forum
Indianapolis, Indiana
Analysis of 25mm PGU-47 APHEI-T Projectile Against Wall Targets

GUN & ELECTRIC WEAPON SYSTEMS DEPARTMENT (E)

Presented by

Jim McConkie
NSWCDD, E33

7-10 May 2018

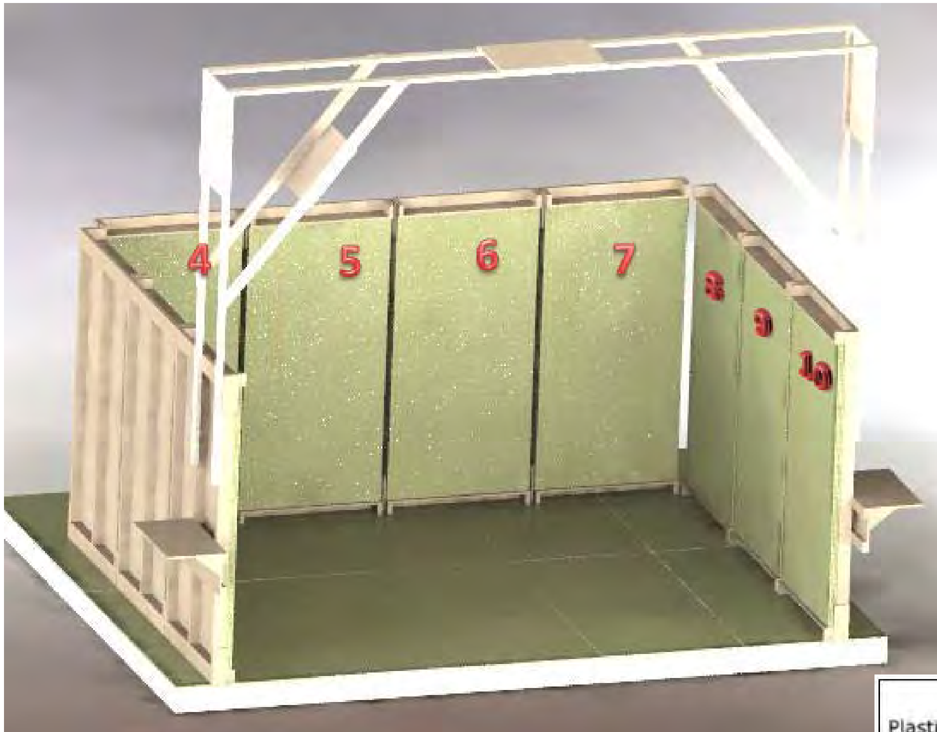
Outline

- Analysis Approach
- Test Description
  - Test Data Deficiencies
- ZDATA Construction
  - PMAT Tool
- WarheadView
  - Program Description
  - Probability Of Incapacitation
  - Personnel Model
  - Target Configuration
  - Analysis Description
- Results
- Summary

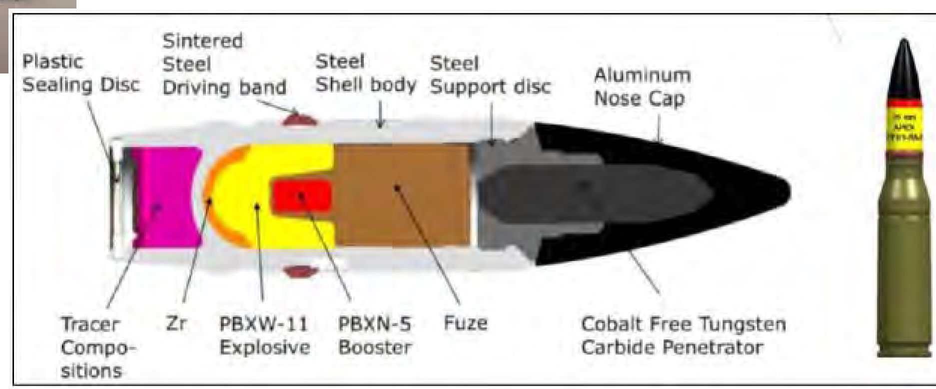
Analysis Approach

- Assemble warhead characterization file (ZDATA) for each test shot
  - Obtain projectile fragment impact data from E40
  - Determine fragment mass for non-recovered fragments using PMAT
  - Determine impact velocity using velocity screen data or PMAT
  - Compute fragment initial conditions based on impact state and estimated average drag coefficient
- Use WarheadView to compute probability of incapacitation (P_{inc}) of projectile fragments for a matrix of personnel targets
  - 46 personnel targets located in 16x16-foot room
  - Projectile impact point on wall varied using a grid of 468 points
  - Serious and Lethal wounding casualty criteria used
    - Include summer uniform fragment velocity cut-off

Test Description

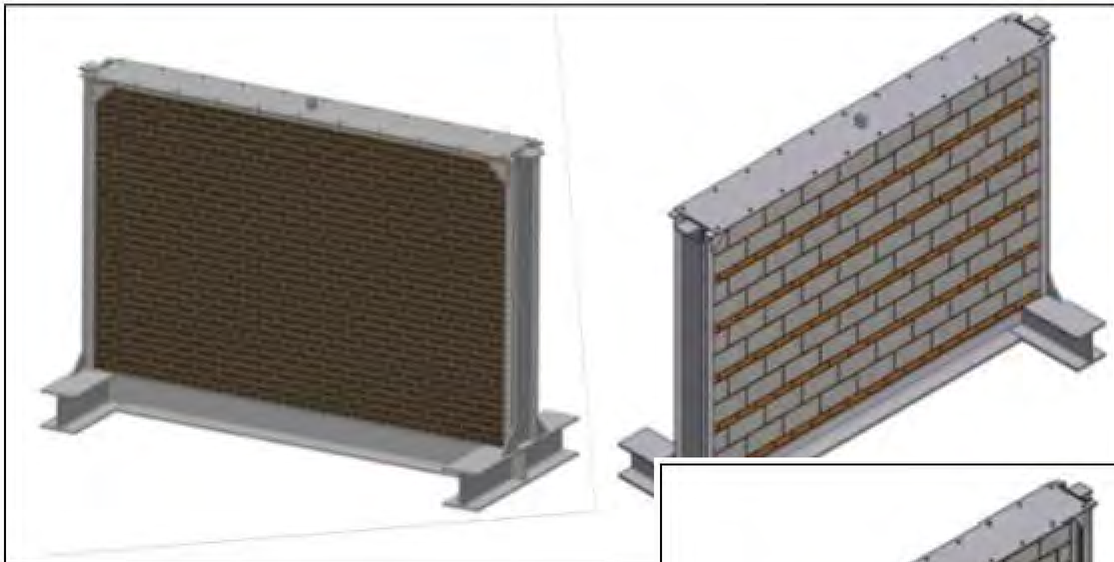


- Wall target placed in front of 12x16x8-foot plywood room
  - Brick-over-block wall
  - Concrete Masonry wall
- Fragment impact locations on plywood sheets were recorded
- Velocity screens covered back wall and both side walls
- Projectile: PGU-47/U

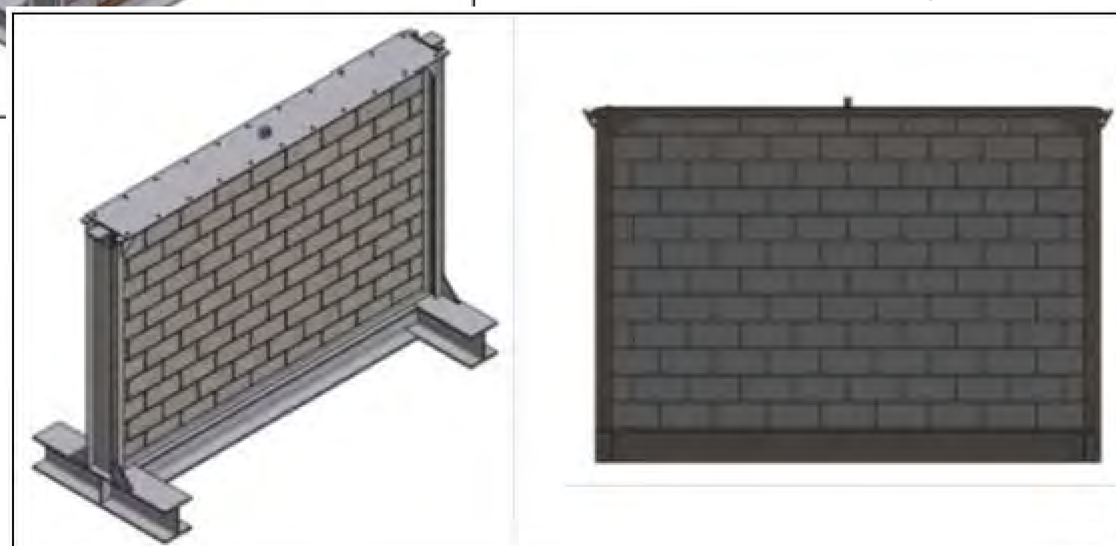


Wall Targets

Brick-over-Block



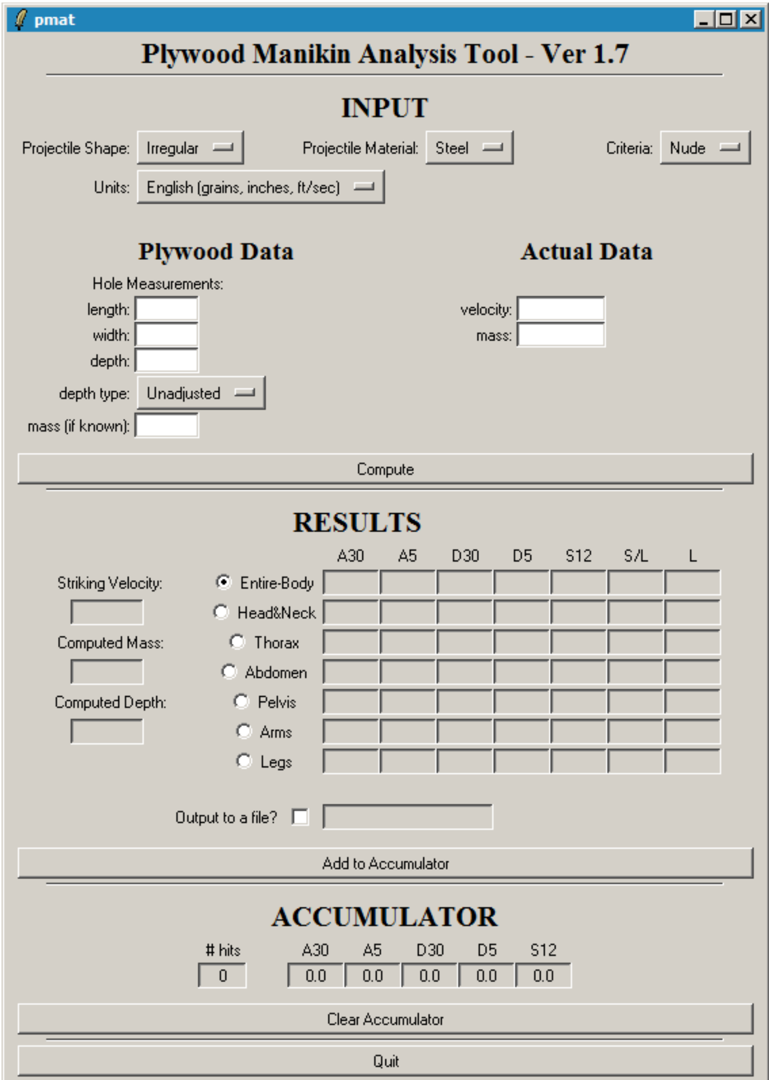
Concrete Masonry Unit



ZDATA Construction

- Fragment polar angle and azimuth angle determined from fragment impact location (relative to burst point)
- Fragment impact velocity:
  - For fragments that completely perforated the plywood (non-recovered), velocity screen data was used
  - Otherwise, the lower of velocity screen or PMAT value was used
  - JTCG drag curve used to compute initial velocity
- Fragment mass:
  - Mass was measured for all recovered fragments
  - Otherwise, use PMAT to estimate mass
- Fragment shape assumed to be irregular
- Used ETB format for ZDATA file
  - Allows deterministic analysis
  - Standard JTCG ZDATA format could be constructed if desired

PMAT Tool

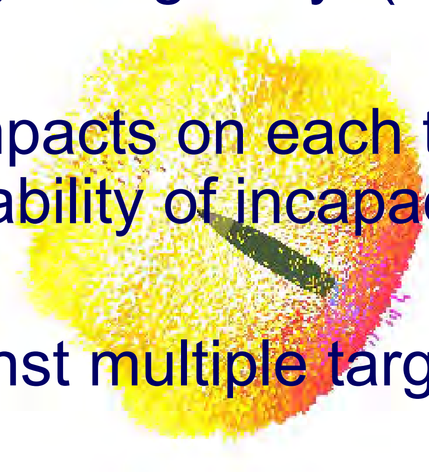


- Computes fragment mass and impact velocity based on size of hole in plywood (L,W,D)
  - Four fragment material options (steel, tungsten, etc.)
  - Four fragment shapes
- Fragment hole size measured for all fragments that completely perforated plywood layers
- Program can also compute resulting P_{inc} (not used)

WarheadView Description

Warhead Fragment Trajectory Visualization Program

- Program to visually display the trajectories of warhead fragments resulting from the detonation of single or multiple blast-fragment warheads or projectiles.
- Fragment initial positions and velocities are computed according to the warhead characterization (ZDATA) file and combined with the weapon position and velocity
- Each fragment trajectory is simulated until impact and includes effects of drag and gravity (JTCG drag curves are used)
- Number of fragment impacts on each target object is recorded and the probability of incapacitation is computed for each hit
- Multiple weapons against multiple targets can be simulated



Probability Of Incapacitation

- Probability of incapacitation (P_{inc}) as a function of the number of lethal hits (N_{Lethal}):

$$P_{inc} = 1 - e^{-N_{Lethal}}$$

- The number of lethal hits is the summation of the probability of incapacitation ($P_{I/H}$) of each hit, which is computed using the Sperrazza-Kokinakis (S-K) equation:

$$N_{Lethal} = \sum P_{I/H}$$

$$P_{I/H} = 1 - e^{-a\left(mV^{3/2} - b\right)^{n}}$$

- Summer uniform velocity cut-off included:

$$V_{50} = \sqrt{kA/M}$$

$$k = (-1.7942 \log M + 7.543) \times 10^{6}$$

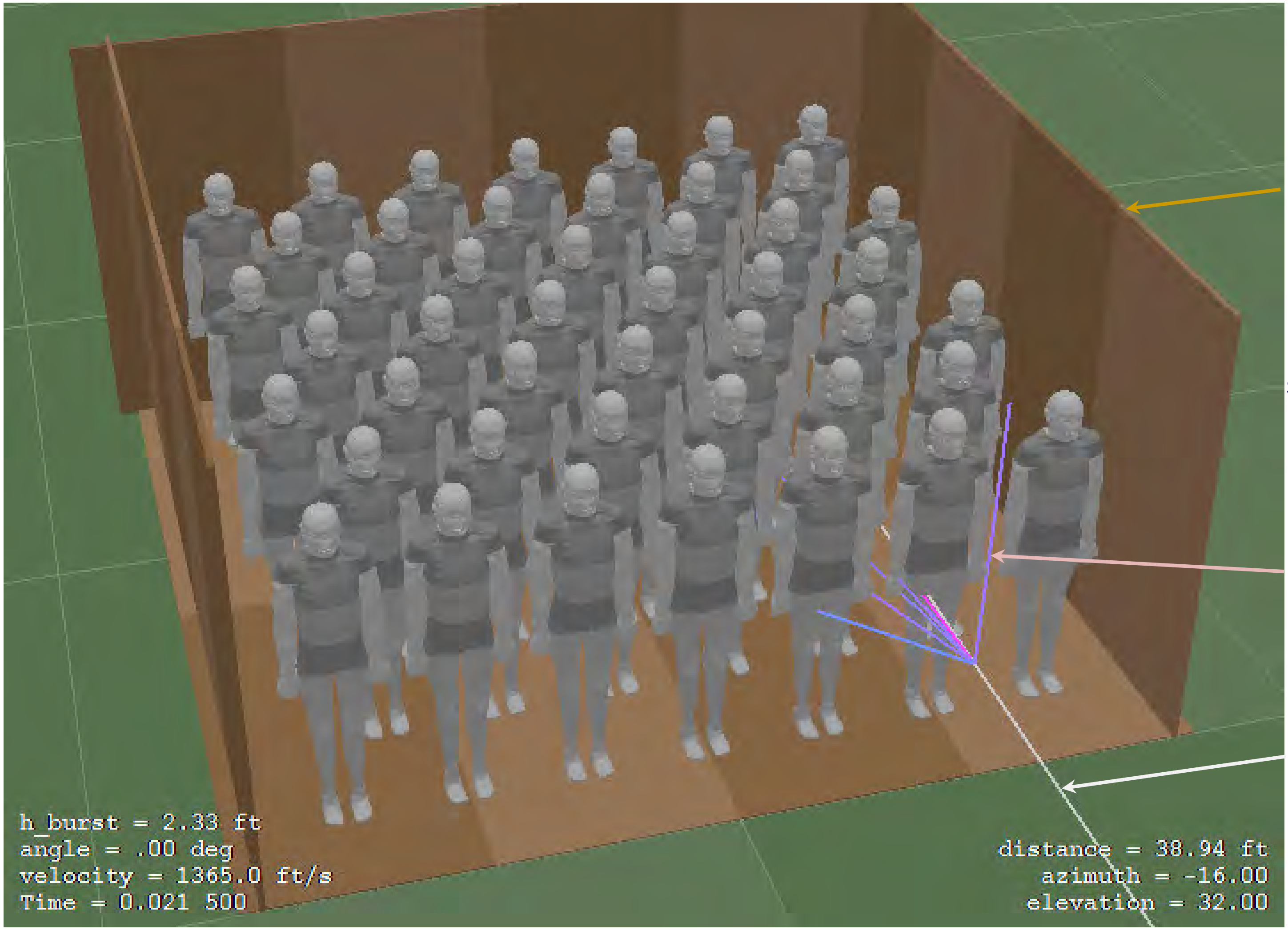
Personnel Model

6-Pt Standing Man

- Personnel model divided into six segments
  - Head/Neck
  - Thorax
  - Abdomen
  - Pelvis
  - Arm
  - Leg
- Separate S-K coefficients for each segment
  - Serious wounding
  - Lethal wounding

WarheadView Target Configuration

46 Personnel Targets



16x16-foot room

(Front wall not shown)

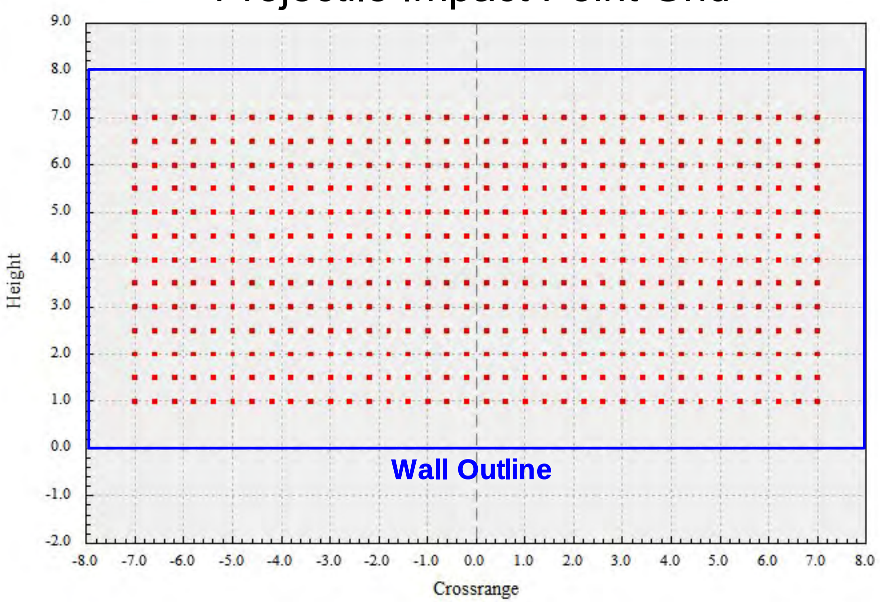
Projectile fragment paths

Projectile path

WarheadView Analysis

- Projectile impact point varied across height and width of front wall
  - Horizontal: -7 to +7 feet, every 0.4 feet
  - Vertical: 1 to 7 feet, every 0.5 feet
- Probability of incapacitation (P_{inc}) computed for each personnel target
  - Serious wounding criteria
  - Lethal wounding criteria
- For each impact point:
  - Average P_{inc} of all personnel targets
  - Maximum P_{inc} for all personnel targets
- 8 test shots analyzed
  - Shots 2, 4, 10, 12 (Brick-over-block wall)
  - Shots 5, 8, 13, 14 (Concrete masonry wall)

Projectile Impact Point Grid



WarheadView Analysis

Interpretation of Results

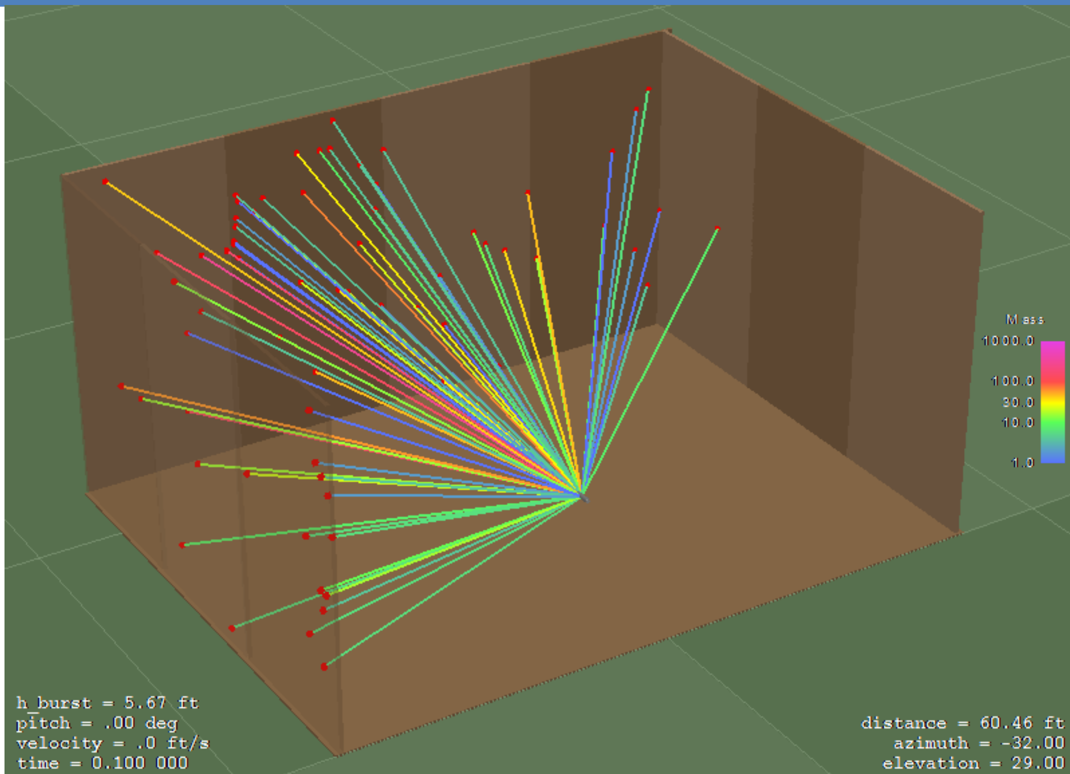
- Average P_{inc} of all personnel targets:
  - This is the expected value of P_{inc} for a single projectile against a single personnel located at a random point in the room
  - The reported average value (in the summary table) is the average for all personnel and all impact points
    - This includes the assumption that the projectile impact point is random and uniformly distributed on the wall
  - The power-rule could be used to combine the average P_{inc} in order to get a corresponding value for multiple shots
  - The maximum value of average-P_{inc} (included with plots) represents the best-case impact point (for a single personnel at a random location)
- Maximum P_{inc} for all personnel targets:
  - The reported value represents the maximum across all personnel and all impact points
  - This is the best-case P_{inc} for a single projectile against a single personnel in the room (at the best-case impact location)

Summary of Test Shots

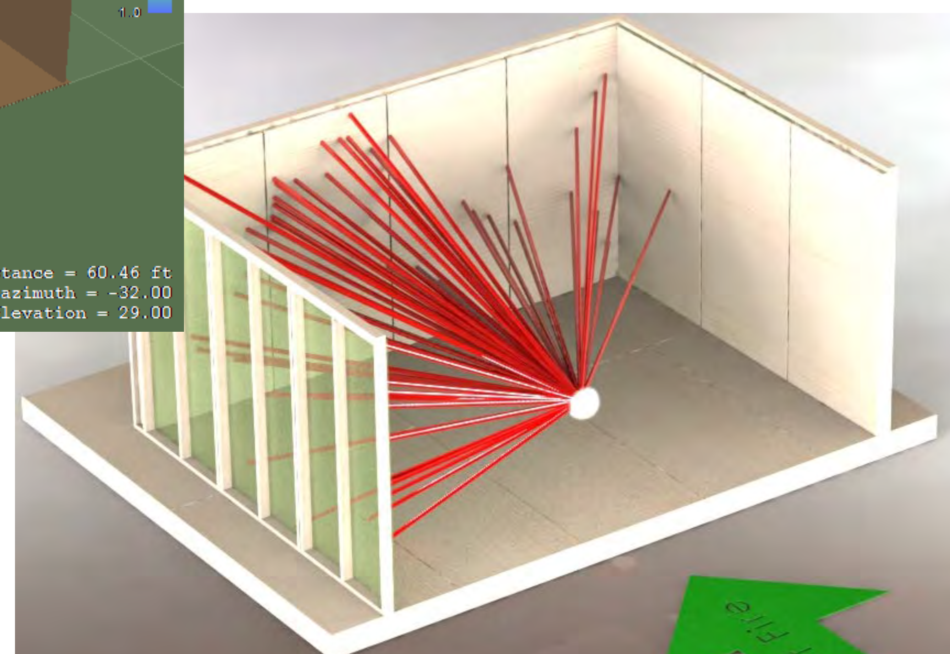
PGU-47/U

		Projectile		
Shot	Wall Target	Type	Angle	Velocity (ft/s)
2	Brick	PGU-47	0	3086.9
3	Brick	PGU-47	0	1993.1
4	Brick	PGU-47	0	3104.0
5	CMU	PGU-47	0	3113.5
8	CMU	PGU-47	0	2128.3
9	Brick	PGU-47	0	2181.1
10	Brick	PGU-47	0	3100.1
11	Brick	PGU-47	45°	1943.2
12	Brick	PGU-47	45°	3110.9
13	CMU	PGU-47	45°	1955.1
14	CMU	PGU-47	45°	3105.6

Fragment Trajectories: Shot 5

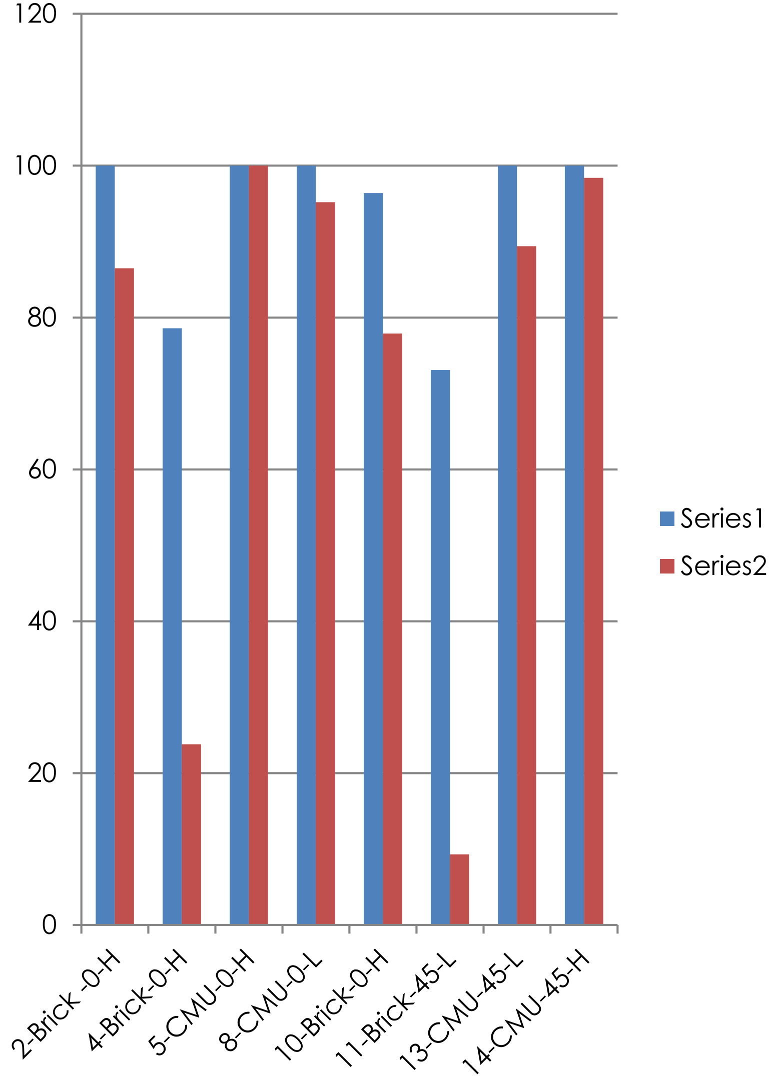


← Fragment trajectory simulations in WarheadView



Summary of Test Shots and Results

PGU-47/U

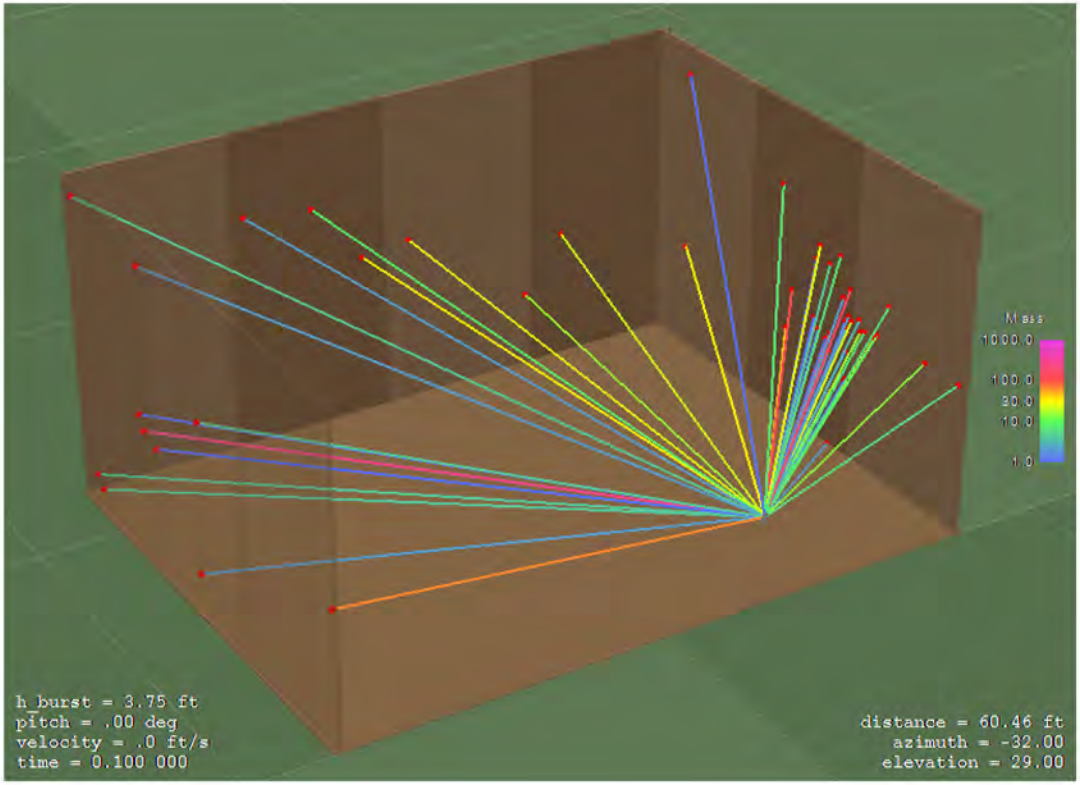


DISTRIBUTION A. Approved for public release: distribution unlimited.

Summary

- Eight PGU-47 25-mm shots analyzed
  - Four against brick-over-block walls
  - Four against concrete masonry unit walls
- Projectile fragment mass and velocities were directly measured or estimated from PMAT
  - For Shots 4 & 12 – only the penetrator was recorded as penetrating the brick-over-block wall and thru the witness room wall. The Fragmentation was trapped in the wall.
- Average and maximum P_{inc} computed for matrix of personnel targets
- Significant difference observed in P_{inc} between brick wall and concrete masonry (CMU) wall
  - Impact/penetration of CMU wall produced large numbers of fragments, resulting in much higher P_{inc} values

Questions


Mass
1000.0
100.0
30.0
10.0
1.0
h_burst = 3.75 ft
pitch = .00 deg
velocity = .0 ft/s
time = 0.100 000
distance = 60.46 ft
azimuth = -32.00
elevation = 29.00

Always a Step Ahead

ARDEC

ARMAMENTS

Small Caliber Multiplex Technology

Abstract #20232

Presented by:

Christopher Parisi

UNPARALLELED COMMITMENT & SOLUTIONS

Act like someone's life depends on what we do.

U.S. ARMY

U.S. ARMY RDECOM

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER

DEFINITIONS

Small Caliber:

.22 up to .50

Multiplex:

Cartridge contains more than one projectile or bullet

U.S. ARMY RDECOM

HISTORY

ARDEC

Multiplex cartridge technology is not a new concept

1862 – Patent composed for “Improvement in Compound Bullets for Small Arms”

1879 – Government proposal for triplex (three-bullet) rifle round was put together but subsequently rejected

1945 – Nazis had designed a duplex (two-bullet) rifle round as part of an SS project

1952 – Government technical memorandum concluded that the current infantry weapon and ammunition at that time had an undesirably low Probability of Hit ($P_{(h)}$) on man-sized targets

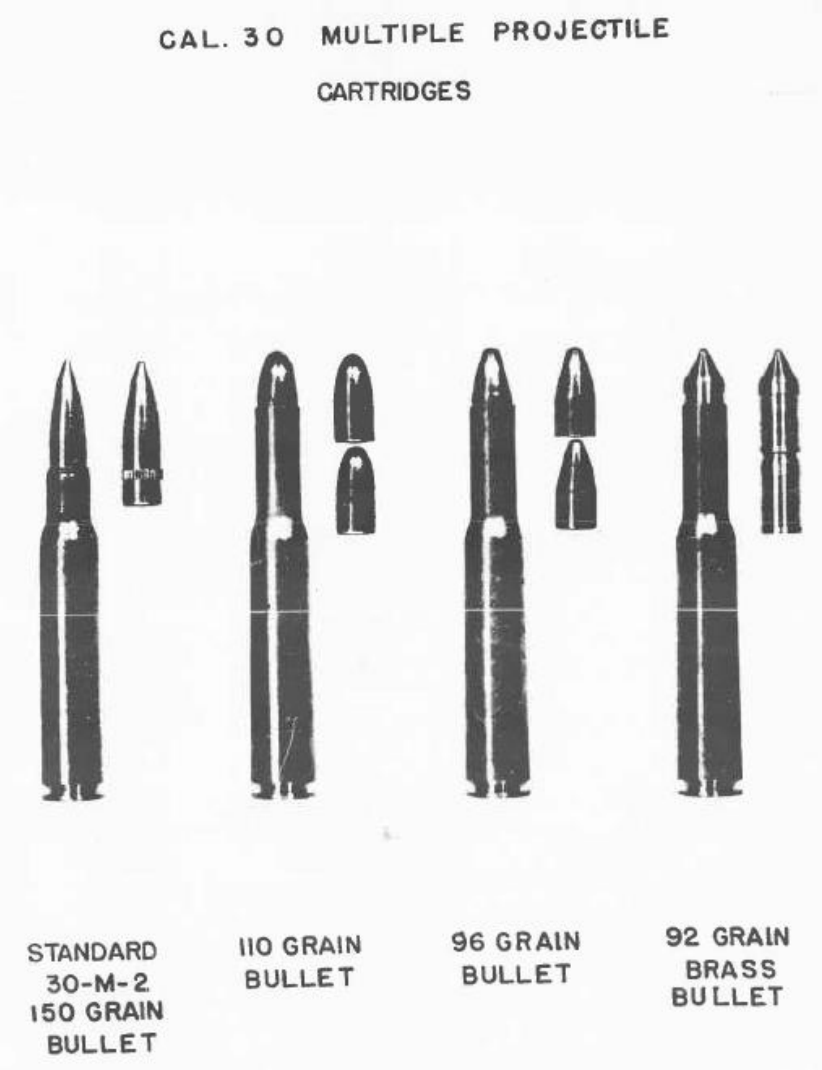
HISTORY

Project Salvo

Initiated February 4, 1952 by Olin Mathieson Chemical Corp

Phase I:

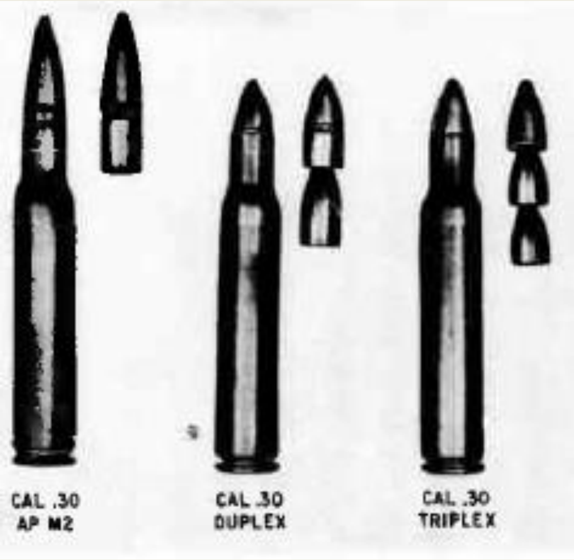
- Perform extensive $P_{(h)}$ studies and analytics to prove performance benefits of multiplex cartridges over conventional single-bullet technology
- Address M1 rifle $P_{(h)}$ via a .30 caliber duplex cartridge with dispersion less than 40” @ 300yds
- Modify weapon chamber to accept cartridge case with a longer neck

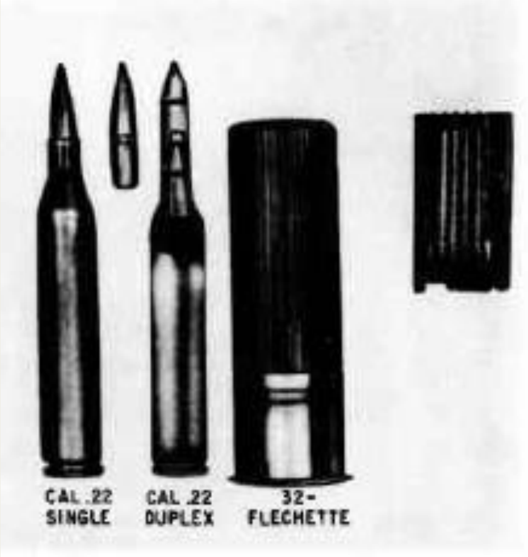


Project Salvo

Phase II:

- Design multiplex cartridges that would operate without modifying M14 weapon chambers or cartridge cases
- Minimize sacrifices in soft tissue damage, hard target penetration
- Increase effective range to 500yds
- Experiment with flechette shot shells
- Perform sensitivity analyses with automatic and burst fire
- Conduct extensive live-fire testing (paper targets, gelatin, soldier helmets)
- Design for cost-effective manufacturability

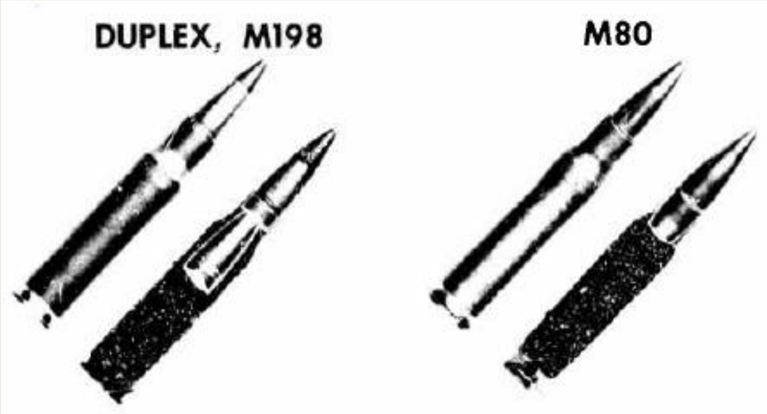




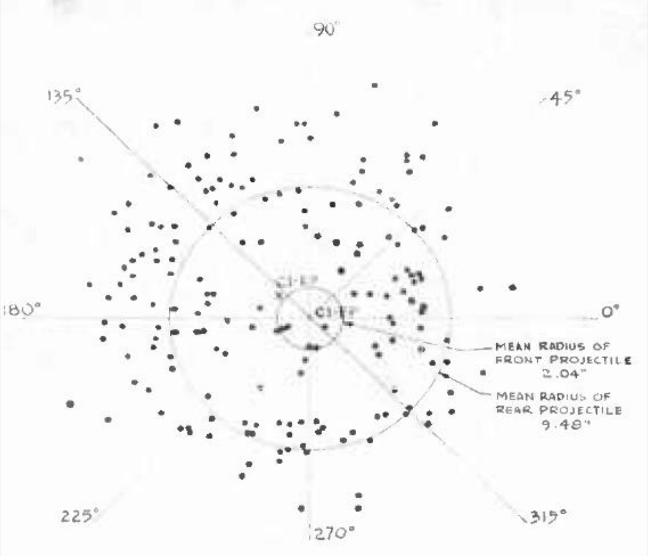
Project Salvo

Lessons Learned:

- Multiplex cartridges yielded a 74% increase in $P_{(h)}$ over single-bullet cartridges out to 500yds range and still offered viable penetration and performance across the intended target set
- Smaller calibers than .30 yielded favorable results but could not produce the same benefits at longer ranges, so .30 caliber was chosen going forward



Dispersion @ 100yds



Helmet penetration @ 500yds

U.S. ARMY RDECOM

HISTORY

ARDEC

Cartridge, 7.62mm Ball, Duplex, M198

- USG Type-Classified 7.62mm cartridge
- Interoperable with unmodified M14 rifle
- Tighter dispersion than all previous multiplex cartridges
- Penetrated helmets and helmet liners at 500yds
- Similar lethality characteristics to conventional ammo
- Produced at Frankford Arsenal

*However, in 1965 the M198 Duplex was considered **not suitable** for Army use due to the fact that it did not offer a ***substantial*** combat advantage over the standard ball cartridge.

ARDEC Armament Evolution

PROBLEM

Enemy Forces are becoming:

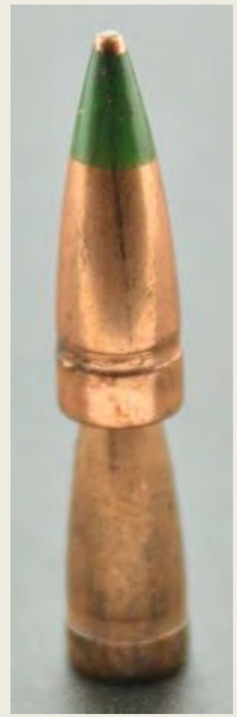
- Faster
- More agile
- Harder to defeat
- More capable

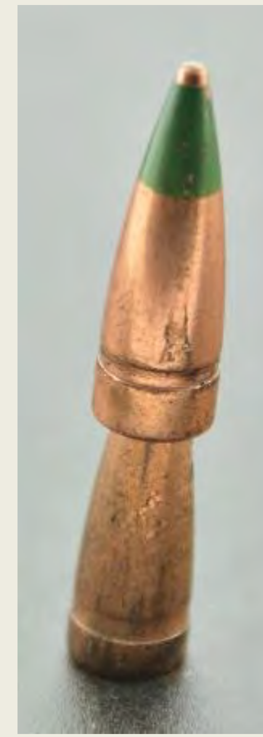
OBJECTIVE

ARDEC must remain a step ahead of the emerging/evolving threat spectrum through ***superior armament design***

ARDEC Armament Evolution

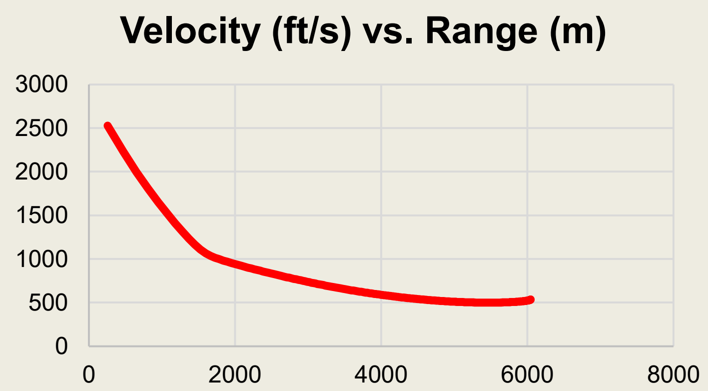
- Leverage of historical data and concepts
- Iterative design process
    - Cutting edge modeling & simulation
    - Extensive testing, state-of-the-art data acquisition equipment

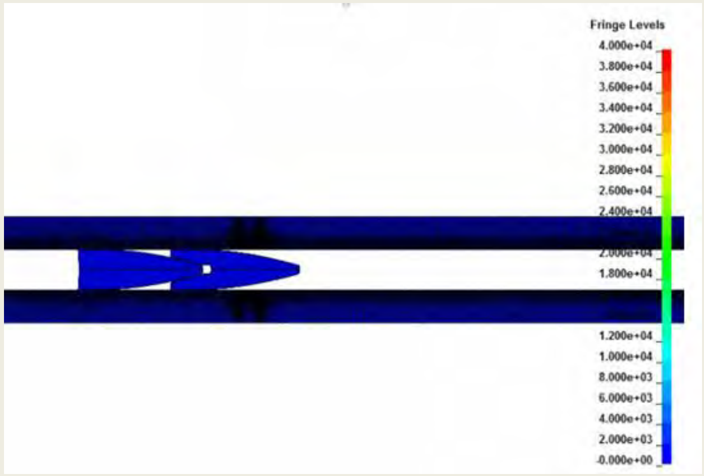


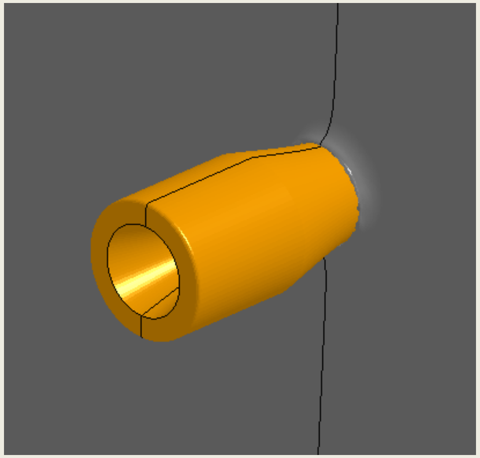


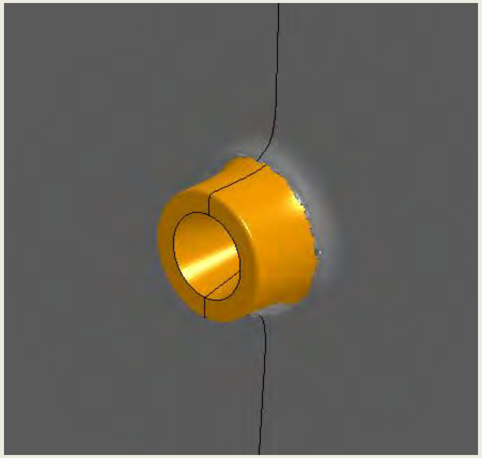
Modeling & Simulation

- Aeroballistics
- In-Bore
- Terminal



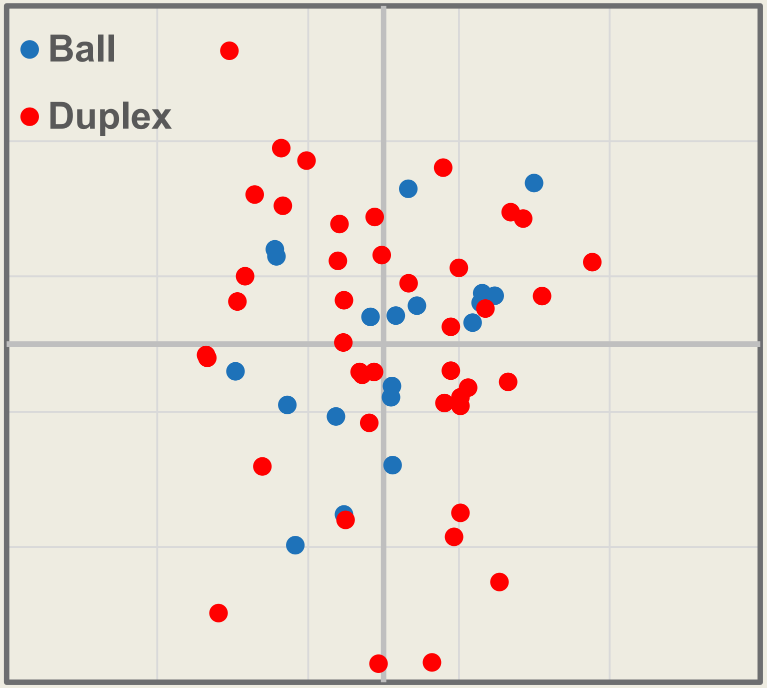






Testing

- EPVAT
- High-Speed Video
- Radar
- Electronic Accuracy Scoring



ARDEC Armament Evolution

→ Scalable multiplex cartridge technology

→ Proven performance benefits

ARDEC Armament Evolution

Performance Benefits:

- Increased $P_{(h)} \rightarrow$ Increased $P_{(i)}$
- Lower collateral damage
- Increased threat suppression
- Smaller Surface Danger Zone (SDZ)
  - Enhances useable battlespace
  - Allows for more training range options
- Scalable technology allows for use in various weapon systems
- Reconfigurable technology allows for mission adaption

QUESTIONS?

Christopher Parisi

ARDEC Project Officer

US Army ARDEC

Bldg 65N

Picatinny Arsenal, NJ 07806

christopher.c.parisi.civ@mail.mil

973-724-9878

Target Acquisition
Fire Control Technology
Presentation + Panel Discussion

(10 Minute Presentations)

Naval Surface Warfare Center, Crane Division

Crane, IN

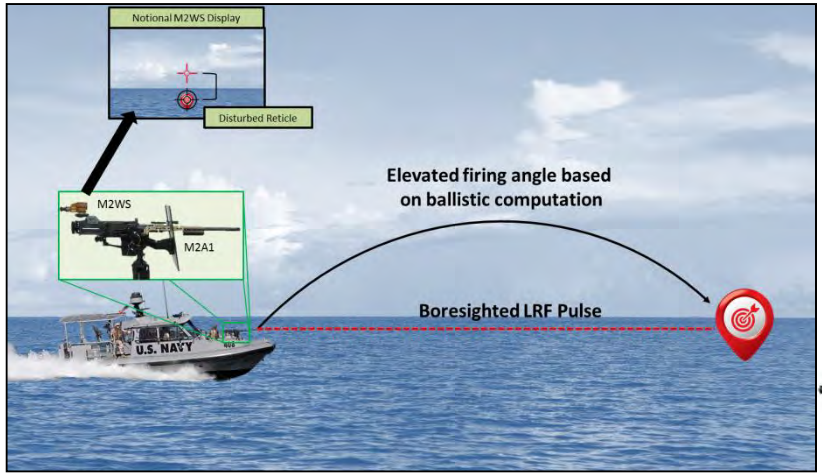
Gregory Petty

10 May 2018

NDIA Armament Conference / Small Arms Division Themes
"Armament System Response to the Evolving Threat Spectrum"
"Small Arms Technology Which Creates Asymmetric Operational Advantage for Soldiers, Sailors, Airmen and Marines"

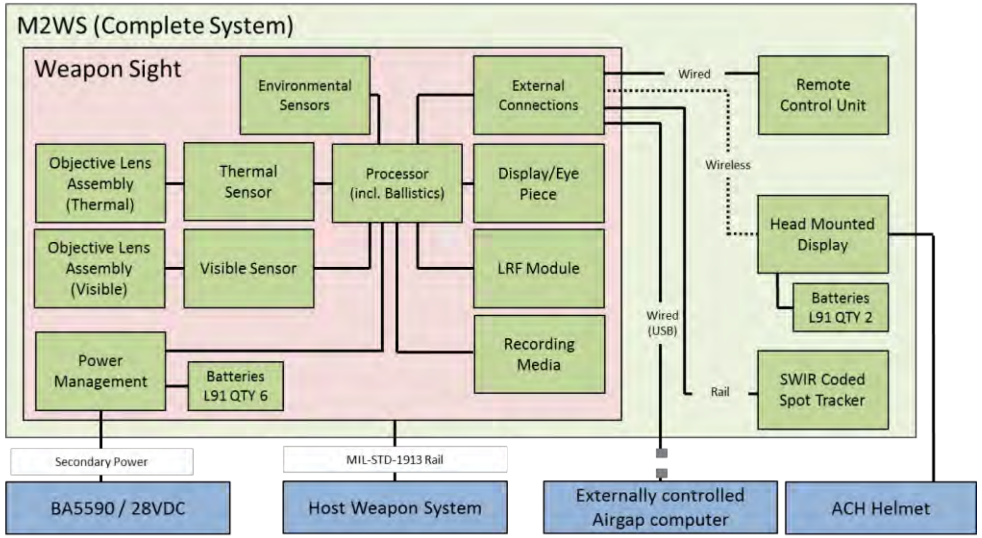
M2 Weapon Sight (M2WS)

The M2 day/night Weapon Sight (M2WS) is an integrated system under development that will provide the Warfighter with both thermal and visible spectrum imaging capabilities for crew-served weapons such as the M2HB/M2A1. Additionally, the M2WS takes advantage of the integrated laser range finder (LRF) and environmental sensors to provide the user a disturbed reticle based on an automatic ballistic calculation to improve the probability of first round hit.



Notional System Usage

Preliminary M2WS Model



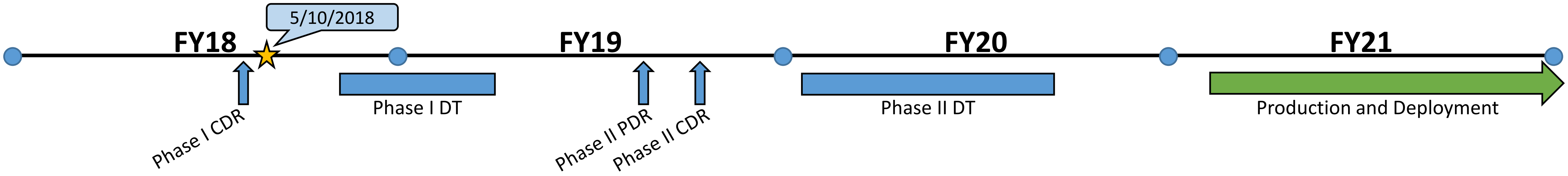
- Provides target detection capabilities out to the effective range of the host weapon.
- Enables improved target detection in adverse weather.
- Utilizes LRF and environmental sensors to improve probability of first round hit.
- Records Motion Imagery (MI) to support after action reporting and training exercises.

System Response to the Evolving Threat Spectrum

- Aspects of Evolving Threat Spectrum
  - Increased target detection range equates to increased decision time.
- Highlight Fire Control Technology Capabilities to Cope with Emerging Threats
  - Combination of imaging sensors provides greater capability to the warfighter
    - Visible, Long Wave Infrared, Short Wave Infrared
  - Decision making and crew-served weapon operation still left to the warfighter.
  - Disturbed reticle capability
- Prioritization to Balance Needs
  - Inherent trade off in all EO/IR sensors – target detect range vs. Field of View (FOV)
  - SWaP-C
    - Weight is less critical for crew-served applications; limits utility on shoulder fired weapons.
    - Multiple sensors, LRF, HMD, and recording function limit the system run time.

True Operational Advantages for Soldiers, Sailors, Airmen and Marines

- The M2WS gives warfighters increased target acquisition and fire control capability for crew-served weapon systems through the use of multiple imaging sensors, laser range finder, and disturbed reticle capability.
  - Use of the M2WS over existing crew-served weapon aiming solutions include:
    - Increased first round hit % via LRF and ballistic offset
    - The ability to detect targets 24/7 out to the effective range of the host weapon
- Existing Navy systems utilize products such as the SU-252/U as a thermal sight on crew-served weapons such as the M2HB and M240B.
- No COTS solutions are being pursued as interim solutions between the SU-252/U and M2WS.



Presented to:

NDIA

MISSILE S&T STRATEGIC OVERVIEW

Distribution Statement A - Approved for Public Release - Distribution Unlimited. Review completed by AMRDEC Public Affairs Office 2018. Control number 3777

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Presented by:

DR. TERRANCE R. WEST

MISSILE SCIENCE AND TECHNOLOGY

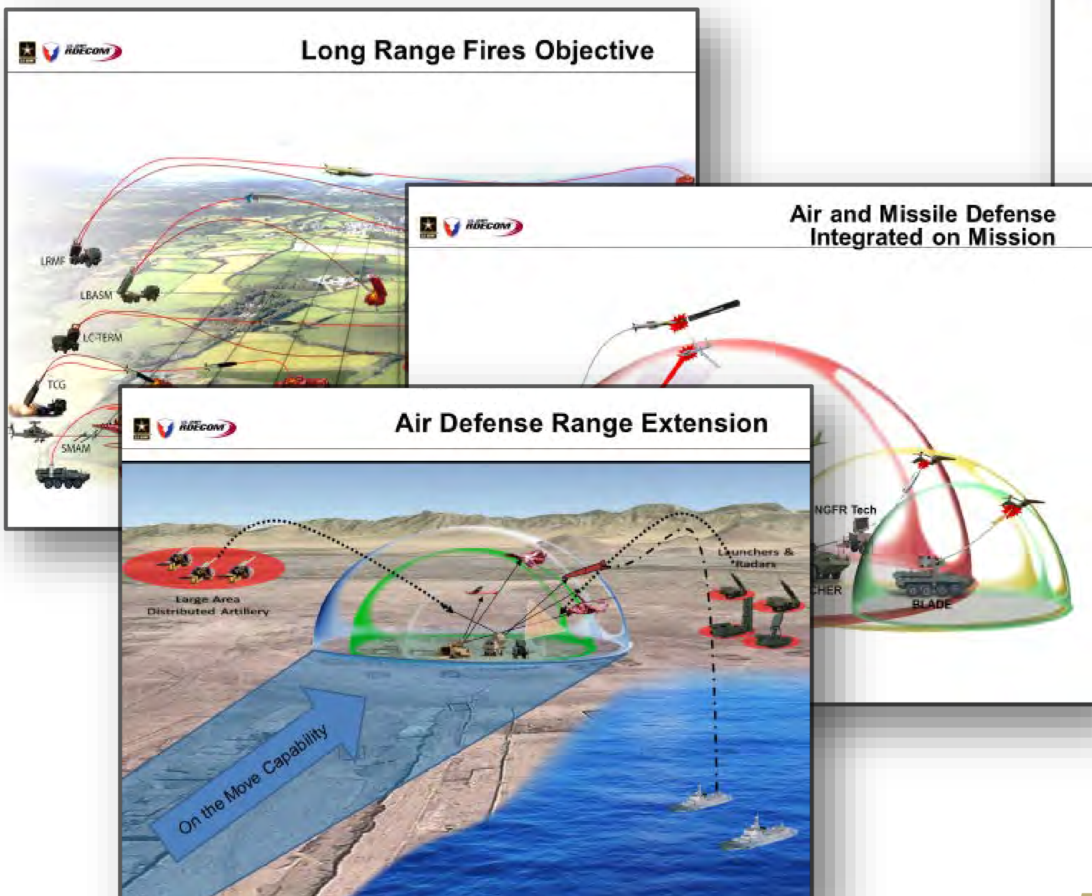
PLANS AND EXECUTION

WEAPONS DEVELOPMENT & INTEGRATION DIRECTORATE

AVIATION & MISSILE RESEARCH, DEVELOPMENT & ENGINEERING CENTER

Missile S&T Addressing the CSA Priorities

- **Engage First [Long Range Precision Fires]**
- **Expanding the Dome [Air & Missile Defense]**
- **On the Move [LRPF & AMD]**



SECRETARY OF THE ARMY
WASHINGTON

29 SEP 2017

MEMORANDUM FOR THE DEPUTY UNDER SECRETARY OF THE ARMY

SUBJECT: Science and Technology Portfolio Realignment

1. The August 2017 senior leader review of the Fiscal Year 19-23 Program Objective Memorandum determined that the investment portfolio does not fully support the Army's new modernization priorities:

a. Precision Fires

b. Next Generation Combat Vehicle (NGCV)

c. Future Vertical Lift (FVL)

d. Network/Command, Control, Communications and Intelligence (C3I)

e. Air and Missile Defense (AMD)

f. Soldier Lethality

AMRDEC Missile S&T Alignment to Army Modernization Priorities

U.S. ARMY RDECOM

AMRDEC

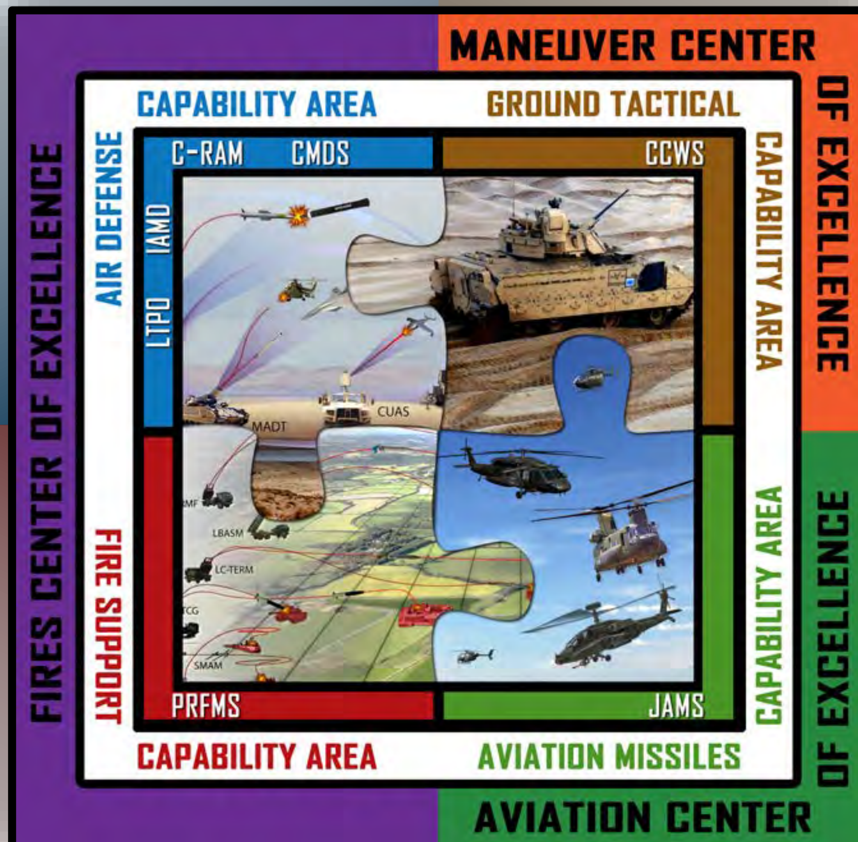
Army Modernization Priorities

Air & Missile Defense

Technologies for the development of mobile air defense systems that reduce the cost curve of missile defense, restore overmatch, survive volley-fire attacks, and operate within sophisticated A2AD and contested domains

Long Range Fires

Technologies for the development, integration and delivery of long range fires at the tactical, operational, and strategic echelons to restore overmatch, improve deterrence, and disrupt A2AD on a complex, contested and expanded battlefield.



Next Generation Combat Vehicle

Technologies for active protection systems that will increase our ability to survive and win in the complex and densely urbanized terrain of an intensely lethal and distributed battlefield where all domains are continually contested.

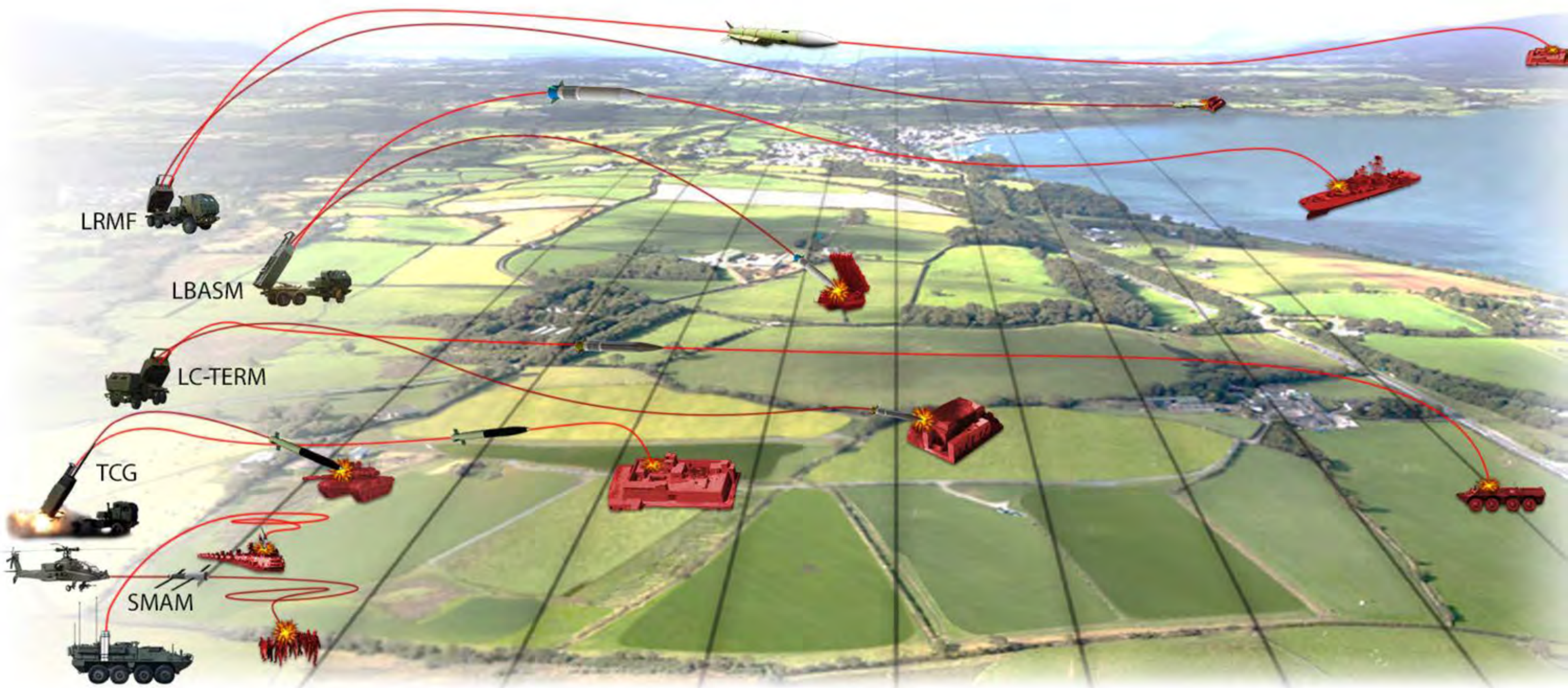
Technologies for enhanced lethal effects that will increase our capability to win in the complex and densely urbanized terrain of a lethal and distributed battlefield.

Future Vertical Lift

Technologies for the development, integration, and delivery of aviation launched air-to-ground and air-to-air missile systems to restore overmatch within sophisticated A2AD and contested domains

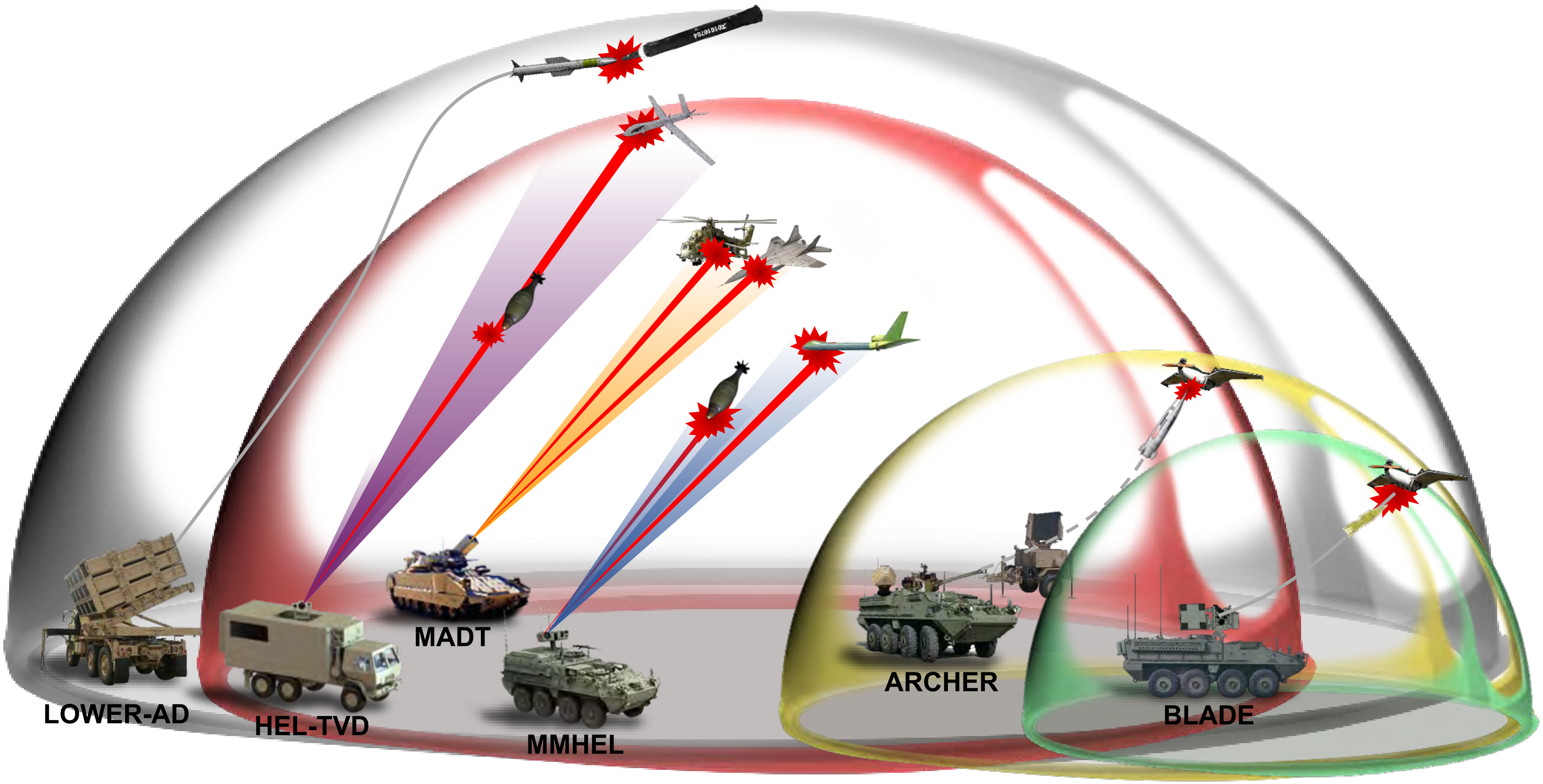
ENGAGE FIRST **EXPAND THE DOME** **ON THE MOVE**

Long Range Precision Fires Objective



Provide Capability to Engage Targets at Extended Range

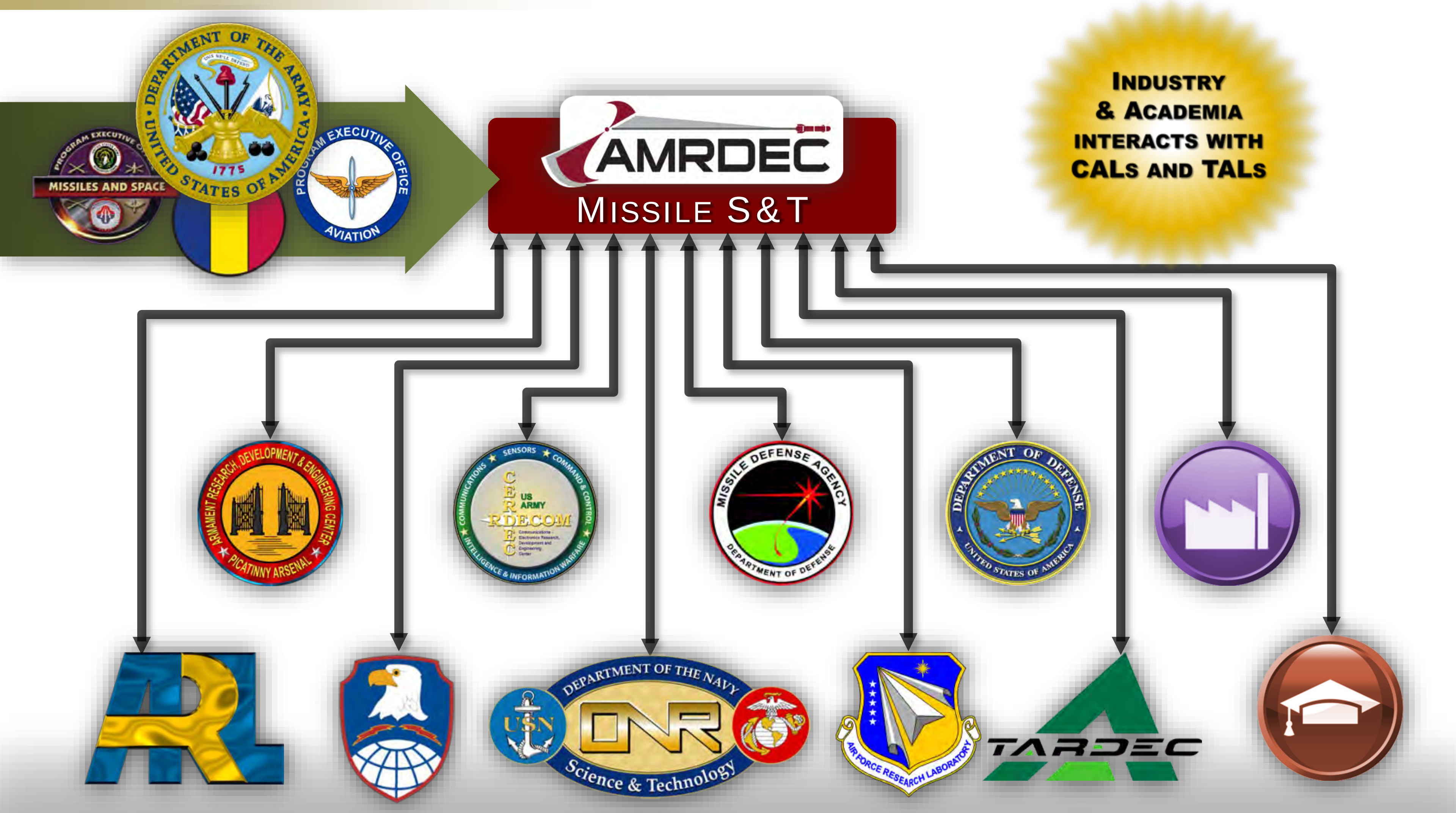
AMD Objective



Provide Capability to Engage Targets at Extended Range

AMRDEC Missile S&T Aligned to Army Priorities

Missile S&T Collaboration



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AMRDEC-PAO@amrdec.army.mil

9MM SMAW MK217 CARTRIDGE

A Wild Ride – for a wild & weird cartridge

NDIA ARAMAMENTS MAY 10, 2018

Indianapolis, IN

9MM SMAW CARTRIDGE

A Wild Ride because …..

1) Extremely unique cartridge – numerous technical challenges

2) Long personal/company history going back over 35 years with my father – Brass Extrusion Labs Ltd.(B.E.L.L.) and MAST Technology

3) On its <u>*last production run*</u> for the last 20 years, including this current run on a 5 year IDIQ

4) Tail wagging the dog on velocity – cartridge sets rocket velocity, in some cases. Ballistic match to the rockets.

5) MAST was founded to go after this contract

6) This was Brass Extrusions first intro into DOD contraxcts

9MM SMAW CARTRIDGE

Overall History –

-Israeli Design – unverified

-Radaway Green Build in Late 1970's

-Brass Extrusion Labs Limited Build in 1980's for McDonald Douglas

-MAST founded July 1990 to go after SMAW Cartridge

-MAST Build for ATK in 1993

- MAST lost 1st Army contract 1994 only to return after competitor T/D

- Multiple MAST builds including current 5 year for Nammo-Talley to US Army

TARGET EFFECTS

MUNITIONS	HEDP High Explosive Dual Purpose		HEAA High Explosive Anti-Armor		CPR Common Practice Round	
ENCASED ROCKET:						
Length:	29.50 in	74.93 cm	33.20 in	84.33 cm	29.50 in	74.9 cm
Weight:	13.10 lb	5.95 kg	14.10 lb	6.40 kg	13.25 lb	6.01 kg
ASSAULT ROCKET:						
Length:	22.2 in	56.4 cm	32.4 in	82.3 cm	22.0 in	55.9 cm
Weight:	9.58 lb	4.35 kg	9.72 lb	4.41 kg	9.66 lb	4.38 kg
WARHEAD:						
Length:	7.5 in	19.05 cm	16.0 in	40.7 cm		
Weight:	4.31 lb	1.96 kg	3.55 lb	1.61 kg		
WEAPON READY-TO-FIRE:						
Length:	54.25 in	137.80 cm	54.25 in	137.80 cm	54.25 in	137.80 cm
Weight:	26.00 lb	11.80 kg	27.80 lb	12.62 kg	26.00 lb	11.80 kg

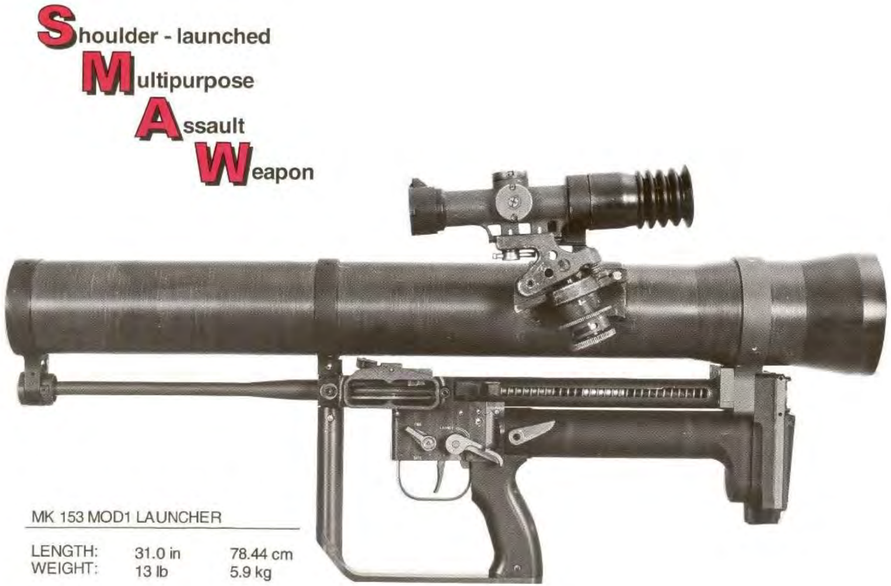
MUZZLE VELOCITY: 720 ft/sec (nominal) 219 m/s

FIRING RANGE: 500 meters

CMS Defense Systems
P.O. Box 5990 · Titusville, FL 32783
Tel: 1-407-268-4020 · Fax: 1-407-268-0474

9MM SMAW CARTRIDGE

Personal History –
B.E.L.L. - Early 80's Target Pit Crew
B.E.L.L. - Mid 80's Packing into 20 Rd boxes
MAST – Mid 90's machine operator
MAST – Mid 90's Outdoor Range Ballistician
MAST – Late 90's Program Manager
MAST – Early 2000's B/P & PM
MAST – Late 2000's B/P & SME
MAST – Late 2010's B/P & SME

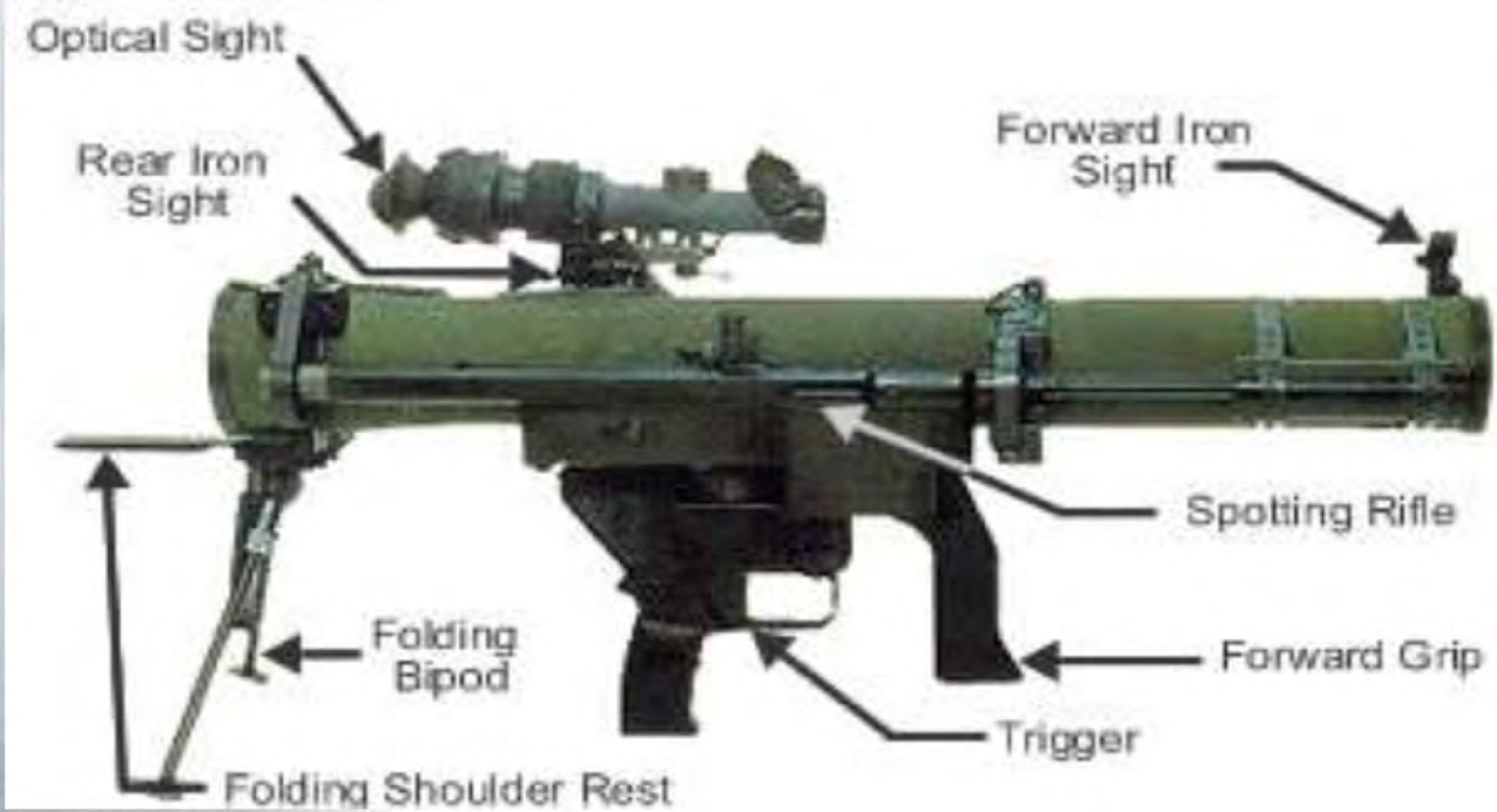


9MM SMAW CARTRIDGE

Cartridge Purpose –

1) Spotting Cartridge for SMAW Rocket – HEDP, HEAA & CP
2) Ballistic Match to 83mm Rocket – same Arc and trajectory
3) Lasers not developed in 70's and 80's
4) Lasers don't work well in snow, rain or other interference
5) Spotting Cartridge act similar to rocket in wind & environmental
6) Similar to AT4 and other shoulder launched

9mm SMAW Weapon



MAST TECHNOLOGY

83mm SMAW Rockets

HIGH EXPLOSIVE DUAL PURPOSE (HEDP) ROCKET

HIGH EXPLOSIVE ANTI-ARMOR (HEAA) ROCKET

	LENGTH	WEIGHT
■ Weapon ready-to-fire with HEDP	54 in.(1372 mm)	28.9 lb.(13.13 kg)
with HEAA	54 in.(1372 mm)	30.7 lb.(13.95 kg)
■ Launcher as carried Common to HEDP and HEAA	32.5 in.(825 mm)	16.6 lb.(7.5 kg)
■ Encased rocket as carried		
HEDP	29.5 in.(749 mm)	13.1 lb.(5.95 kg)
HEAA	33.2 in.(843 mm)	14.1 lb.(6.4 kg)

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
P.O. Box 516
St. Louis, Missouri 63166
USA

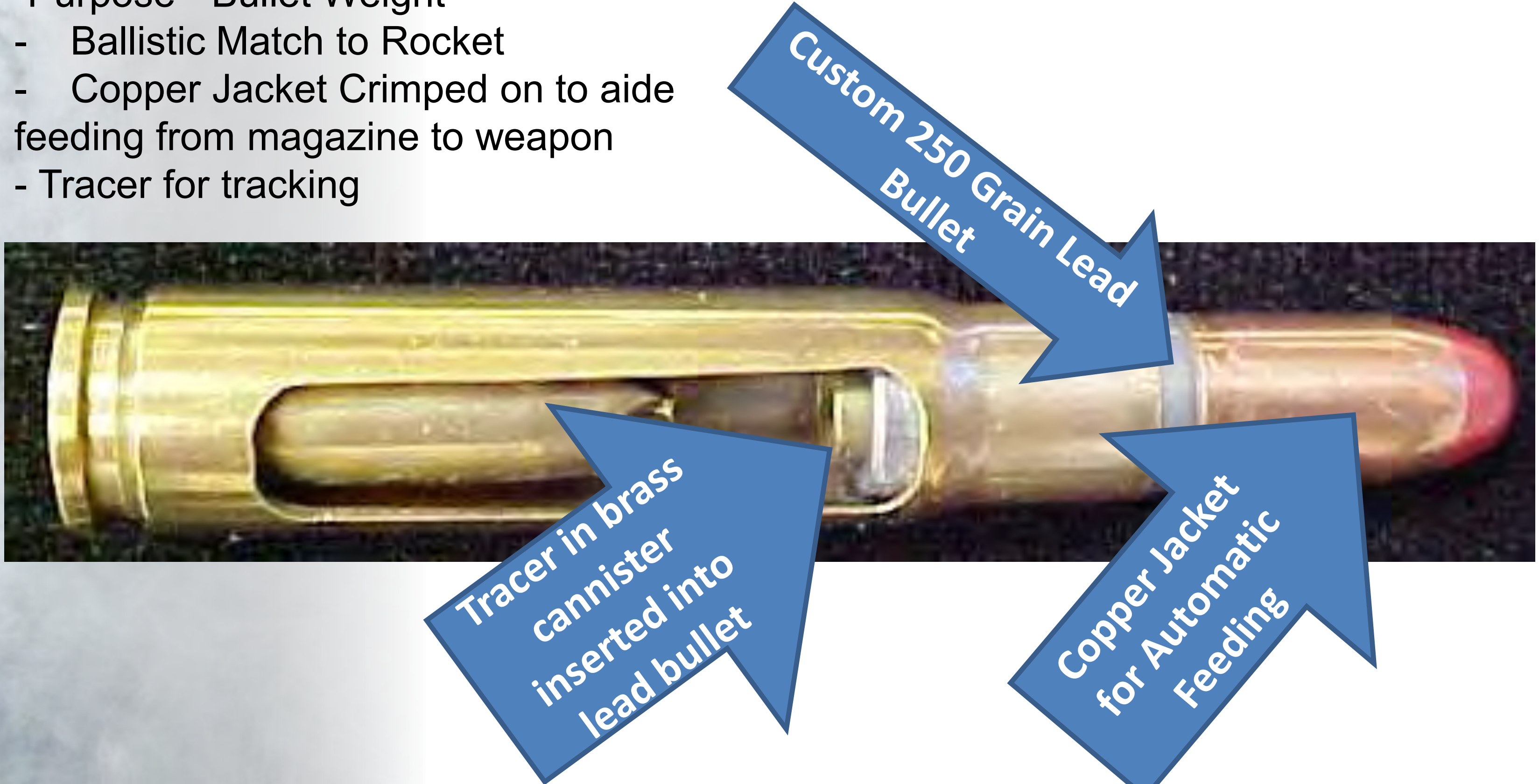
M/C 306-4225
FAX 314-777-4836

C10/9CA-05KA2

CARTRIDGE DETAILS

CTG DETAILS – CUSTOM PROJECTILE

-Purpose - Bullet Weight
- Ballistic Match to Rocket
- Copper Jacket Crimped on to aide feeding from magazine to weapon
- Tracer for tracking



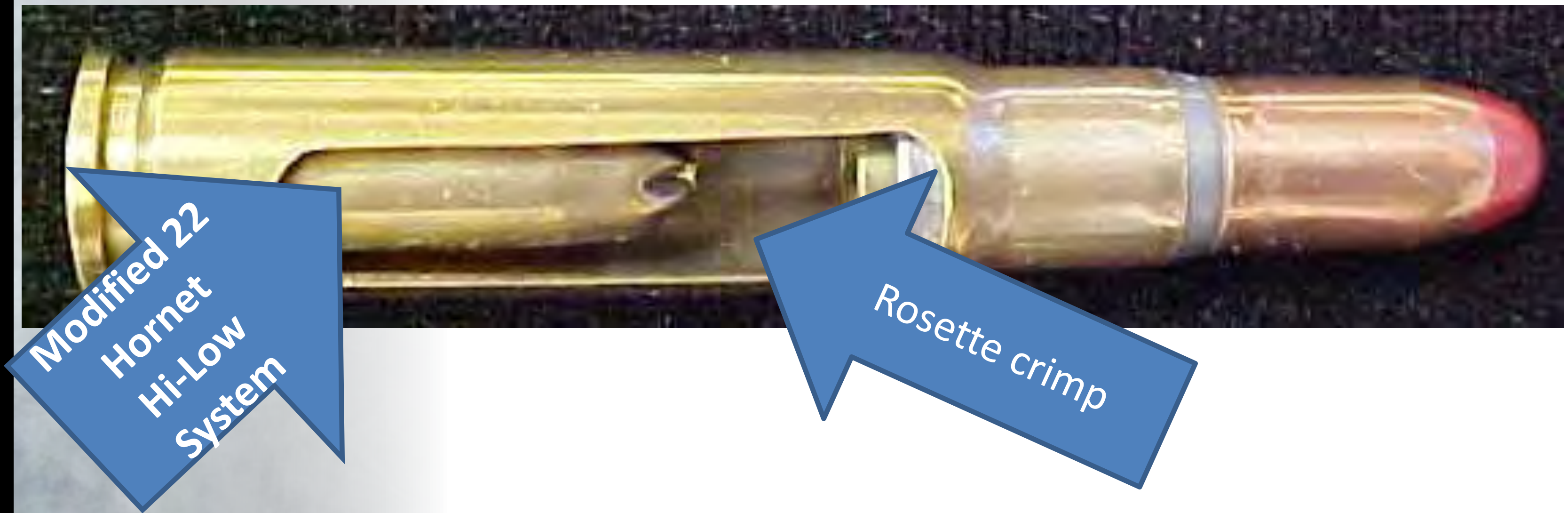
CARTRIDGE TECHNICAL CHALLENGES

TDP/Spec Issue – Trace burn in lead bullet. Lead melts – who knew?

- 6 seconds burn is not uncommon
- Static Burn images below. 100% cannister separation in flight at 350-400M

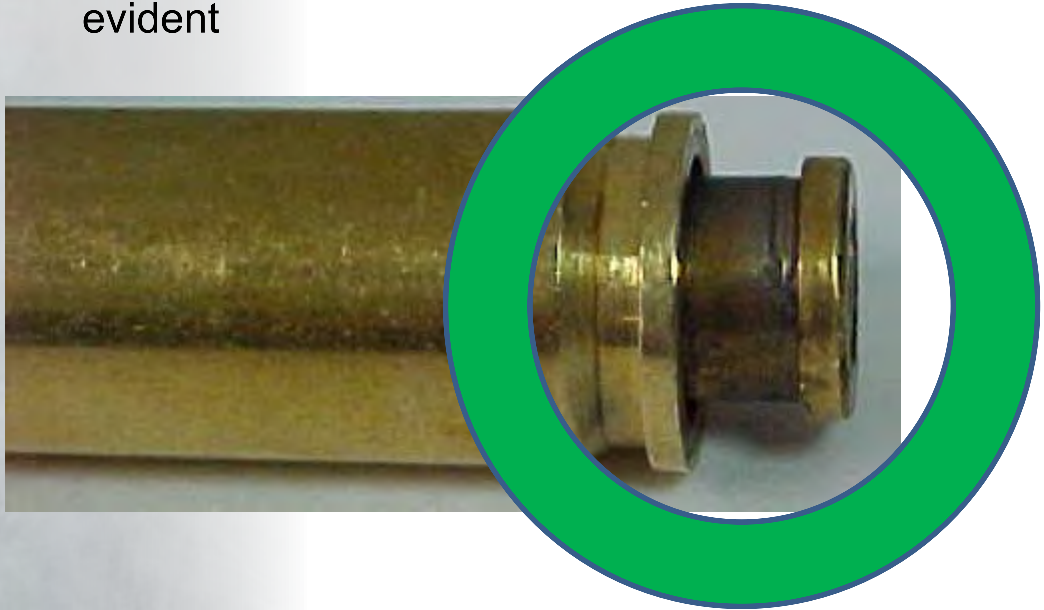
CTG DETAILS HI-LOW SYSTEM

Purpose – 22 Hornet
- Hi-low system to contain propellant in controlled and have more consistent propellant burn & velocity
- To give ‘blow back’ to allow the weapon bolt to function/cycle backwards



CARTRIDGE TECHNICAL CHALLENGES

1) Blow back of Hornet required to function Semi-automatic Spotting Weapon – pictured is ideal state
2) TDP requires that hornet backs out (to cycle bolt), and gas escape is evident



CARTRIDGE TECHNICAL CHALLENGES

TDP/Spec failure

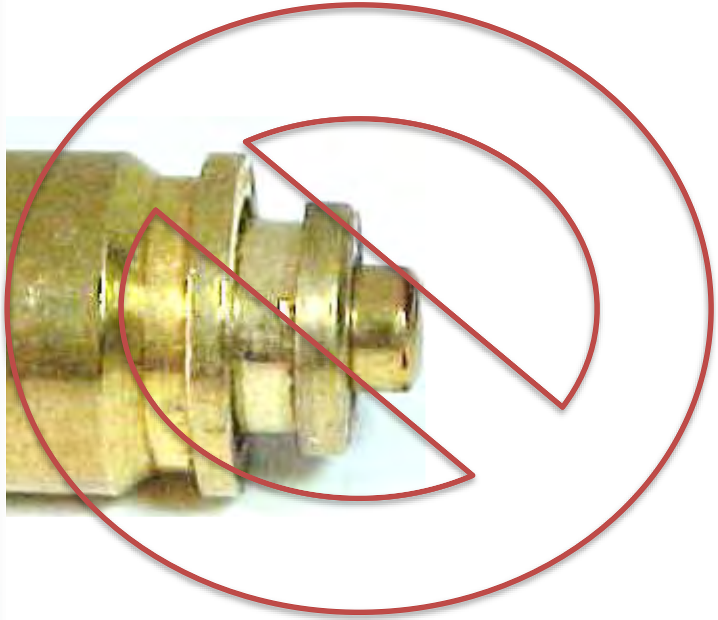
– no gas escape = lockup = failure

- result is considerably higher velocity

- Ignore primer backout for this slide (best picture available to show lockup)
- Often lockup also results in primer backout

CARTRIDGE TECHNICAL CHALLENGES

TDP/Spec failure – primer backout
Dropped primer – as always bad and could cause weapon failure



CARTRIDGE TECHNICAL CHALLENGES

Rosette crimp – the secrete sauce to ensure successful hornet backout without lockup or primer backout.

1) Asymmetrical crimp to ensure that the pedals rupture in an inconsistent manner.

2) Later we added a resize to ensure/control that the pedals open and allow the case to push backward to cycle the bolt

CARTRIDGE TECHNICAL CHALLENGES

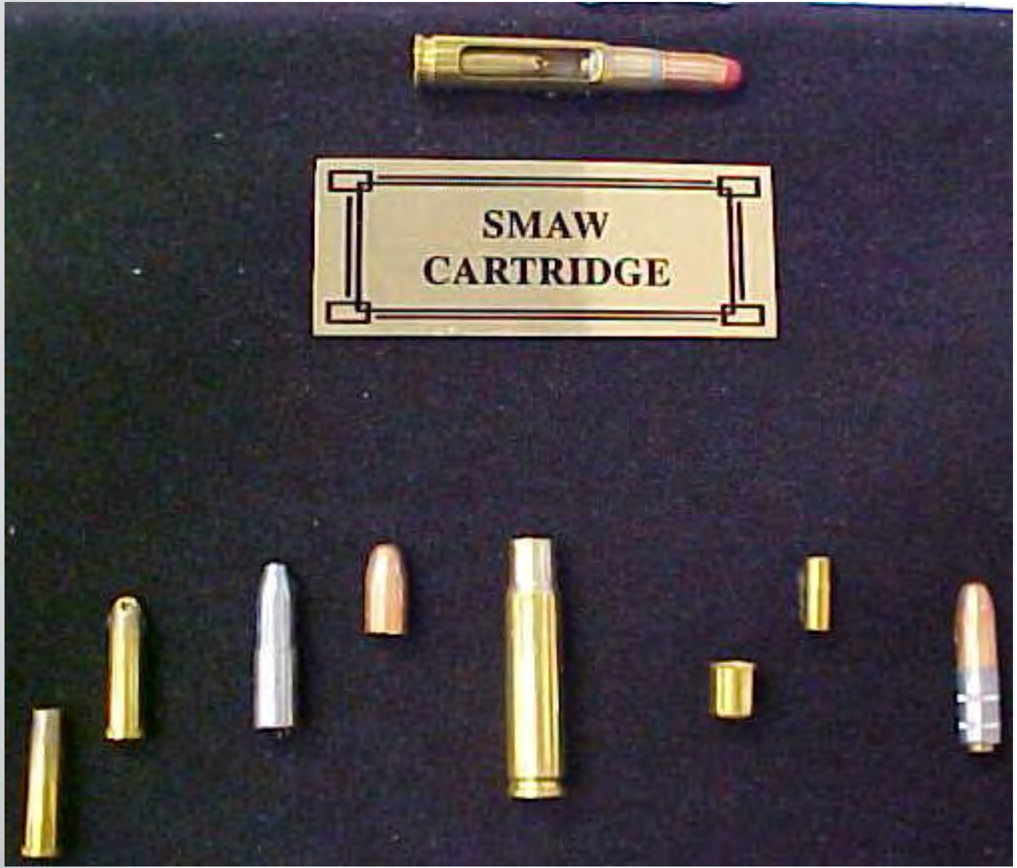
Weapon TECHNICAL Challenges

Old weapon issues created some live fire issues. MAST ended up doing weapon testing which resulted in finding a few issues with weapon.

One issue was springs that were delivered to the drawing however after 50 rounds would fail

Pictured to the right is our weapon spring testing setup

Display



Questions?

What is one thing you would Change about this Presentation?

MAST TECHNOLOGY

QUESTIONS?

Jay Bell | CEO & Majority Shareholder | *MAST Technology, Inc.*

Phone: (816) 796-0480 | jbell3@mast.bz

Adaptive Sensitivity Testing in Armaments: A Case Study

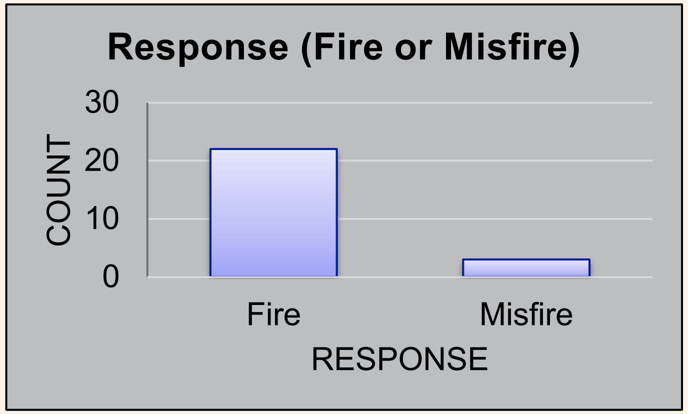
Zach Krogstad
Nick Tashjian
Chris Drake
Doug Ray

NDIA

9 May 2018

BACKGROUND

Modern statistical computing has enabled sensitivity test data to be collected in a more efficient manner



This is applicable to all armament tests where the response is binary

A case study involving small caliber primer testing will be presented

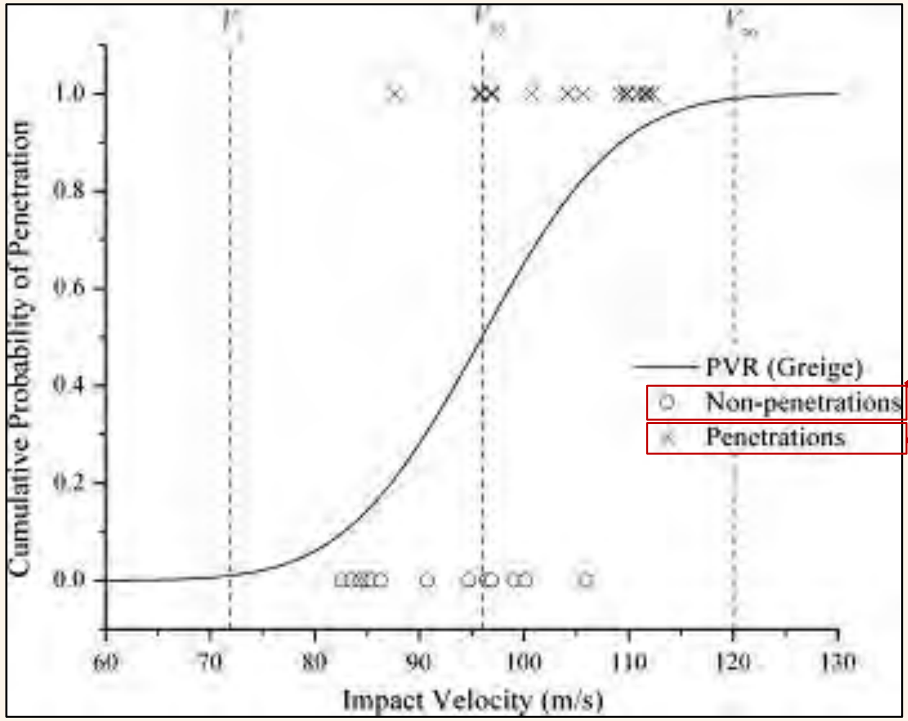
- 200,000+ primers tested per year at LCAAP
- 300 - 600 primers per test
- **Modern methods can reduce this by an order of magnitude**

U.S. ARMY RDECOM

SENSITIVITY TESTING

ARDEC

A common example: armor penetration/perforation

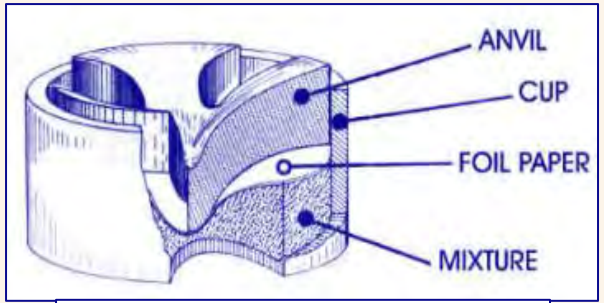


Note: Data are not linked as shown. Graph for illustrative purposes only.[1]

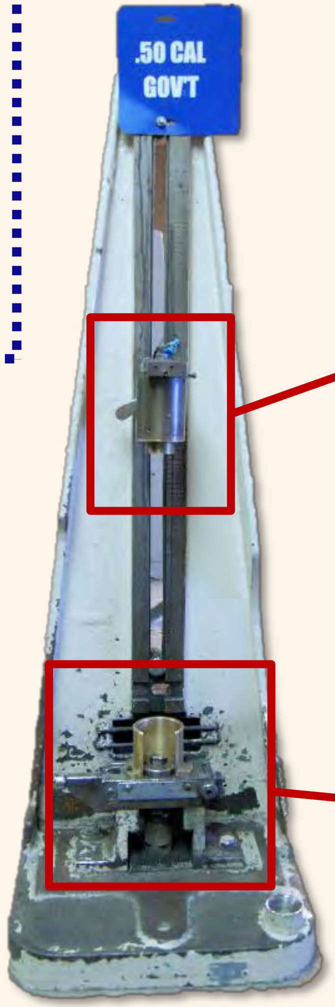
Impact velocity = LOW

Impact velocity = HIGH

PRIMER SENSITIVITY



Small caliber primer



A steel sphere (not pictured) is held in place by a magnet

(size varies per caliber)

Primed cases are placed in the test apparatus

Pseudo firing pin rests on top of primed case in fixture

The sphere is dropped at 1" intervals to generate a range of impact energies

U.S. ARMY RDECOM

THE RUNDOWN METHOD*

ARDEC

*Technically considered an application of the sigmoid dosage-mortality curve (Bliss, 1935)

1. Drop **50** at multiple **1 inch** intervals

No. Firing	No. Misfiring	INTERVALS IN VOLTAGE / HEIGHT(N)
0	50	5
3	47	6
11	39	7
30	20	8
49	1	9
50	0	10

2. Compute test statistics (Hand calculation)

3. Compute average, **H** and standard deviation, **S**

H = 7.64

S = SD * m = 0.92

4. Compare to USG limits

H + 5S	12.2	HEIGHT	<=	USL
H - 2S	5.8	HEIGHT	>=	LSL

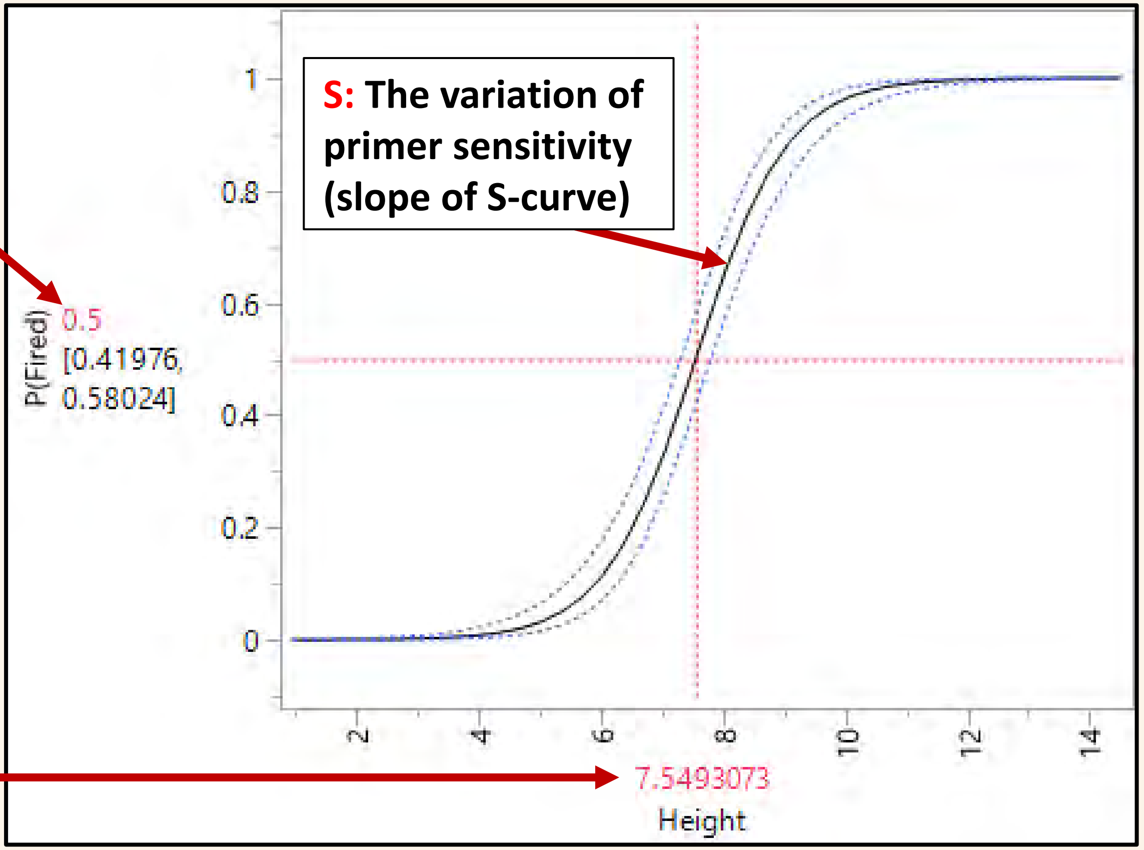
Is this lot of primers under-sensitive?

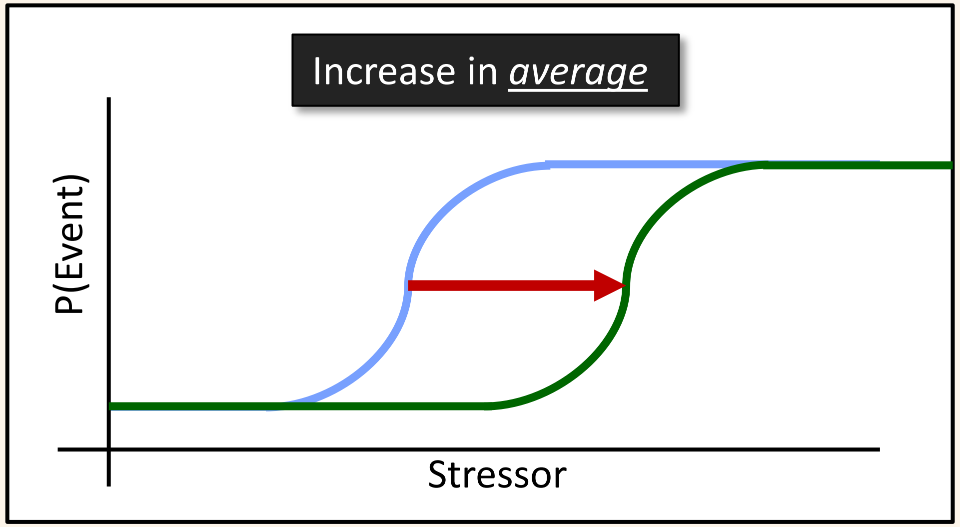
Is this lot of primers over-sensitive?

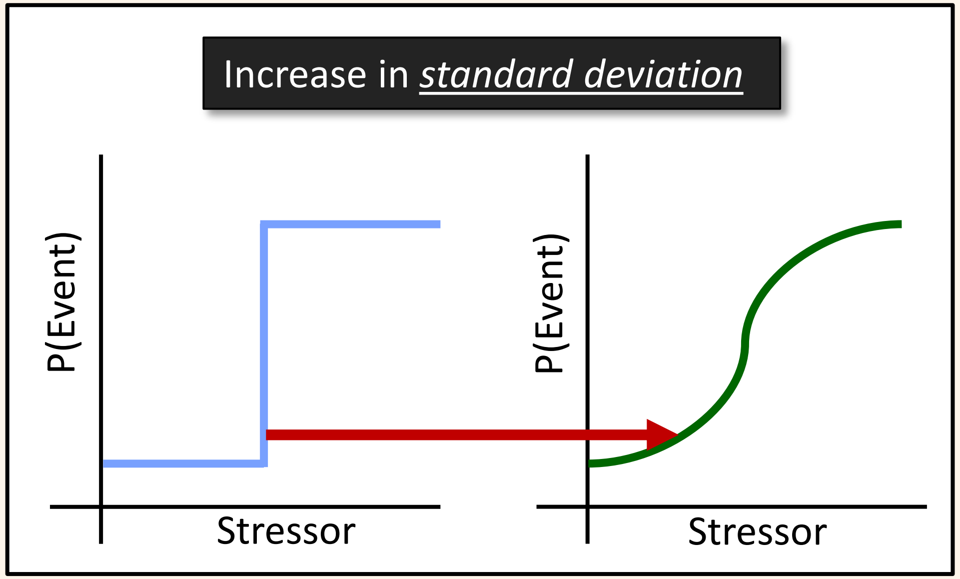
S-CURVES

H: The height at which **50%** of primers are expected to fire (center of S-curve)

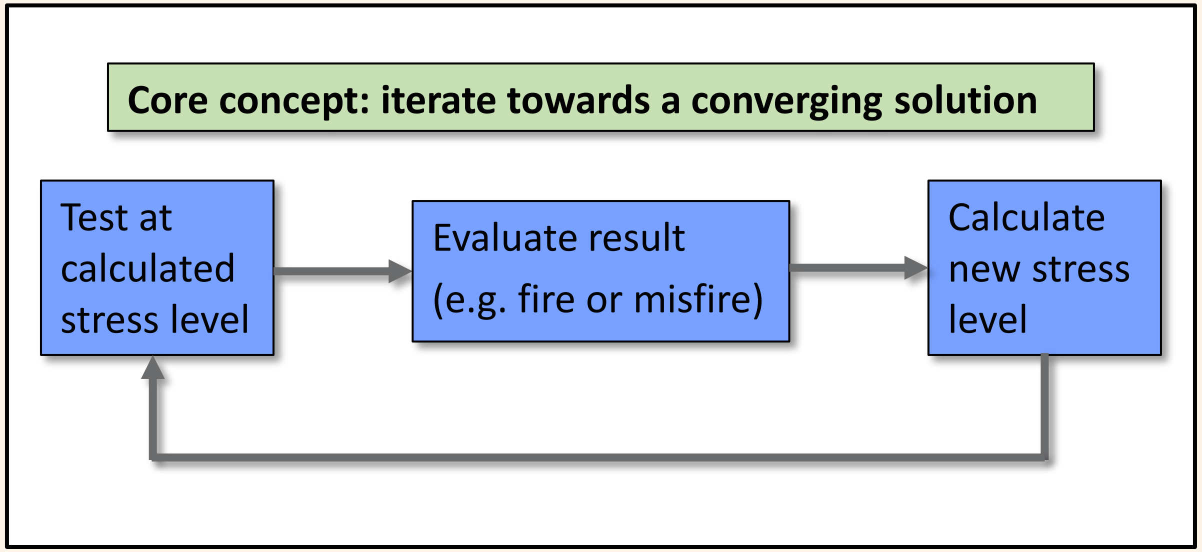
S: The variation of primer sensitivity (slope of S-curve)





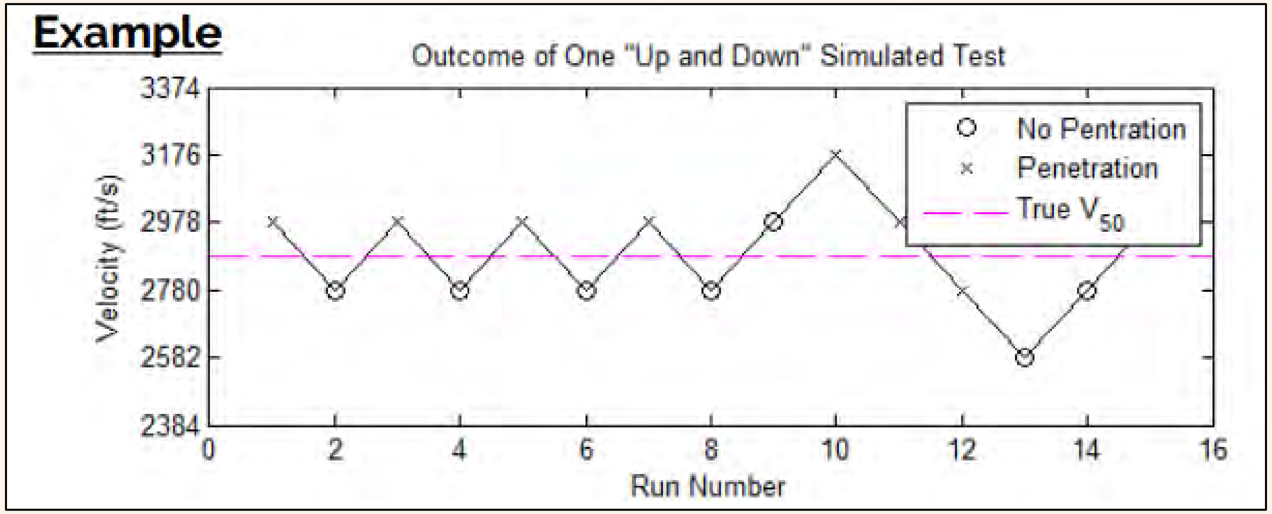


Adaptive Sensitivity Test Methods



Examples of adaptive sensitivity test methods:

- **Bruceton or Up-Down (1948)**
- **Langlie (1962)**
- **Neyer D-Optimal (1994)**
- **Robbins-Monro-Joseph (2004)**
- **3POD (2014)**



Example of Up-Down method[2]

3 Phase Optimal Design (3POD)

- Most recent adaptive method developed by Wu and Tian (2014)
- Conducted in 3 phases, as follows:

I. **Search:** *Identify a reasonable experimental range*
   1. Obtain one event of each type (e.g. 1 fire, 1 misfire)
   2. Find "overlapping region" or "zone of mixed results" (expected a fire, got a misfire, or vice versa)
   3. Refine "zone of mixed results"

II. **Estimate:** *Optimize the parameter estimation in the assumed model*
   - Utilizes D-optimal design criterion to place design points
   - "Where can I test next to gain the most amount of information?"

III. **Approximate:** *Gain more information about a percentile of interest*
   - Converges on 50^{th} percentile by default
   - What if we wanted to know V_{10}? V_{90}?

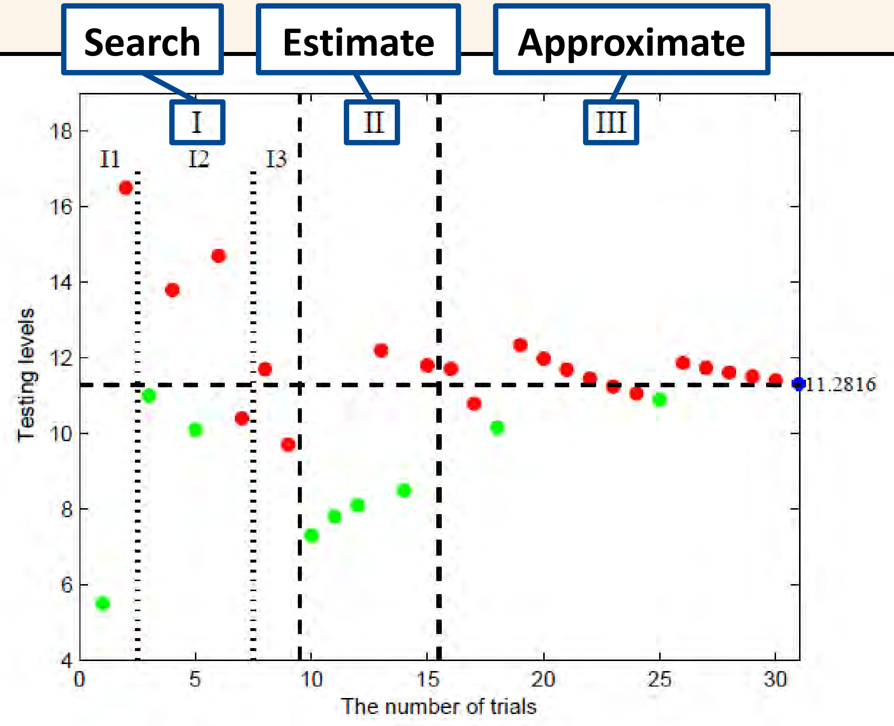
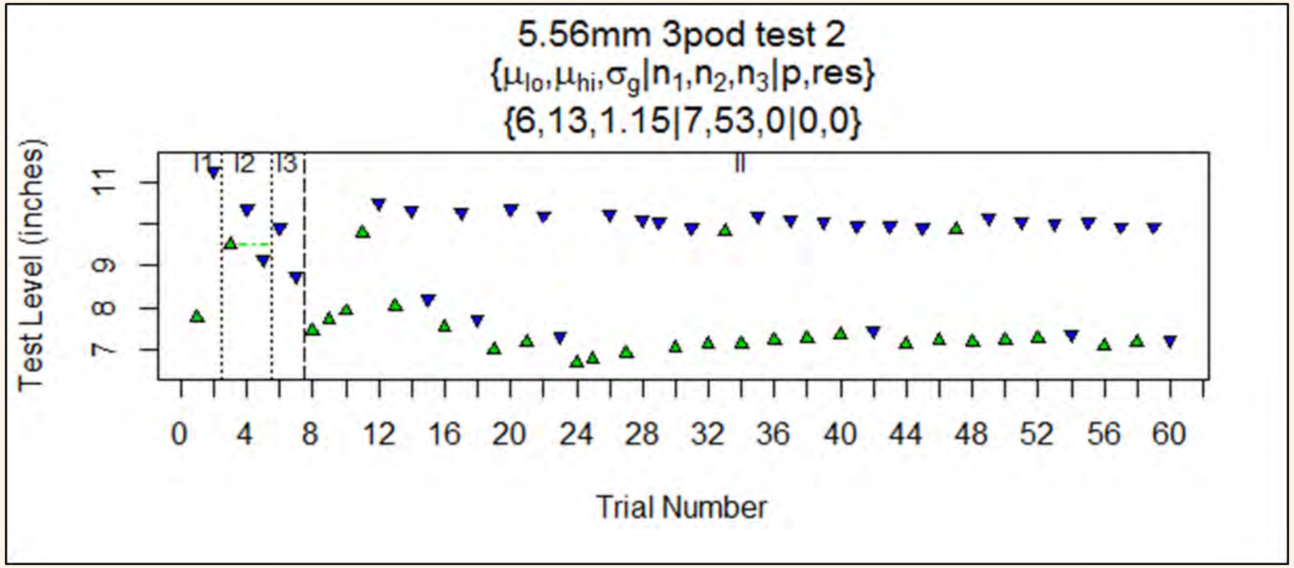


Figure 2 An illustrative example
(Note: A response is marked in red, a non-response in green.)

Example of 3POD method[3]

3POD PRIMER SENSITIVITY

- **ARDEC engineers and statisticians have conducted testing at Picatinny Arsenal and the LCAAP to evaluate efficacy of 3POD**
  - 5.56mm and 7.62mm, .50 cal in progress
- **Only Phases 1 and 2 conducted**
  - Phase 3 not necessary in this application for evaluating H_{50}
- **Most recent tests used linear position transducer to accurately measure drop height**



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SUMMARY

ARDEC

Current Method: Rundown

- **300-600** primed cases required per test
    - Time and labor intensive
- Utilizes **antiquated hand-calculation** to analyze sensitivity data
    - Dosage-mortality curve (1935)
- Uses **1" rods** to adjust drop height

New Method: 3POD

- **30-60** primed cases required per test
- Utilizes **cutting-edge statistical techniques**
    - 3POD (2014) → Regression analysis
- **No limit** to location of drop height within test range

Current Challenges

- New methods would **require modernized equipment**
    - An accurate drop height measurement system
        - E.g. linear position transducer, etc.
    - Computer access during testing
- Uncertainty in **alpha** and **beta** risks
    - **Growth in confidence intervals** resulting from fewer drops
    - Is a binary regression model a **better fit**?

"The Black Box Solution"

Primer lot sample → [• 3POD • Automated • Primers only] → **Primer lot sensitivity**

Further Reading and References

Further Reading:

- 3POD tool "Gonogo"
  - https://www2.isye.gatech.edu/~jeffwu
- "Adaptive Testing of DoD Systems with Binary Response"
  - https://www.tandfonline.com/doi/pdf/10.1080/09332480.2018.1467632?needAccess=true
- 3POD paper: "Three-phase sequential design for sensitivity experiments"
  - https://www2.isye.gatech.edu/~jeffwu/~3pod/optimal_design.pdf
- D-optimal design criteria
  - https://www.itl.nist.gov/div898/handbook/pri/section5/pri521.htm
- "Test Strategies for Experiments with a Binary Response and Single Stress Factor Best Practice"
  - https://www.afit.edu/stat/statcoe_files/Test_strategy_experiments_Binary_response_single_stress_factor_final_.pdf

References:

- [1] "Tutorial on Sensitivity Testing in Live Fire Test and Evaluation", (Johnson et al.)
  - https://www.ida.org/idamedia/Corporate/Files/Publications/IDA_Documents/OED/2016/D-5829.ashx
- [2] "Three-phase sequential design for sensitivity experiments", (Wu, Tian)
  - https://www2.isye.gatech.edu/~jeffwu/~3pod/optimal_design.pdf
- [3] "Experimental investigation of the role of frictional yarn pull-out and windowing on the probabilistic impact response of kevlar fabrics", (Nilakantan et al.)
  - https://doi.org/10.1016/j.compositesb.2014.08.033

Contributions of Variables to Velocity Deviations in Small Caliber Ammunition

Abstract #20209

Dave Stubler, Orbital ATK
Connie Lusto, ARDEC

Test Samples

5.56mm Reference Cartridge
M855 Ball

7.62mm Reference Cartridge
M80 Ball

Caliber .50 Reference Cartridge
M33 Ball

Reference Round Observations

Reference Ammunition

Manufacturing:
- Produced to minimize variation
- Single lots of subcomponents
- Single flow path through manufacturing
- Tightened manufacturing and qualification requirements

Use:
- Used to verify weapon setup
- Shot on every weapon throughout its useful life
- Fired every day before testing
- Experiences varied seasonal/environmental conditions
- Typically lasts 3 to 5 years

Barrel-to-Barrel Differences

- Lake City Ballistics Testing consumes hundreds of test barrels each year.
- Since the same lot of reference is shot through various barrels on each caliber, it is possible to evaluate barrel-to-barrel differences.

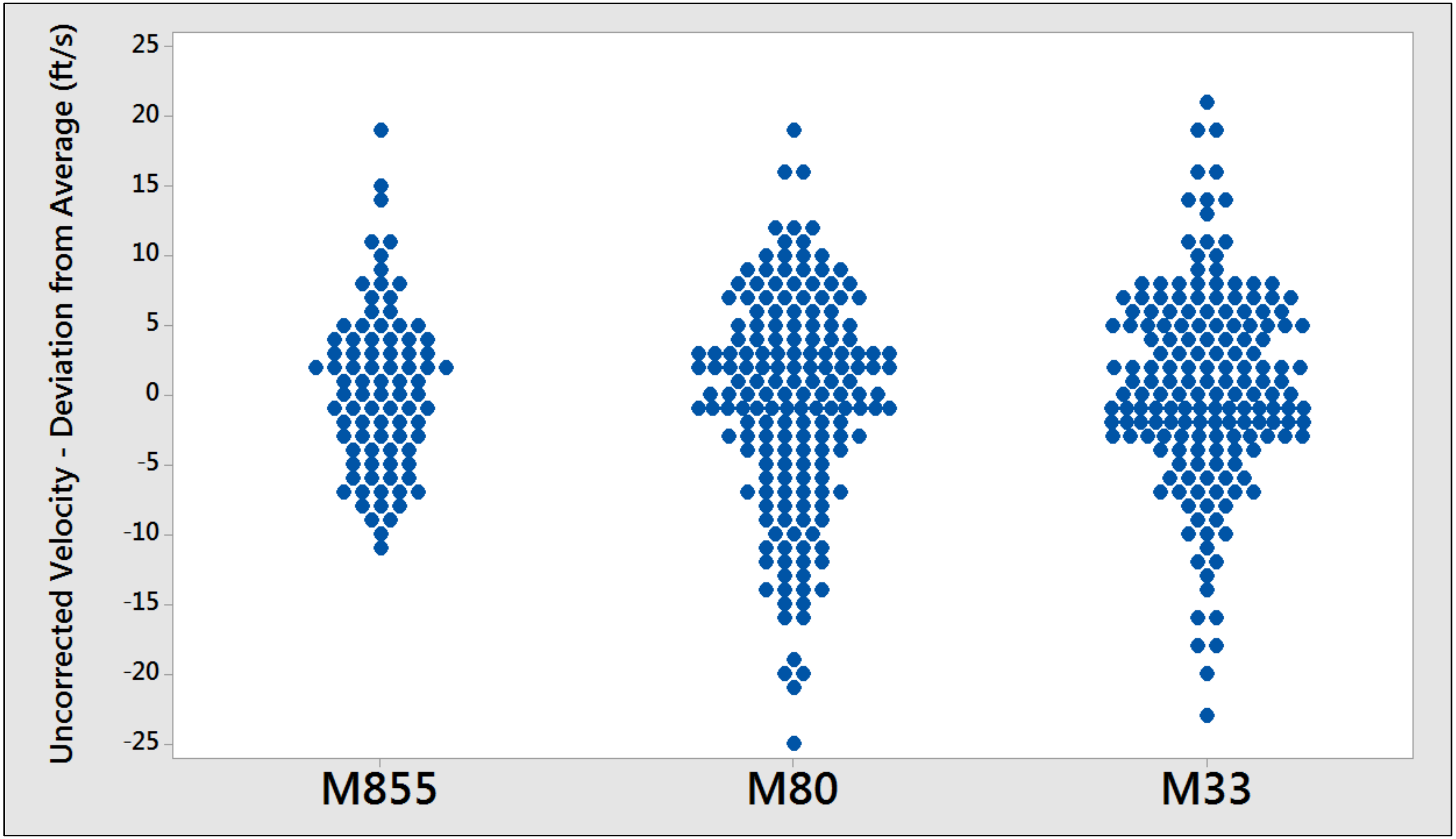
Method of Evaluation:

- Average uncorrected velocities were calculated for reference rounds fired on barrels containing between 100 and 300 rounds (cumulative).

Conclusion:

- The following barrel-to-barrel variations were observed:
    - 5.56mm (M855) = 30 ft/s
    - 7.62mm (M80) = 45 ft/s
    - Caliber .50 (M33) = 45 ft/s

Barrel-to-Barrel Velocity Deltas
(100 to 300 ROB)



Barrel to Barrel Differences: M855 = 30 ft/s; M80 = 45 ft/s; M33 = 45 ft/s

Rounds on Barrel

- EPVAT test barrels at LCAAP are retired after 1,500 rounds fired.
- Since the same lot of reference is shot prior to testing each day throughout a barrel's life, it is possible to evaluate trends based on barrel influence.

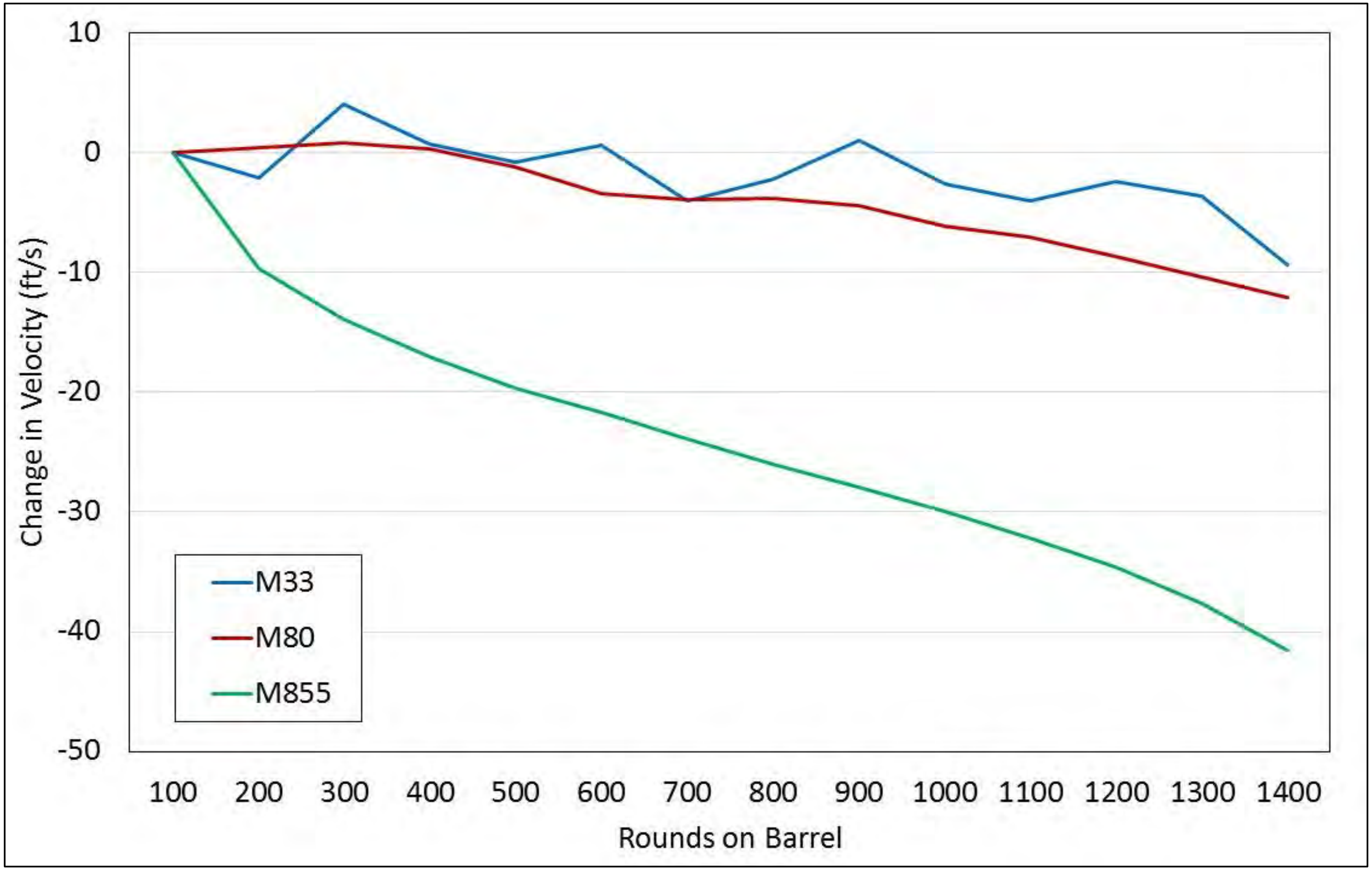
Method of Evaluation:

- Calculate the average reference round uncorrected velocity for each 100 rounds on barrel.

Conclusion:

- The following rounds-on-barrel variations were observed:
  - 5.56mm (M855) = 40 ft/s
  - 7.62mm (M80) = 10 ft/s
  - Caliber .50 (M33) = 10 ft/s

Uncorrected Velocity vs. Rounds on Barrel



M33 & M80 Average Velocity drops by 10 ft/s over the life of an EPVAT barrel
M855 Average Velocity drops by 40 ft/s over the life of an EPVAT barrel

Shot-to-Shot Differences

- Generally, reference rounds are conditioned to ambient prior to validating a test setup.
  - Rounds are taken by the gunner in small quantities from the temperature chamber to the weapon using an insulated container.
- The consistency of reference ammunition provides an excellent opportunity to evaluate shot-to-shot influences during testing.

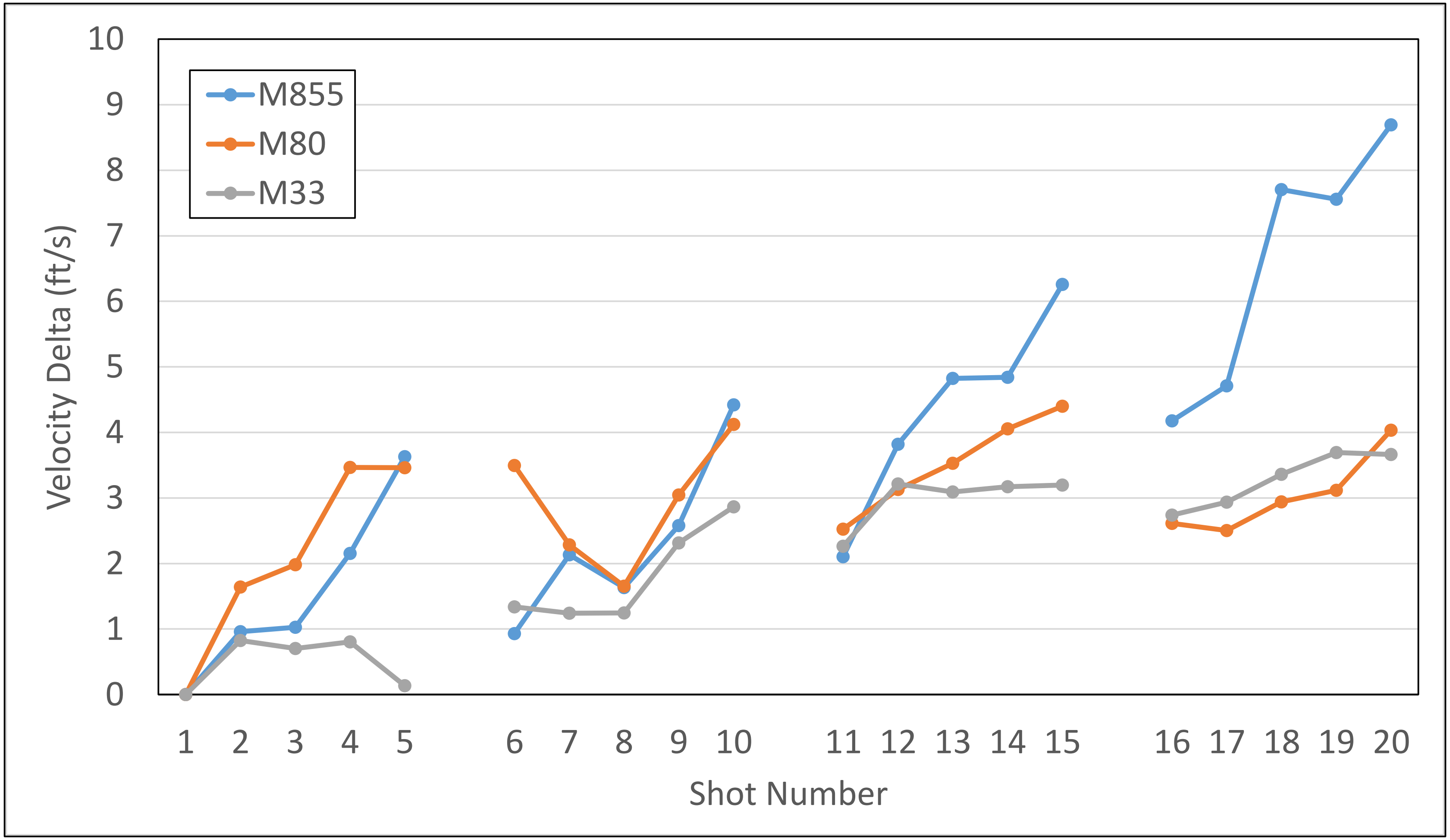
Method of Evaluation:

- Calculate the average uncorrected velocity for each round fired during the 20-round reference evaluation over a two year period.

Conclusion:

- Average velocity generally increases throughout a 20-round shot sequence as follows:
  - 5.56mm (M855) = 8 ft/s
  - 7.62mm (M80) = 4 ft/s
  - Caliber .50 (M33) = 4 ft/s

Shot-to-Shot Velocity Delta



M855 Average Velocity increases by 8 ft/s over 20 rounds fired
M33 & M80 Average Velocity increases by 4 ft/s over 20 rounds fired

Observations from Normal Production

Observations from Normal Production

- Lake City consumes many propellant lots during cartridge production.
- As with any manufactured product, propellant is subject to marginal performance variability.
- Lake City goes through a rigorous evaluation process to select a custom charge weight for each propellant lot used in its entirety during ammunition production.
- This process provides an excellent opportunity to evaluate propellant influence to velocity performance.

Propellant Charge Weights

- Propellant variations will inevitably lead to fluctuations in charge weights, and in turn, ballistic performance.
  - Grain size/distribution, deterrent placement/quantity, surface coatings, chemical weight percentage variations, moisture content, etc.
- Other variables, sometimes related to trends in subcomponents at the time of charge establishment, can also contribute to differences.
  - Web thickness, projectile weight, case volume, ullage, etc.

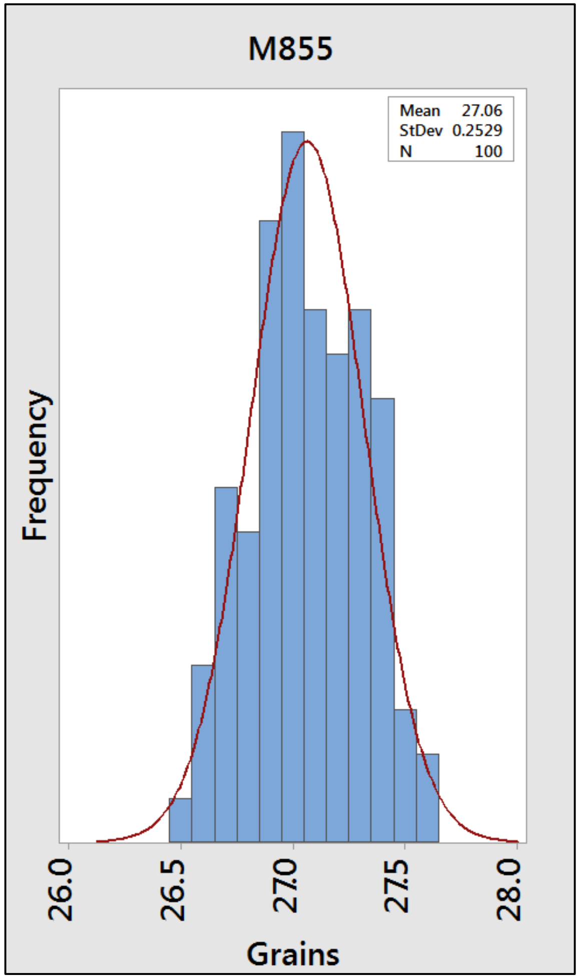
Method of Evaluation:

- Compare target charge weight for 100 propellant lots for each caliber.

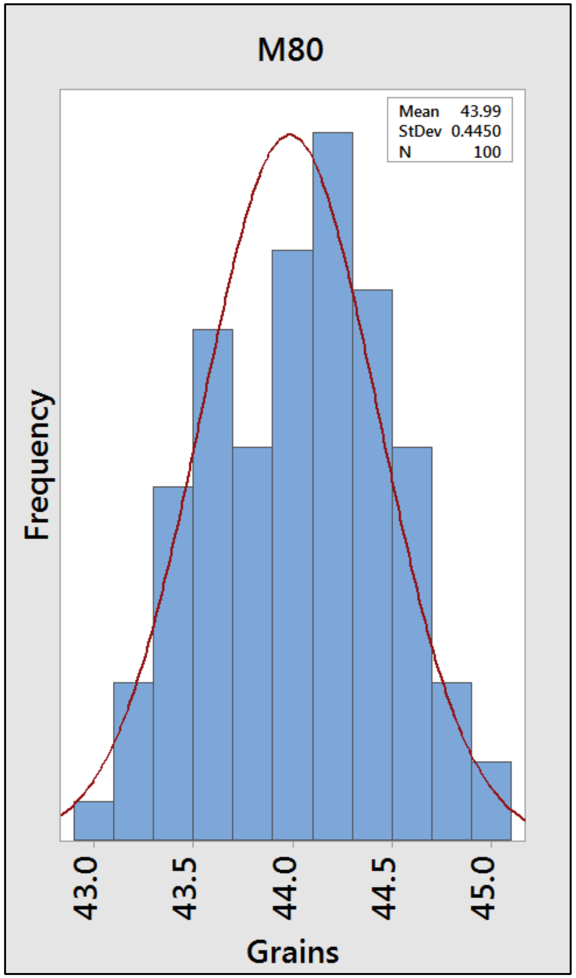
Conclusion:

- Target charge weight variations to achieve velocity requirements demonstrate the following trends:
  - 5.56mm (M855) = 1.5 grains / 6%
  - 7.62mm (M80) = 2.5 grains / 6%
  - Caliber .50 (M33) = 24 grains / 10%

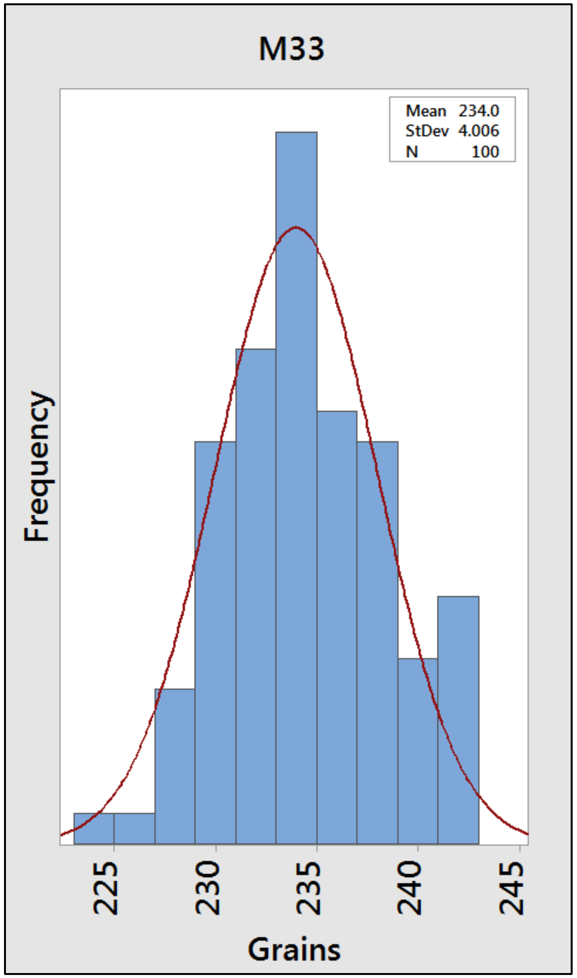
Propellant Charge Weights
(100 Propellant Lots)



1.5 grains / 6%



2.5 grains / 6%



24 grains / 10%

Charge Weight Velocity Deltas

- The propellant variables previously discussed, when paired with general variation in cartridge production, have potentially wide-spread ballistic effects when charge weights are subsequently adjusted.

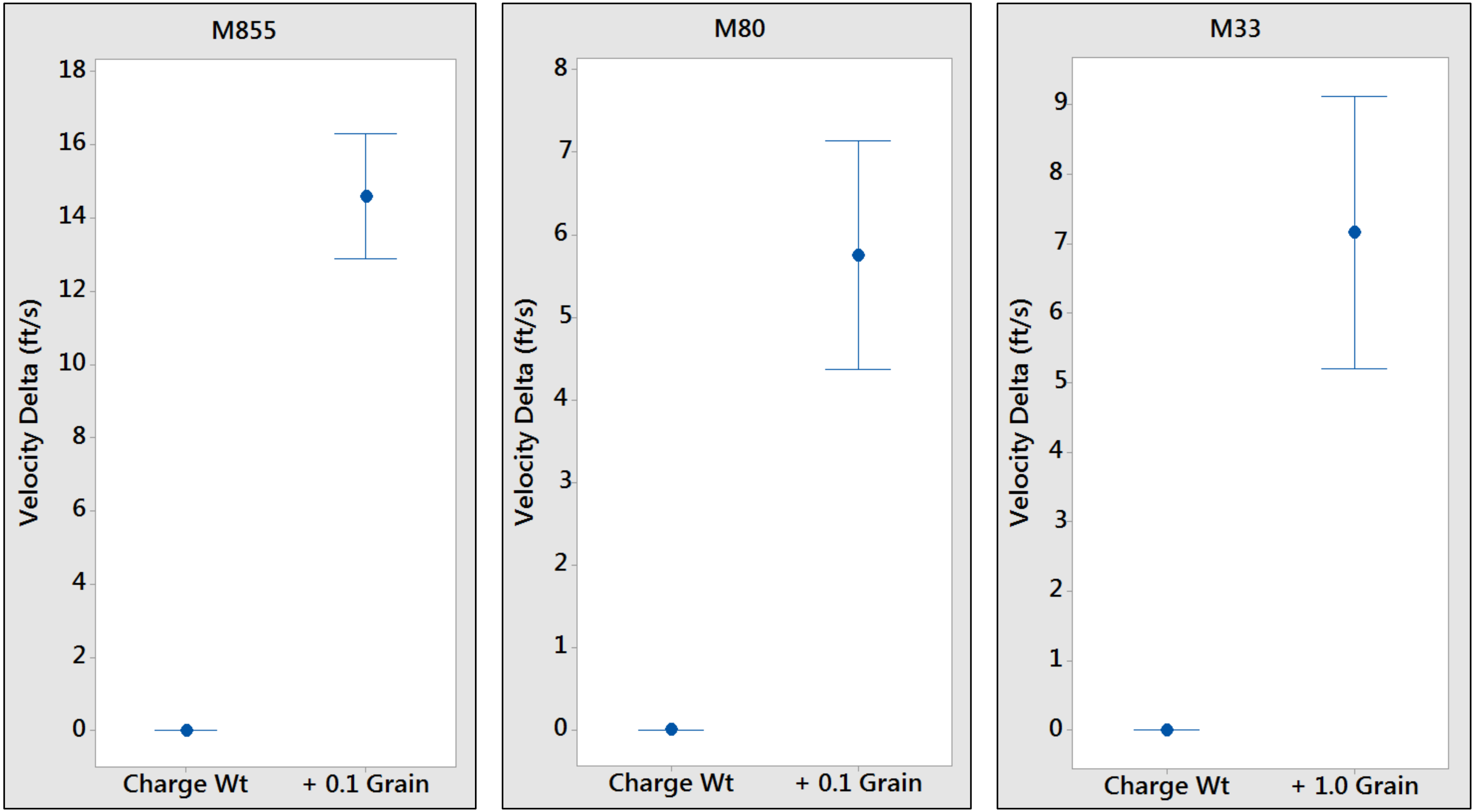
Method of Evaluation:

- Identify 100 propellant lots from each caliber that were loaded with at least 2 different charge weights. Perform regression on effect of increasing charge weights.

Conclusion:

- The effect of incremental charge weight adjustments:
  - 5.56mm (M855): 0.1 grain = 14 ft/s
  - 7.62mm (M80): 0.1 grain = 6 ft/s
  - Caliber .50 (M33): 1.0 grain = 7 ft/s

Charge Weight Velocity Deltas
(60 Propellant Lots each)



0.1 grain = 14 ft/s

0.1 grain = 6 ft/s

1.0 grain = 7 ft/s

Contact Info and Acknowledgements

Dave Stubler

Chief Engineer, Cal. 50

OATK, Lake City Army Ammunition Plant

david.stubler@orbitalATK.com

816-796-4753

Connie M. Lusto

Physicist, Cal .50/5.56mm Production

ARDEC, Picatinny Arsenal

connie.m.lusto.civ@mail.mil

973-724-1352

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Marcos Collado, ARDEC

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Dan Gubernat, ARDEC

Mark Minisi, ARDEC

Gerald (Mike) Scott, ARDEC

Jerry Shephard, OATK

2018 NDIA
Armament Systems Forum

Small Arms Systems Track
Wednesday, 9 MAY 2018

7-10 MAY 2018

COL Hector Gonzalez, Project Manager,
Maneuver Ammunition Systems
US Army Program Executive Office Ammunition
Picatinny Arsenal, NJ 07806-5000
hector.a.gonzalez6.mil@mail.mil
973.724.5307

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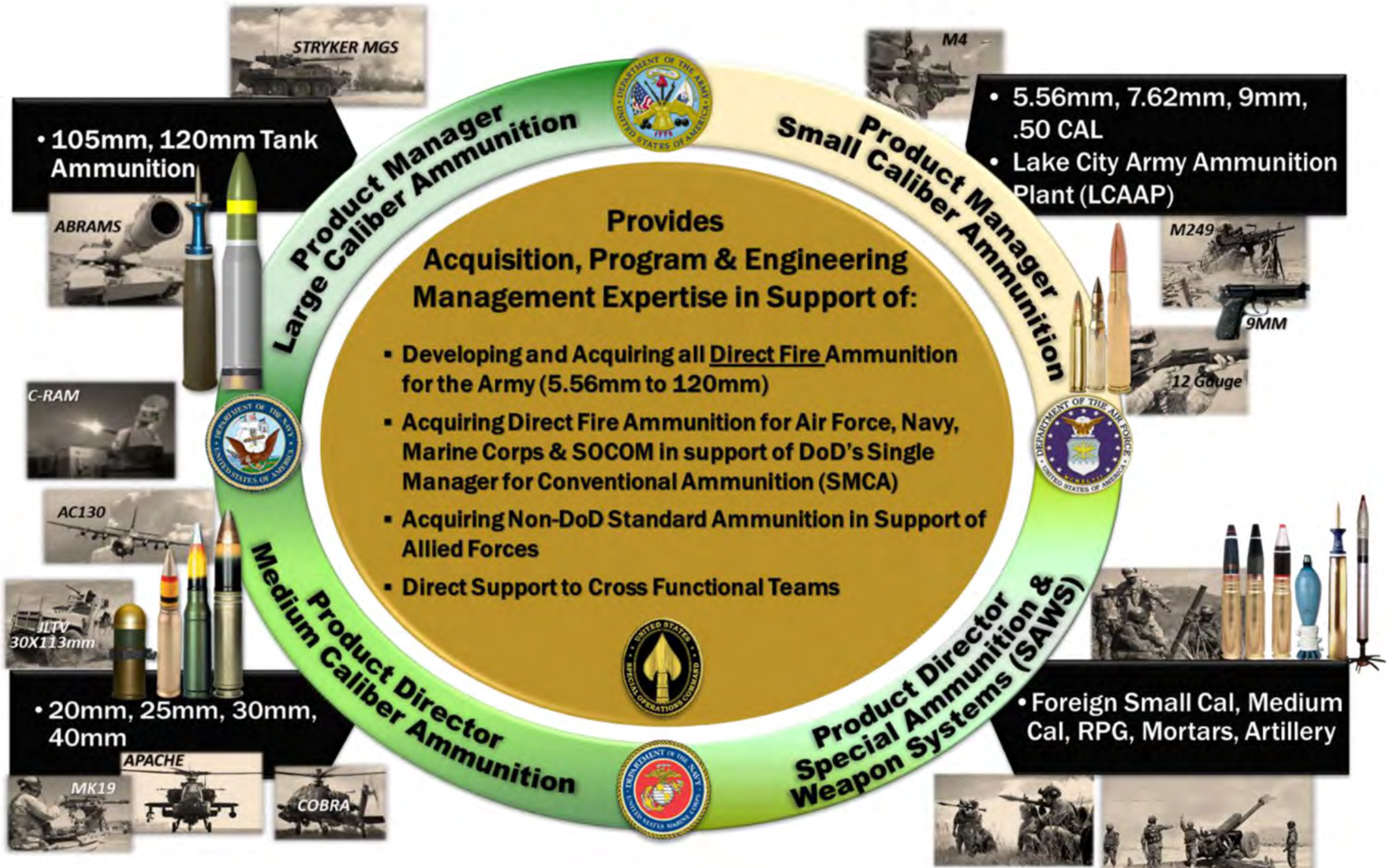
Project Manager Maneuver Ammunition Systems (PM MAS)



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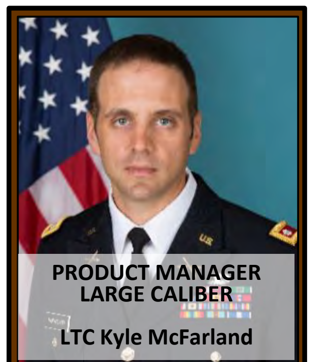
PM MAS Organization
PM / DPM


PROJECT MANAGER
COL Hector Gonzalez


DEPUTY PROJECT MANAGER
Mr. Matthew Zimmerman


PRODUCT MANAGER SMALL CALIBER
LTC Andrew Lunoff


PRODUCT DIRECTOR MEDIUM CALIBER
Mr. Christopher Seacord


PRODUCT MANAGER LARGE CALIBER
LTC Kyle McFarland


PRODUCT DIRECTOR SPECIAL AMMO & WEAPON SYSTEMS(SAWS)
LTC Lawrence Dring


BUSINESS MANAGER (Actg.)
Ms. Laura Emanski


CHIEF ENGINEER SYSTEMS ENG. & TECH. INTEGRATION (SETI)
Mr. Thomas Coradeschi


DEPUTY PRODUCT MANAGER
Mr. Robert Muth

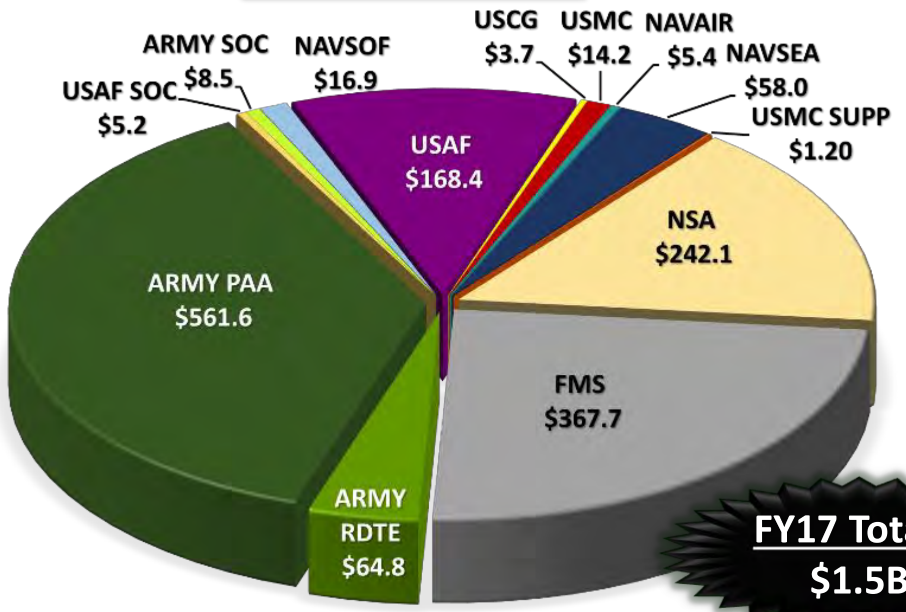

DEPUTY PRODUCT DIRECTOR
Mr. Kevin Vo


DEPUTY PRODUCT MANAGER
Mr. Stephen Bielamowicz


DEPUTY PRODUCT DIRECTOR
Mr. Frank Altamura

Support to Warfighter

PRODUCTION



FY17 Total $
$1.5B

QTY Deliveries:	FY17
Small Caliber	782M
Medium Caliber	16M
Large Caliber	58K
SAWS	110M
TOTAL QTY.	908M

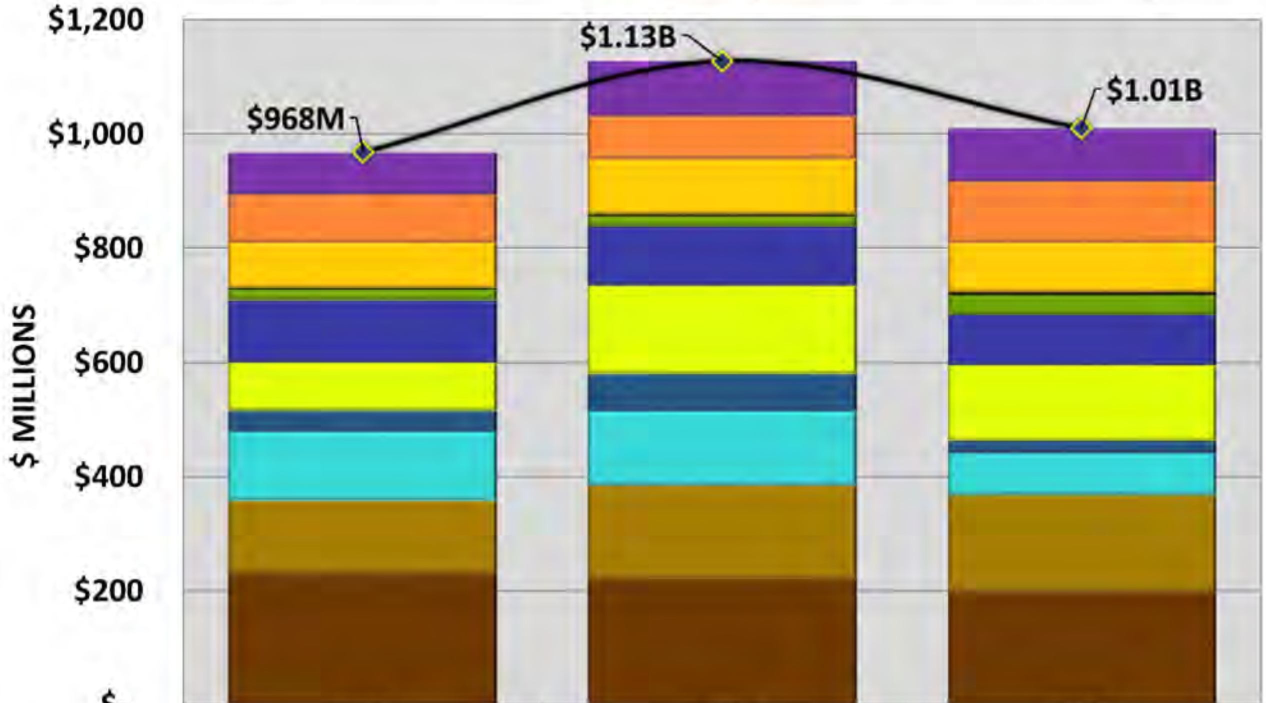
FY18 Fielding

- 20mm M940 JUONS
- 30mm Stryker Suite (4)

DEVELOPMENT

SMALL CALIBER	XM1158, Advanced Armor Piercing (ADVAP)	ACAT III
SMALL CALIBER	7.62mm One Way Luminescence (OWL)	ACAT IV
SMALL CALIBER	7.62mm Reduced Range Ammunition (RRA)	ACAT IV
SMALL CALIBER	.50 CAL Reduced Range Ammunition (RRA)	ACAT IV
MEDIUM CALIBER	30mm Airburst	ACAT III
MEDIUM CALIBER	30mm Stryker Lethality	ACAT III
MEDIUM CALIBER	40mm I-HEDP	ACAT III
MEDIUM CALIBER	40mm Door Breach	ACAT IV
MEDIUM CALIBER	40mm HEAB	ACAT III
MEDIUM CALIBER	40mm Low Velocity (LV) TP-DNT	ACAT IV
MEDIUM CALIBER	40mm High Velocity (HV) TP-DNT	ACAT IV
LARGE CALIBER	120mm Advanced Multi-Purpose (AMP)	ACAT III
LARGE CALIBER	120mm M829A4	ACAT III
LARGE CALIBER	105mm M724A2	ACAT IV

PB19 All Services (FY17-FY19)



	FY17	FY18	FY19
5.56mm	$74	$96	$92
7.62mm	$84	$76	$108
.50 CAL	$79	$97	$87
MISC	$3	$4	$5
HANDGUN	$19	$18	$34
20mm	$109	$104	$88
30mm	$84	$154	$132
25mm	$38	$65	$22
40mm	$120	$129	$74
105mm, 120mm	$127	$164	$168
SAWS	$232	$222*	$200*
TOTALS	$968	$1128	$1010

*PROJECTED

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Future PM MAS Competitive Opportunities

Program/ Item/ Description	Projected RFP Release	Projected Award Date	Potential Contract Value	Contract Strategy	Contract Type
FY18					
Medium Caliber Family	MAR 18	AUG 18	$2B	Limited Competition	IDIQ
40mm, HEAB	MAY 18	SEP 18	$36M	Competitive	DOTC
Large Caliber Support	MAY 18	OCT 18	$3.8M	SBSA	FFP
PM MAS Support	MAY 18	NOV 18	$13.6M	Competitive	IDIQ
- FY19 -					
Dummy, Drilled, Inert	AUG 18	JAN 19	$6M	Competitive	FFP
40mm, LV Door Breach	MAY 18	MAR 19	$52.4M	Competitive	FFP
12 Gauge Breaching	JUN 18	MAR 19	$18M	Competitive	IDIQ
40mm, NRE	JUN 18	MAR 19	$15M	Competitive	IDIQ
40mm, HV HEDP-AB	JUL 18	MAR 19	$92.9M	Limited Competition	TBD
.300 WINMAG	JUL 18	MAR 19	$6M	Competitive	FFP
Lake City AAP Production	NOV 18	SEP 19	$8.37B	Competitive	FFP

Small Caliber Ammunition
Future Capabilities

7-10 MAY 2018

LTC Drew Lunoff, Product Director, Small Caliber Ammunition
US Army Program Executive Office Ammunition
Picatinny Arsenal, NJ 07806-5000
Andrew.s.Lunoff.mil@mail.mil
973.724.1521

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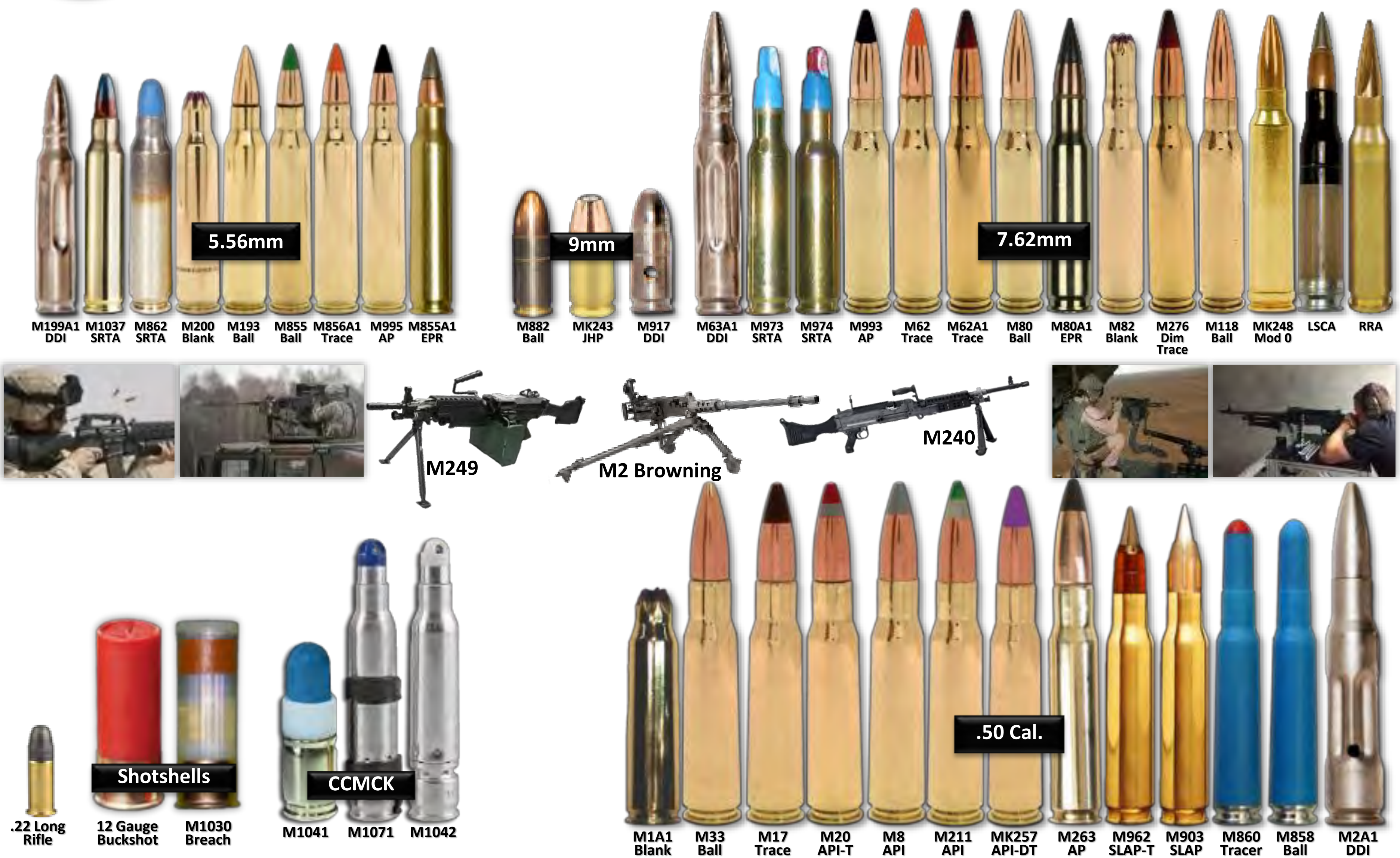
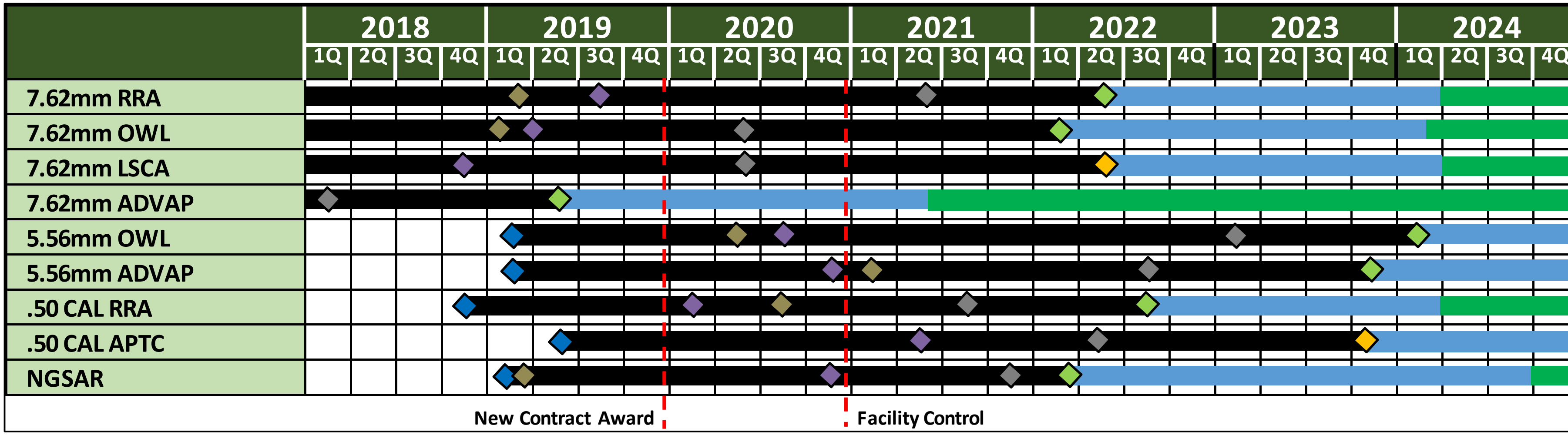
Small Caliber Ammunition Family



Potential Future Technologies



- Materiel DeveL. Decision (MDD)
- Preliminary Design Review (PDR)
- Milestone B (MS B)
- Critical Design Review (CDR)
- Milestone C (MS C)
- Fielding Decision (FD)

Research & Development

Plan / Facilitize for Production

Production

Advanced Armor Piercing (ADVAP)
Provide overmatch capability vs. broad spectrum of hard targets *Increase Lethality*

One Way Luminescence (OWL)
Significantly reduced signature preventing threat from tracing round back to shooter while providing Enhanced Performance Round (EPR) effects in the tracer *Enhance Warfighter Survivability & Enhance Lethality*

Lightweight Small Caliber Ammunition (LSCA)
Reduce Warfighter burden *Lighten Warfighter Load*

Reduced Range Ammo (RRA)
Reduce maximum range while maintaining tactically relevant training range *Improve Warfighter Training*

All Purpose Tactical Cartridge (APTC)
Improve .50 caliber capability to include overmatch capability against broad spectrum of targets; implement LSCA and OWL *Increase Lethality / Lighten Warfighter Load / Enhance Warfighter Survivability*

Next Generation Squad Automatic (NGSAR) Ammunition
Provide leap ahead performance at squad level including improved overmatch against a broad spectrum of targets *Increase Lethality / Lighten Warfighter Load / Enhance Warfighter Survivability*

Small Caliber DOTC Opportunities

AMM-19-01	**Next Generation Family of Ammunition projectile, components and subassemblies**	…development and delivery of prototype Government designed projectiles, components and subassemblies for small arms weapons systems below .50 caliber. The contractor will explore alternate manufacturing methods to machine, cast, and manufacture the prototype parts … then develop new prototypes based on new methods and designs
AMM-19-02	**Close Combat Mission Capability Kit (CCMCK) & ammunition for the Next Generation Weapon Systems**	…innovative and cost-effective… low velocity marking ammunition. The system will provide normal environmental/weapon employment cues (aiming, firing, ejection, immediate action, load, and re-load, etc.) and immediate target feedback through force-on-force, interactive live fire scenario task, and mission execution
AMM-19-03	**Small caliber propellant**	…propellant that could improve performance, safety, and producibility…prototype propellants shall include analysis by state-of-the-art analytical techniques including Insensitive Munitions/Final Hazards Classification, performance, characterization, functionality, and qualification testing
AMM-19-04	**Tracer cartridges for the Next Generation Family of Ammunition**	…innovative and cost-effective tracer cartridge for the Next Generation Squad Automatic Rifle (NGSAR) / Next Generation Carbine (NGSC)
AMM-19-05	**Reduced Range Training Cartridges for the Next Generation Family of Ammunition**	…innovative and cost-effective Reduced Range Training Ammunition (RRTA) for the Next Generation Squad Automatic Rifle (NGSAR) / Next Generation Squad Carbine (NGSC)… to allow soldiers to effectively train with standard service ammunition on ranges with reduced Surface Danger Zones (SDZ)
AMM-19-06	**[Lightweight] ammunition, components or sub-assemblies**	…development of lightweight small caliber ammunition and components. The prototypes shall provide a minimum of 10% overall weight savings for cartridges, subassemblies and components
AMM-19-07	**Ammunition, components, or sub-assemblies**	…removal of lead from its small caliber cartridges configurations… the prototypes will be fully utilized through demonstrations/testing

Enhanced White Papers Due in BIDS by 15 MAY 2018

Small Caliber DOTC Opportunities (cont.)

AMM-19-08	**Projectiles, cases, cartridges, and other cartridge components for .50 caliber and below**	…development and evaluation of prototype solutions to enhance performance, affordability, manufacturability, test requirements, consistency, and environmental effects in small caliber ammunition. Enhancements can include, but are not limited to, alternative components, subcomponents, ancillary components, energetics, test materials/equipment, and reduced product variability. Environmental effects improvements can include, but are not limited to, materials and technology to reduce cartridge effects on the environment and environmental effects on the cartridge such as: corrosion prevention, removal of lead in ammunition systems, solvent-less waterproofing, and mercury replacement
AMM-19-09	**prototype projectiles, propellants, cartridge configurations, and process control methods for .50 caliber and below**	…technical solutions to enhance dispersion performance and/or consistency. Enhancements can include but are not limited to reduction in dispersion requirement for acceptance and/or reduction in lot to lot dispersion performance
AMM-19-10	**prototype hardware, inspection systems, and process control methods for .50 caliber and below**	…eliminate the contamination of key nonconforming and/or erroneous components/product throughout the manufacturing process. Solutions can include but are not limited to, containers, process control, and inspection systems/methods.
AMM-19-11	**small caliber (.50 caliber and below) projectiles containing alternate tracer systems and/or trace system components**	…development, improvement, optimization, and/or manufacture of alternate tracer …only be visible from behind the projectile…
AMM-19-12	**ammunition, components, or sub-assemblies of projectile and cartridge configurations**	…development of… Reduced Range Ammunition. This program seeks to leverage and develop Non-Developmental Items (NDI), Commercial-Off-The-Shelf (COTS) solutions, and new technology concepts and prototypes that maintain or improve effective range, accuracy, reduce weight, reduce cost, improve health effects for Soldiers, and/or reduce the maximum range (Surface Danger Zone)
AMM-19-13	**cartridges cases, and assemblies related to Small Caliber Ammunition and Weapons**	…development of alternative cartridge case configurations that enhance performance, increase lethality, reduce weight, reduce cost, or improve health effects for soldiers. The technologies shall be applicable to traditional shouldered cases or nontraditional designs such as Cased Telescoped (CT), caseless, sub-caliber or others. Prototypes may be intended as drop in solutions for current weapons or be in support of next generation weapon systems

Enhanced White Papers Due in BIDS by 15 MAY 2018

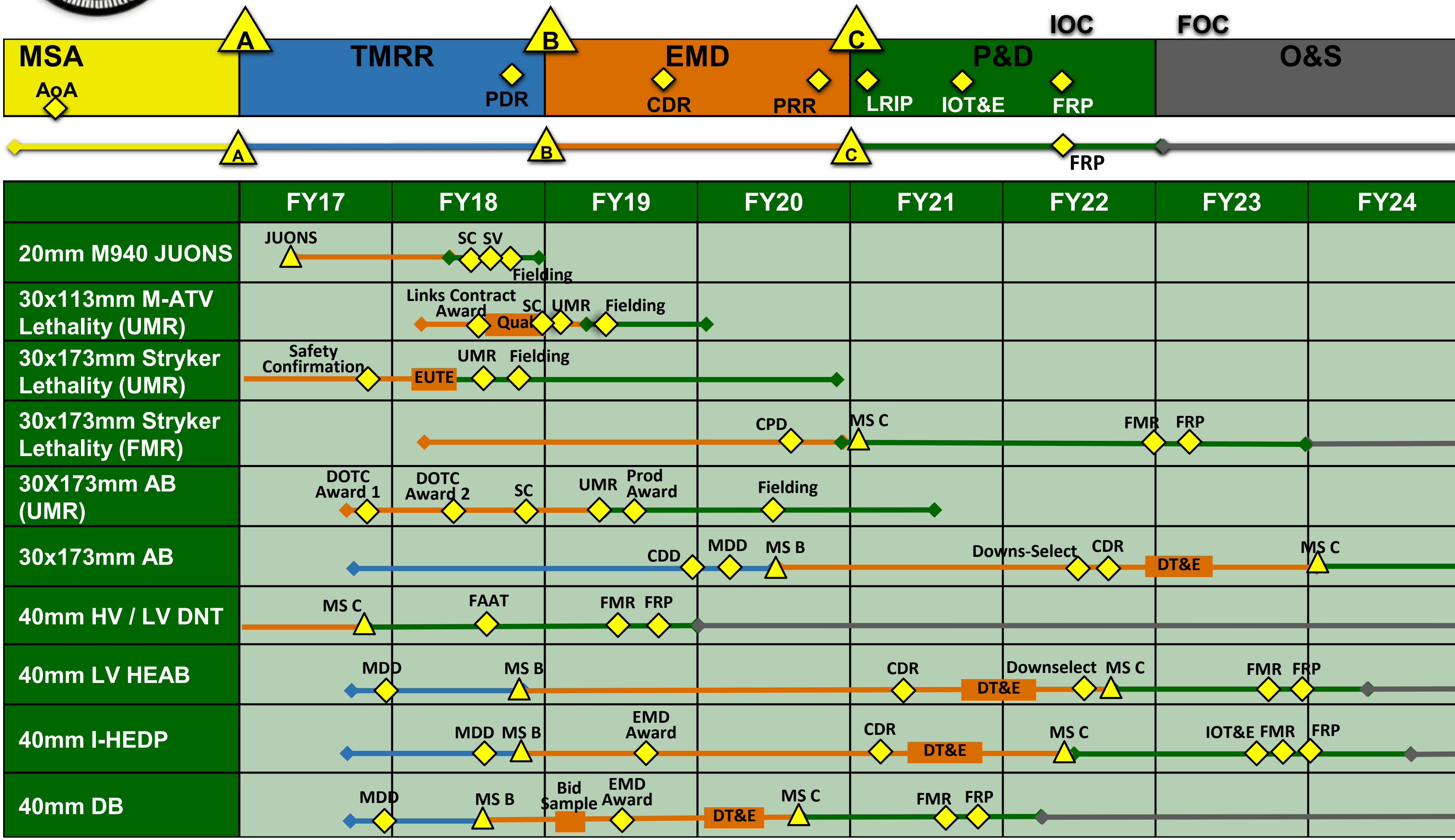
Medium Caliber Ammunition Future Capabilities

7-10 MAY 2018

Chris Seacord, Product Manager, Medium Caliber Ammunition
US Army Program Executive Office Ammunition
Picatinny Arsenal, NJ 07806-5000
christopher.r.seacord.civ@mail.mil
973.724.2090
04 MAY 18 v4-FINAL

Medium Caliber Ammunition

Medium Caliber
Development Program Overview



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Medium Caliber DOTC Opportunities

AMM-18-14	**Integrated multi-mode selectable fuze and setter for M789 cartridge and M230 weapon system**	Selectable proximity airburst munition for the Apache
AMM-18-16	**Next Generation technologies for medium caliber cannon ammunitions**	Archer and ARAPS
AMM-18-17	**30x113mm cannon caliber ammunition**	Linked Ammo for JLTV
AMM-18-26	**Next generation 40mm grenade cartridge ammunition**	40mm C-UAS and SRAP
AMM-19-05	**40mm High Velocity XM1176 High Explosive Dual Purpose Airburst (HEDP AB)**	
AMM-19-06	**40mm Low Velocity XM1167 Door Breaching**	
AMM-19-08	**Multi-Mode Selectable Proximity Airburst 30x113mm**	LW30
AMM-19-09	**30x173mm Programmable Airburst**	Stryker Platform w/ 30mm cannon

Questions?

Contributing Factors to Proper Tracer Performance

Thomas Gmyrek, ARDEC
Kaleb Luna, Orbital ATK

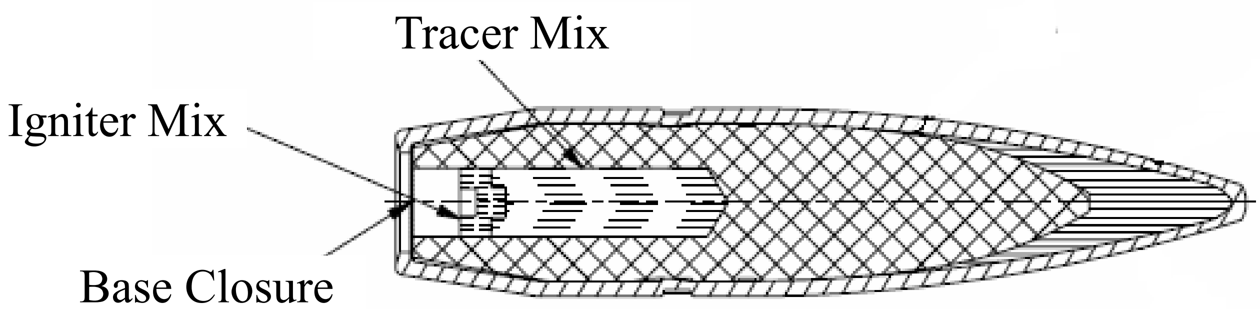
Tracers 101

Tracers are projectiles that are produced with a pyrotechnic charge allowing the trajectory to be visible to the naked eye

Typical Components :

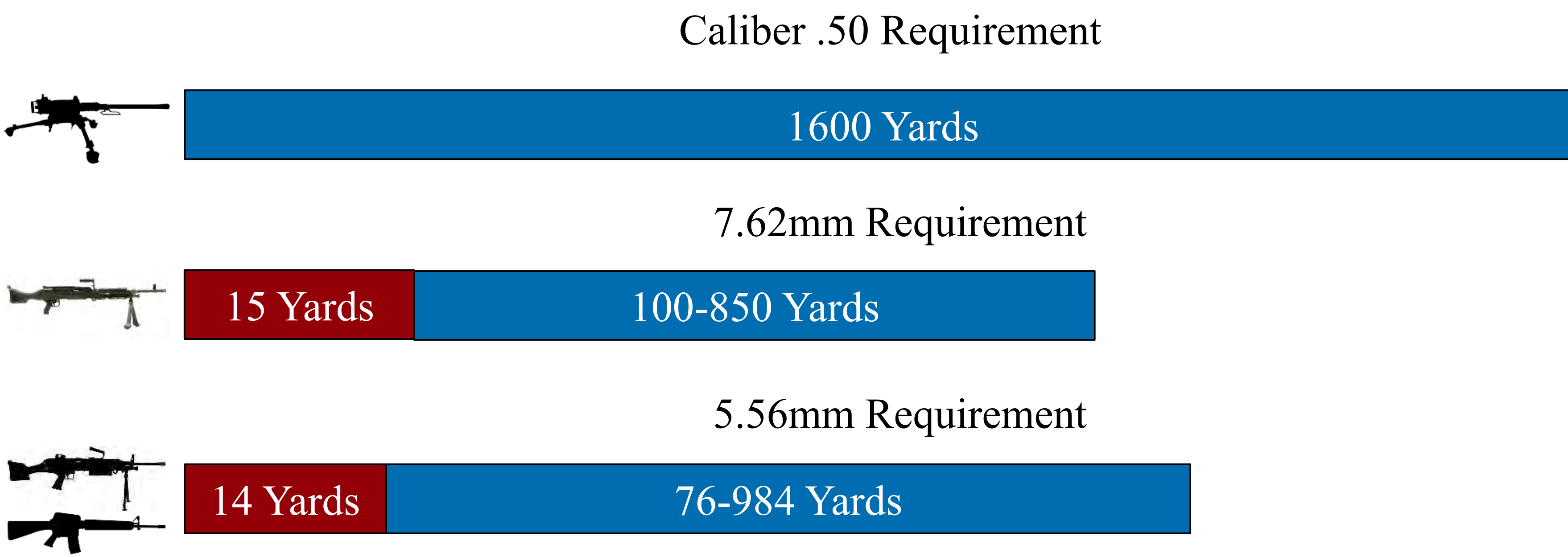
Strontium Nitrate – Oxidizer that creates red color when lit
Magnesium – Ignites for pyrotechnic effect
PVC - Binder

Typical tracer configurations for US Army tracer projectiles



When correctly matched with ball ammunition, tracer provides a significant advantage when engaging both point and area targets

Current Requirements and Scoring



Traditional methods of scoring involve human witnessing at various distances. This method has a high level of subjectivity between what is called full luminosity and what is faint enough to be considered a “blind”.

Current testing methods at LCAAP also include the usage of camera systems that automatically score acceptable trace at various witnessing distances.

Broken Tracer Column

Deformation of a tracer column is a known failure mode for tracer munitions that will often affect its probability of ignition.

The greatest probability of a broken tracer column occurs when there is both a high pyrotechnic charge and a high core insertion pressure.

If the conical profile is not maintained and its surface area is compromised, it will not fully ignite.

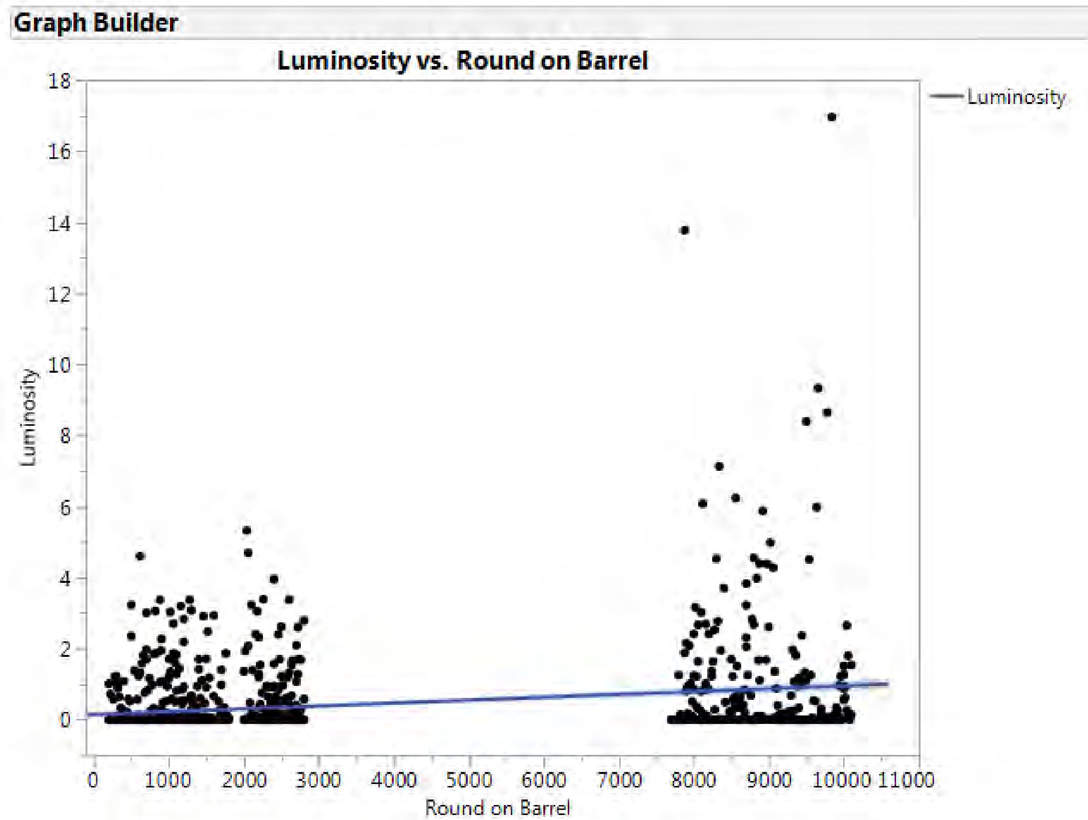
The usage of a flow agent in the pyrotechnic is critical when attempting to achieve proper charging height.

Barrel Life

Tests conducted with 7.62mm ammunition in 2017 as part of the Muzzle Signature Program tracer signatures over the life of a barrel.

Analysis showed a relationship between round count and variability in luminosity.

Rounds seen with high muzzle luminosity often failed to maintain ignition and had inconsistent luminosity.

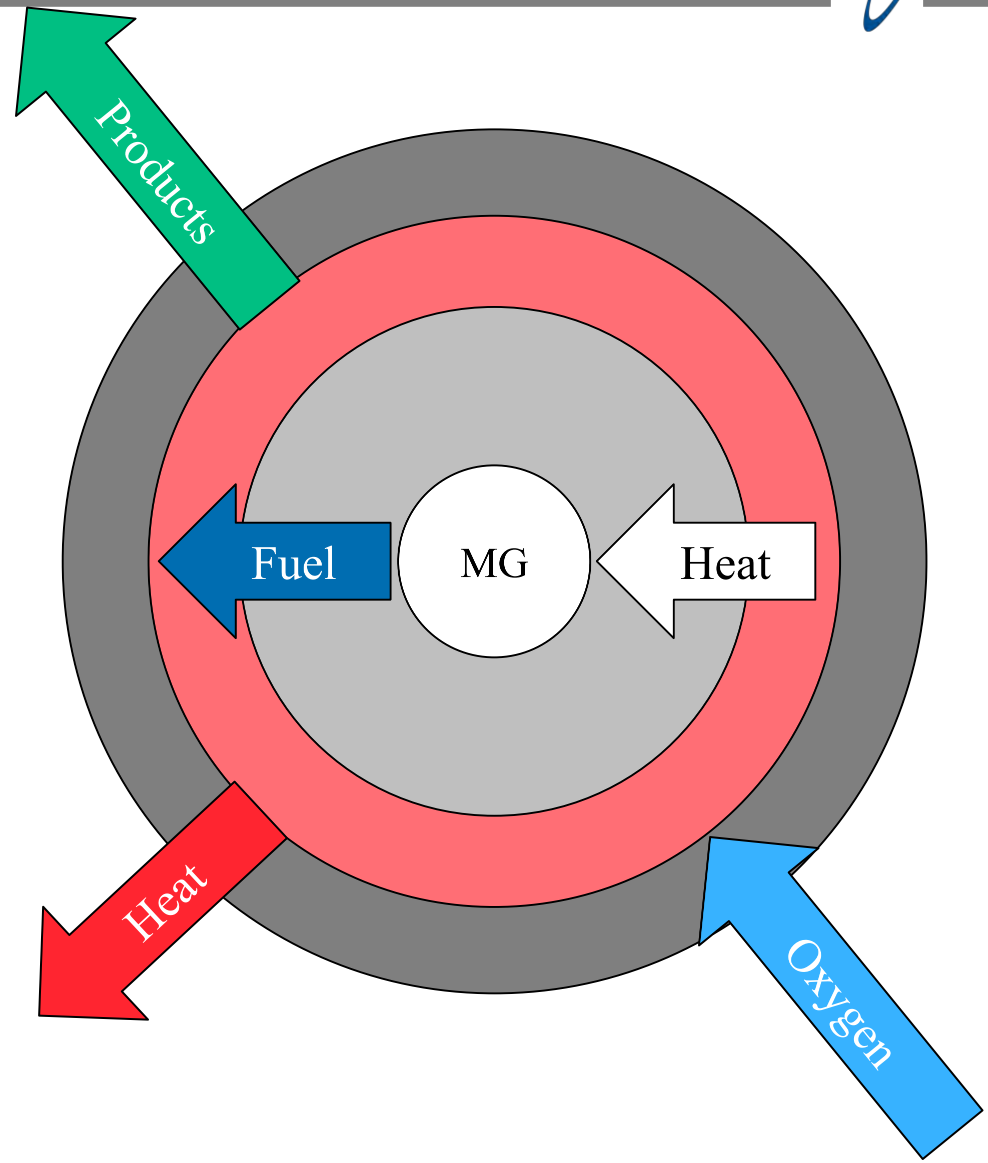


Magnesium Burn

Magnesium content contributes significantly to the heat and light output of a tracer projectile.

The rate of energy release is heavily dependent on the particle size of the magnesium.

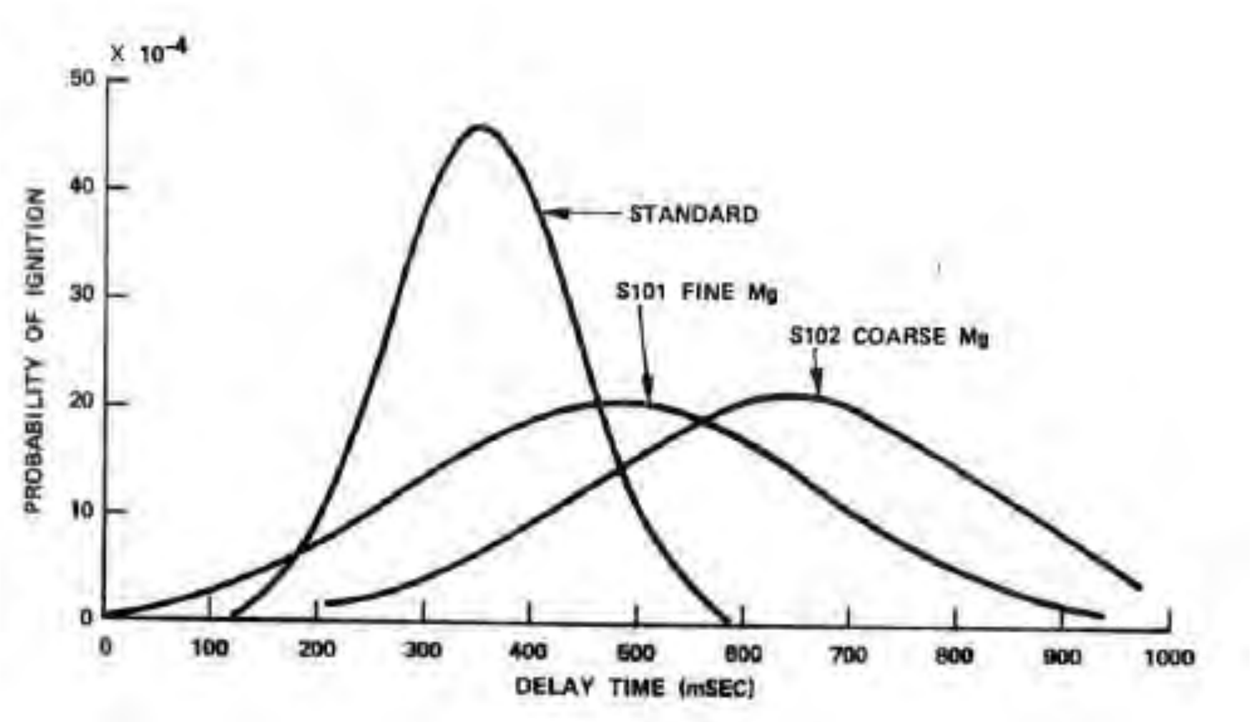
If proper magnesium particle size is not maintained, the tracer will either burn bright for a short period of time, or burn dim for a long period of time



Magnesium Burn

Studies conducted in 1979 by Dr. Gerald Holst on large caliber also looked at Mg granularity. Dr. Holst's investigations focused primarily on the impact of grain size in terms of probability of ignition and delay in ignition instead of luminosity.

The study revealed that there is a clear optimal grain size and that the failure mode for both fine and coarse grains will look similar.



Deformed Closure

Due to past experiences within the Caliber .50 family with base closures causing a number of ballistic defects, an investigation was started to see its impact on tracer ignition.

Caliber .50 tracer projectiles were intentionally made with poorly cut and partial base closures and fired.

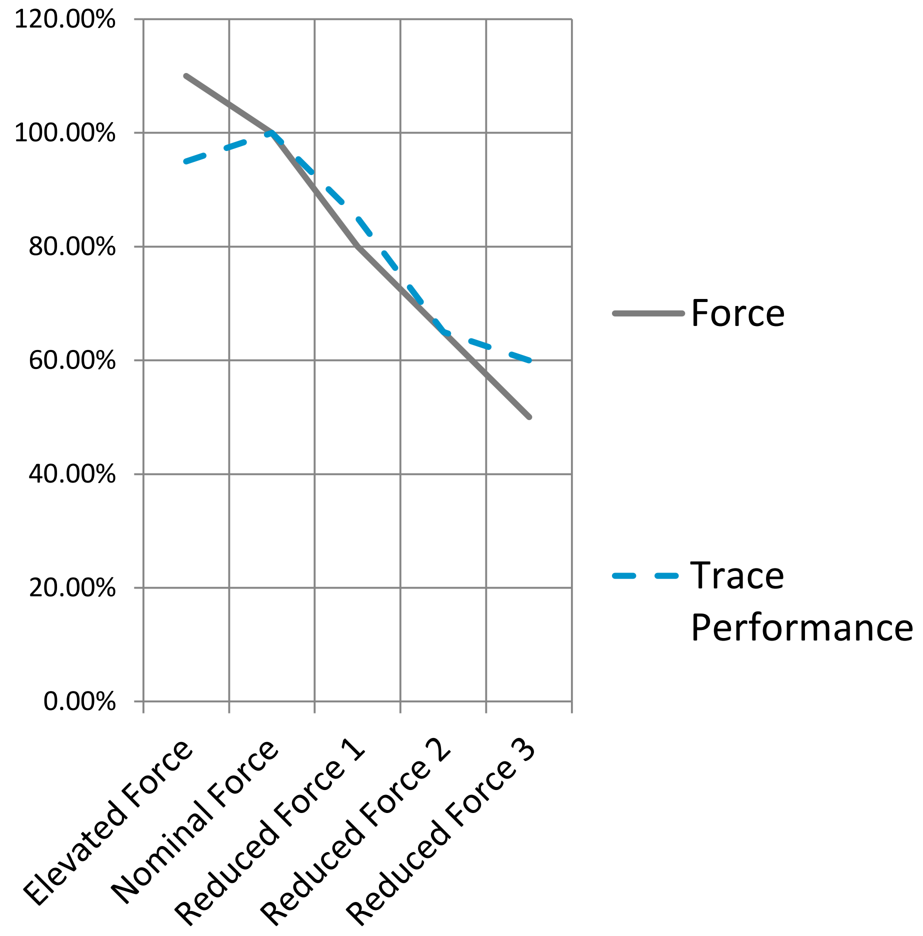
There were no trace performance defects observed during this testing.

Consolidation Forces

Experiments have been conducted by Orbital ATK intending to study how the force applied during the tracer consolidation process can affect trace performance.

The study has shown a close relationship between reduced consolidation force and reduced trace performance. Testing with elevated force levels also suggested a slight decline in trace performance.

This suggests that an ideal consolidation pressure can be established, depending on the specific characteristics of a given tracer round.

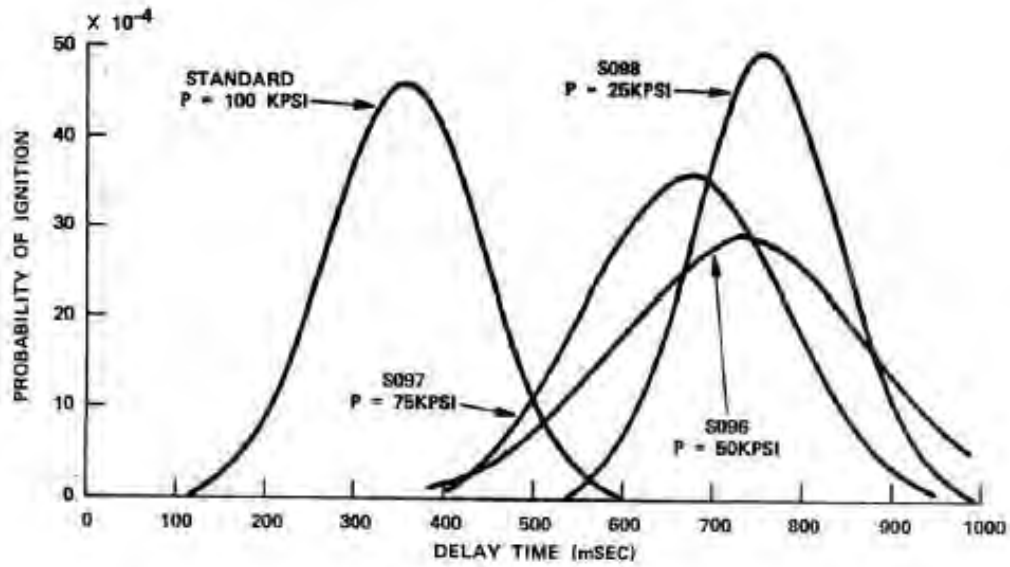


Consolidation Forces

Studies conducted in 1979 by Dr. Gerald Holst on large caliber corroborate a relationship between forces and ignition time.

While it is previously known that lower forces would often have a spill out of pyrotechnic, it also appears to cause a delay in ignition.

Parameters that influence ignition delay are more critical in tracer projectiles that require a standoff ignition such as 7.62mm and 5.56mm



Humidity

Due to the potential variability in seasonal humidity, moisture exposure is a significant environmental factor for tracer columns.

Orbital ATK performed a test consisting of 3 levels of moisture exposure in a temperature controlled environment

Control – Cores stored in a sealed M2 ammunition can

Ambient – Cores stored in an open M2 ammunition can and exposed to moderate humidity

Humid – Cores stored in a closed M2 ammunition can with a wet cloth to increase humidity

CONTROL AMBIENT HUMID

Humidity

After a period of exposure, the cores were processed and shot.

For cores from the “Humid” category, the tracer column was visibly affected with swelling beyond the cavity in some cases.

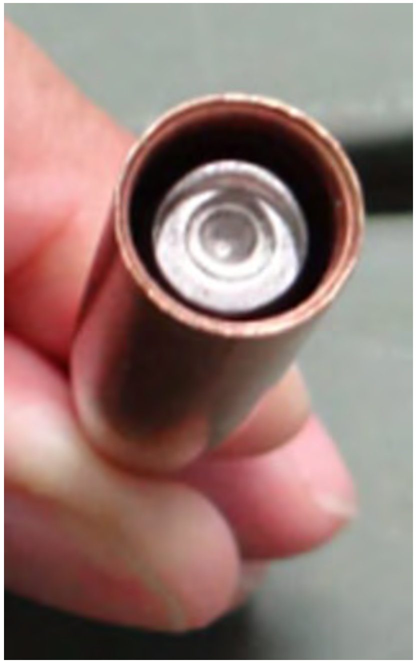
Cores from the Control and Ambient Samples both performed well, while the sample exposed to high humidity experienced failures to ignite.

This testing revealed that there is a strong relationship between humidity and tracer performance due to the hydroscopic characteristics of the mix and the subsequent structural changes to the tracer column.

Deformed Core

Given other evidence that disruption of the tracer column can result in trace performance defects, testing was conducted at LCAAP to simulate a potential cause. This test used excessive core seating pressures to significantly deform the rear of the core in an attempt to disrupt the tracer column.

The sample with significant core deformation shot 100%, with no defects observed. While not completely definitive, the results of this test do not support the hypothesis that deforming the rear of the core during bullet assembly results in tracer defects.

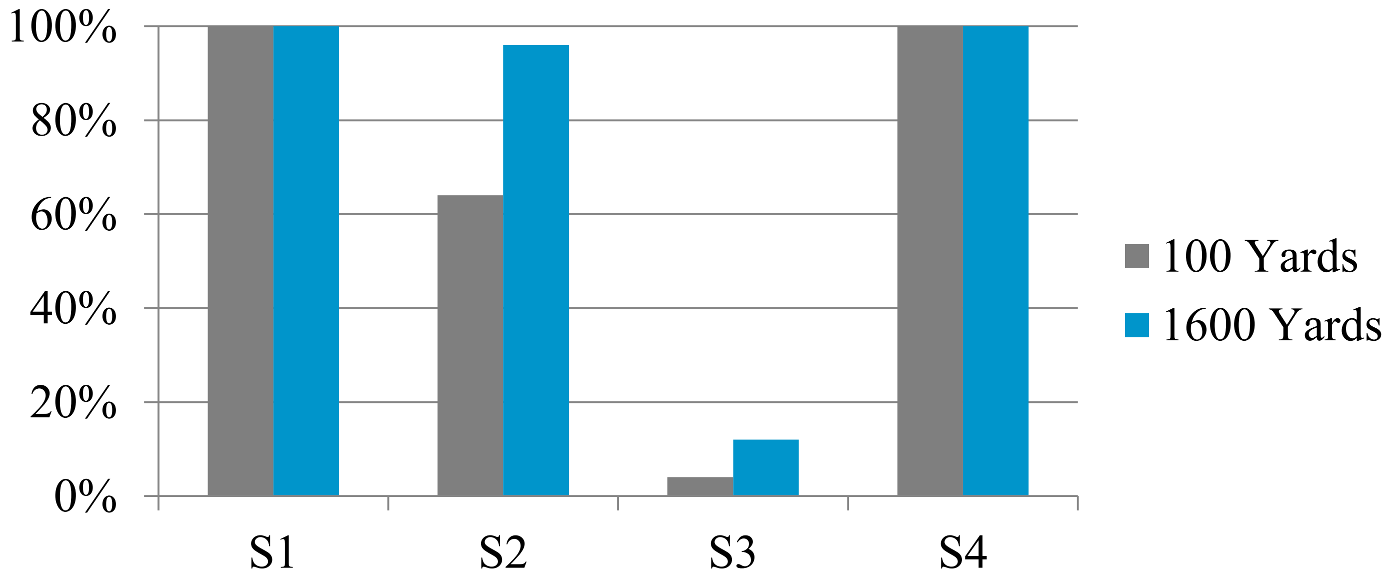


Igniter/Trace Mixing

Depending on tracer column configuration and production techniques, there is a possibility for some quantity of tracer mix to intermingle with the charge of igniter mix.

Testing was conducted to simulate potential blending of the trace mix (R-256) with the igniter mix (I-570).
S1 - “Control” Samples
S2 - “Minor” quantity of R-256 blended with the standard I-570 Charge
S3 - “Severe case” quantity of R-256 blended with the standard I-570 Charge
S4 - “Severe case” quantity of R-256 added before the standard I-570 Charge without blending

The results below indicate that mixing of tracer and igniter mix is undesirable and should be avoided.



Conclusions

There are many factors which are important to the proper functioning of tracer ammunition. The factors discussed in this presentation have varying degrees of impact, but come from studies and investigations undertaken to better understand the causes of trace performance defects.

Through various studies, it has been determined that some of the key contributors of proper tracer ignition are magnesium particle size, consolidation forces, and humidity. While other factors can also contribute, these seem to have a large degree of impact and can produce partial or total failure.

Understanding these factors is key to ensuring effective and reliable performance that the warfighter can count on.

Contact Info

Thomas Gmyrek
Caliber .50 Production Team Lead ARDEC,
Picatinny Arsenal
Thomas.a.Gmyrek.civ@mail.mil
973-724-5076

Kaleb Luna
Caliber .50/7.62mm Bullet Mfg. Engineer
Orbital ATK,
Lake City Army Ammunition Plant
kaleb.luna@orbitalatk.com
816-796-5546

OHIO ORDNANCE WORKS, INC.
Preserving the Past. Engineering the Future.

The Next Advancement of the M240 General Purpose Machine Gun

Lt. Robert W. Landies III, USMCR
Vice President of Manufacturing

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OOW is an ISO 9001:2015 certified company.

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Chardon, OH 44024

has established and maintains a quality management system for the

Design, Manufacture and Repair of Weapons and Military Firearms

An audit was performed and documented in Report No 4101.
Proof has been furnished that the requirements according to

ISO 9001:2015

are fulfilled.
Further clarification regarding the scope of this certificate and the applicability of ISO 9001:2015 requirements may be obtained by contacting TRNA.

Certificate Registration No.

74 300 4101

Certificate Issue Date	Certificate Expiration Date
August 31, 2017	**August 11, 2020**

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MANAGEMENT SYSTEMS CERTIFICATION BODY

Certification of Management Systems

QUALITY POLICY

~~It is the policy of Ohio Ordnance Works, Inc. to provide firearms, parts, accessories and repair services that meet our customer's requirements. Our quality processes are designed to support customer satisfaction and business performance. These processes are continuously monitored through the use of Key Performance Indicators.~~

~~This policy has been presented to all employees through general orientation and is displayed in various locations throughout the company.~~

Previous M240 Improvements

- Single Port Gas Regulator
- MIL-STD-1913 Equipped Feed Cover
- MIL-STD-1913 Accessory Rail System
- Hydraulic Buffer
- Lightweight Adjustable Buttstock
- Lightweight and Shortened Barrels
- Reduced Weight Receiver
- Improved Flash Hider
- Alternative Materials
- Lightweight Trigger Assembly

Select Fire™ Trigger Assembly

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US008087343B2

(12) **United States Patent**
Landies et al.

(10) **Patent No.:** **US 8,087,343 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

(54) **M240 RIFLE WITH SELECT FIRE MECHANISM FOR SELECTIVE FULLY-AUTOMATIC AND SEMI-AUTOMATIC OPERATION**

(75) Inventors: **Robert L. Landies**, Chardon, OH (US); **Thomas M. Hardman**, Chesterland, OH (US); **Daniel L. Albright**, Chardon, OH (US); **Joshua G. Hershberger**, Concord Township, OH (US)

(73) Assignee: **Ohio Ordnance Works, Inc.**, Chardon, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 203 days.

(21) Appl. No.: **12/687,561**

(22) Filed: **Jan. 14, 2010**

(65) **Prior Publication Data**

US 2011/0168008 A1 Jul. 14, 2011

(51) **Int. Cl.**
F41A 19/33 (2006.01)

(52) **U.S. Cl.** **89/140**; 89/139; 89/132; 89/128

(58) **Field of Classification Search** 89/139, 89/140, 129.01, 132, 142, 148, 128
See application file for complete search history.

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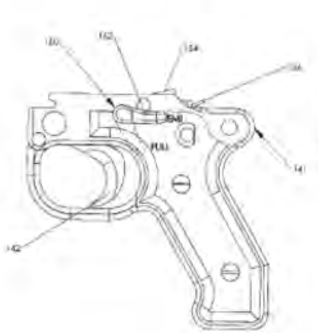
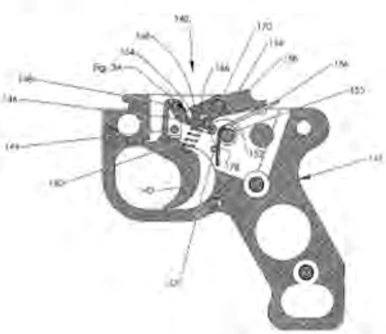
Primary Examiner — Michael David
(74) *Attorney, Agent, or Firm* — Renner Kenner Greive Bobak Taylor & Weber

(57) **ABSTRACT**

A trigger assembly for a trigger housing for an M240 Assault Rifle is provided having a switch accessible at the outside of the trigger housing for changing the firing of the rifle between semi-automatic and fully-automatic fire.

3 Claims, 6 Drawing Sheets





US 20120144992A1

(19) **United States**
(12) **Patent Application Publication**
Landies et al.

(10) **Pub. No.: US 2012/0144992 A1**
(43) **Pub. Date:** **Jun. 14, 2012**

(54) **M249 RIFLE WITH SELECT FIRE MECHANISM FOR SELECTIVE FULLY-AUTOMATIC AND SEMI-AUTOMATIC OPERATION**

(76) Inventors: **Robert L. Landies**, Chardon, OH (US); **Thomas M. Hardman**, Chesterland, OH (US); **Daniel L. Albright**, Chardon, OH (US); **Joshua G. Hershberger**, Concord Township, OH (US)

(21) Appl. No.: **13/023,083**

(22) Filed: **Feb. 8, 2011**

Related U.S. Application Data

(60) Provisional application No. 61/302,335, filed on Feb. 8, 2010.

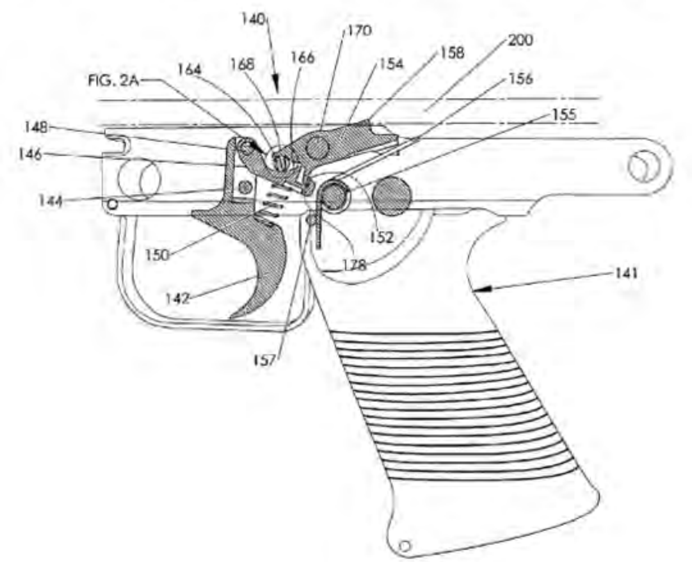
Publication Classification

(51) **Int. Cl.**
F41A 19/06 (2006.01)
F41A 19/10 (2006.01)

(52) **U.S. Cl.** **89/128**

(57) **ABSTRACT**

A trigger assembly for a trigger housing for a M249 fully automatic rifle is provided having a switch accessible at the outside of the trigger housing for changing the firing of the rifle between semi-automatic and fully-automatic fire.




SEMI
FULL

Research and Development

- Developed from the idea that machine gunners needed a way to conserve ammunition during zeroing procedures and when tactically advantageous in combat to use a semi-automatic mode.
- A 3 position selector similar to the configuration in the M-16/M-4 was explored, however was not possible without major changes to the design. Incorporating the Safety into the Selector would produce a less safe product than the existing sliding block style Safety.
- Would not require any modification to host weapon, and would be able to be used by any M240 regardless of manufacturer, date of manufacture, or configuration. All safeties intact and trigger weights would be IAW MIL-M-63314.
- Based on design of OOW240-SLR Trigger Group (Semi-Automatic Only 240 Variant).
- Initial guideline for weight was no more than 6 oz heavier than original. Standard group= 15.2 oz, Select Fire= 15.68 oz.

Testing

- 2 Phases of Endurance Testing conducted. Phase I with 1,000 rounds fired in semi-auto mode only. Phase II with 10,000 rounds fired in both semi and full-auto modes. In both Phases, zero failures attributed to Trigger Assembly. Trigger pull pre-test was 12.25 lbs in Semi, 10 lbs in Full-Auto. Post-test Semi was 11.5 lbs, and Full-Auto was 9.75 lbs.
- The Selector was cycled 10,000 times with Selector resistance weight measured post-test. Weight Pre-Test=29 oz, Post-test=24 oz.
- Drop Tests were conducted from two meters on all six sides of weapon.
- Vibration Tests were conducted after failure mode identified where Sear would reset during long strings of sustained full auto fire. It was found that as the Sear leg contacted the Safety, vibration would travel through Disconnector and dislodge Sear. Sear leg was shortened slightly and design change was verified that sustained full auto fire would not trip Sear.
- Double Tap Testing was conducted with Rigid Buffer/Backplate and 3rd gas position at ~900rpm. No double taps were experienced.

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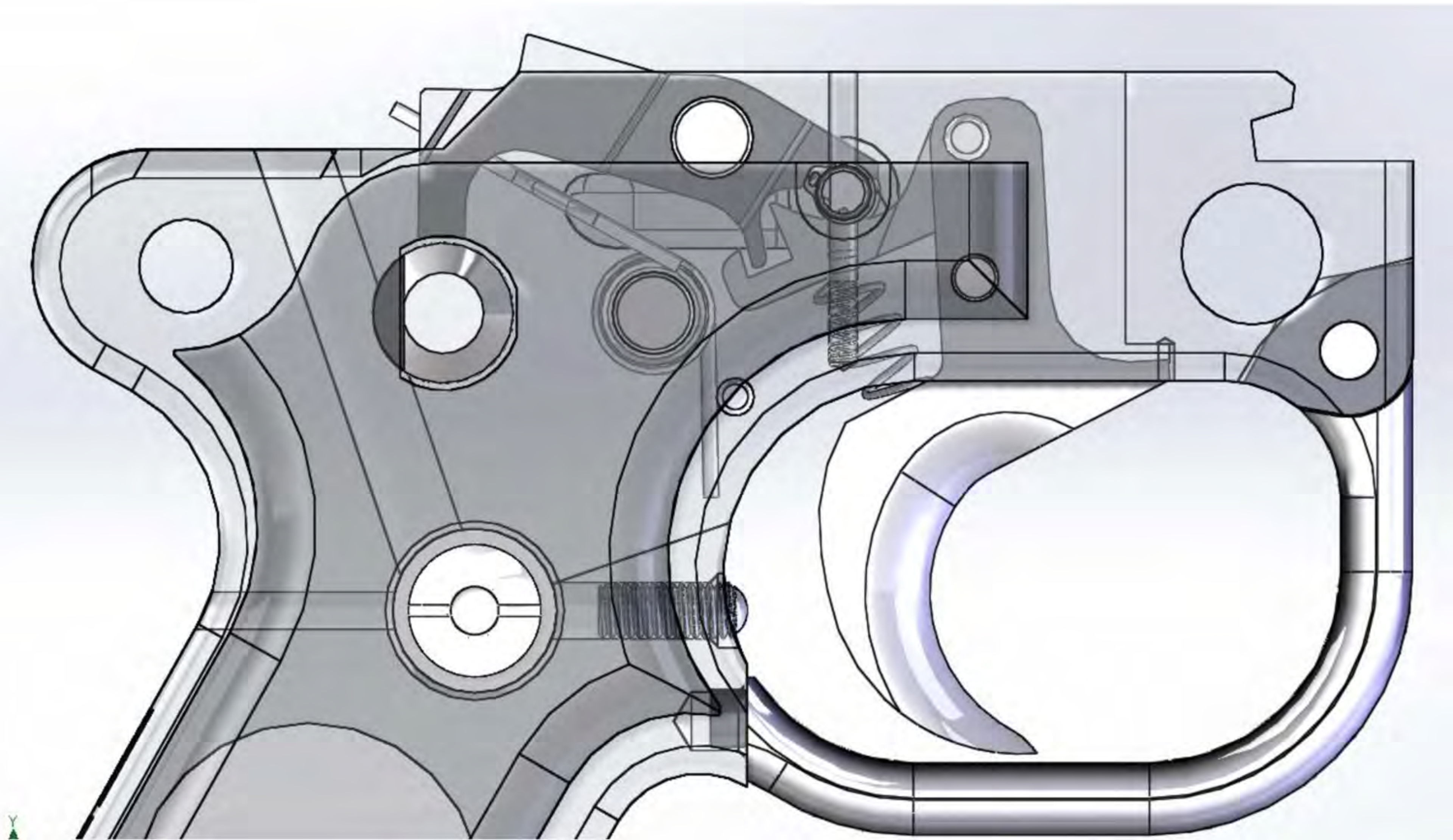

Future Improvements

- Explore further weight reduction through the use of alternative materials and manufacturing processes without reduction in performance or reliability.
- Component improvements and new designs to match the modularity of advancing accessories.


FULL

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With the combination of our in house manufacturing resources and our robust quality system we are able to produce a superior product for our customers.

We stand behind all of our products 100%.

Thank you for your time.

Modernizing Field Artillery Maintenance Equipment

2018 Armaments Systems Forum

James Brooker, VP of Engineering

Otis Technology

Abstract # 20256

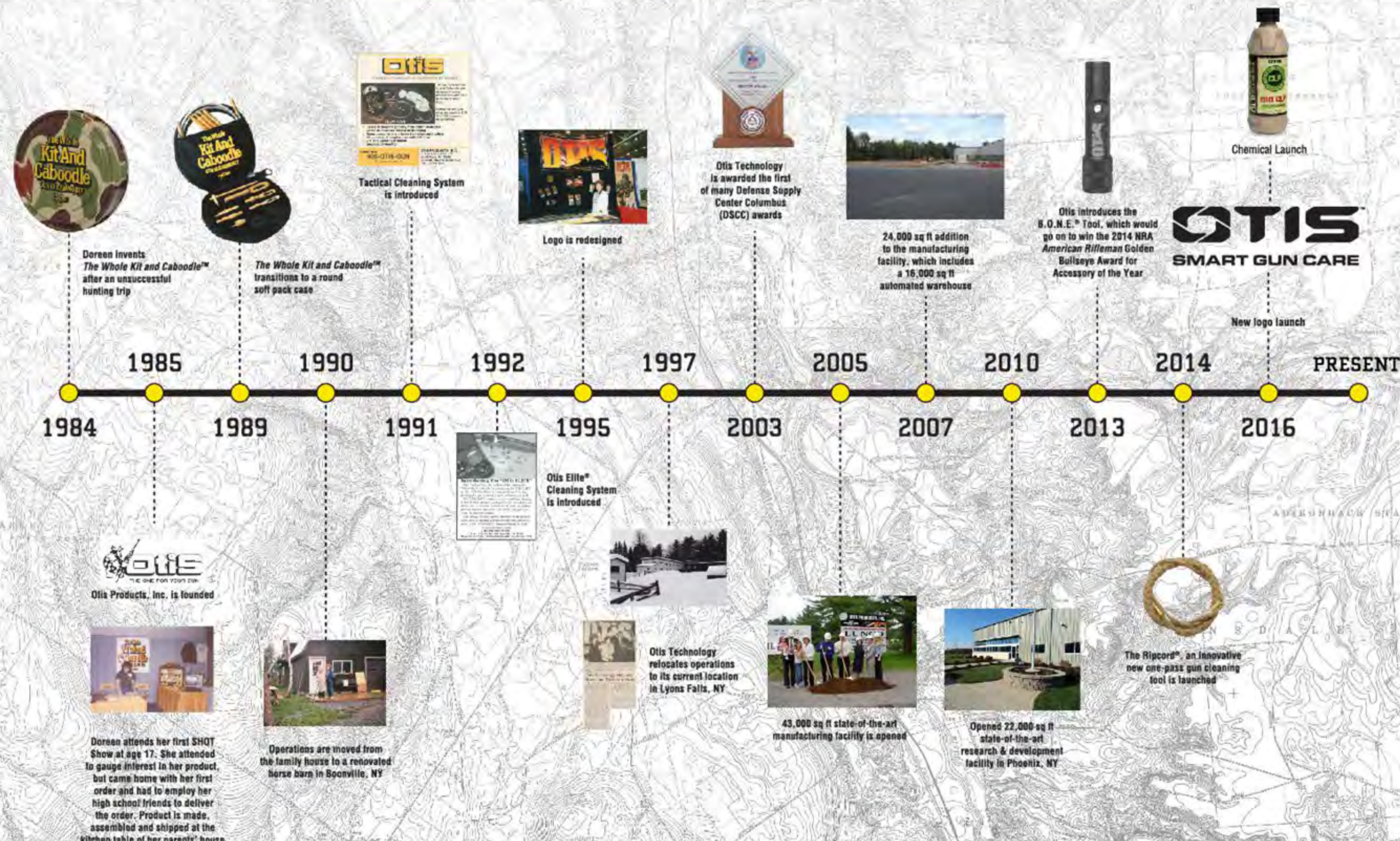
OTIS DEFENSE

Introduction

- Otis Technology founded in 1985 by Doreen Garrett
  - Revolutionized Breech-to-Muzzle® small arms cleaning in Military and Commercial markets
  - In 2010 Otis established a dedicated engineering center near Syracuse, NY to focus on new product

OTIS™ DEFENSE

HISTORY OF OTIS



Cleaning Innovation

- Current State:

- Challenges:
  - Large number of personnel to operate
  - Time to assemble / disassemble rods
  - Poor ergonomics

OTIS DEFENSE

Cleaning Innovation

- Project Goals
  - Reduce time & personnel required
  - Effective
  - Compact
  - Control cost

OTIS™
DEFENSE

Cleaning Innovation

- New Technologies
  - Designed to reduce personnel and time required
    - Power-assisted devices
      - Air Powered
      - Electric
    - Manual
      - Rod
      - Cable

OTIS DEFENSE

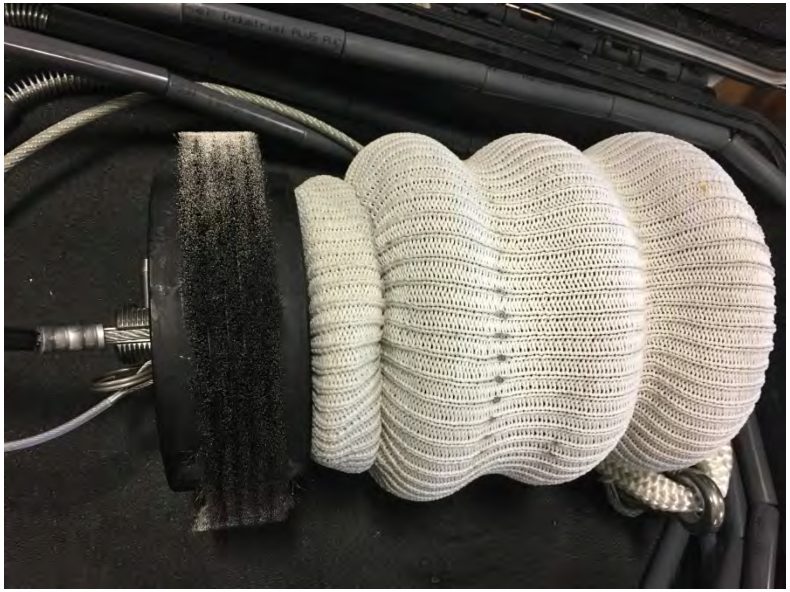
Otis Large Bore Cleaning System Highlights

- Control swab diameter
- Cable rigidity while feeding cable

OTIS DEFENSE

Otis Large Bore Cleaning System Highlights

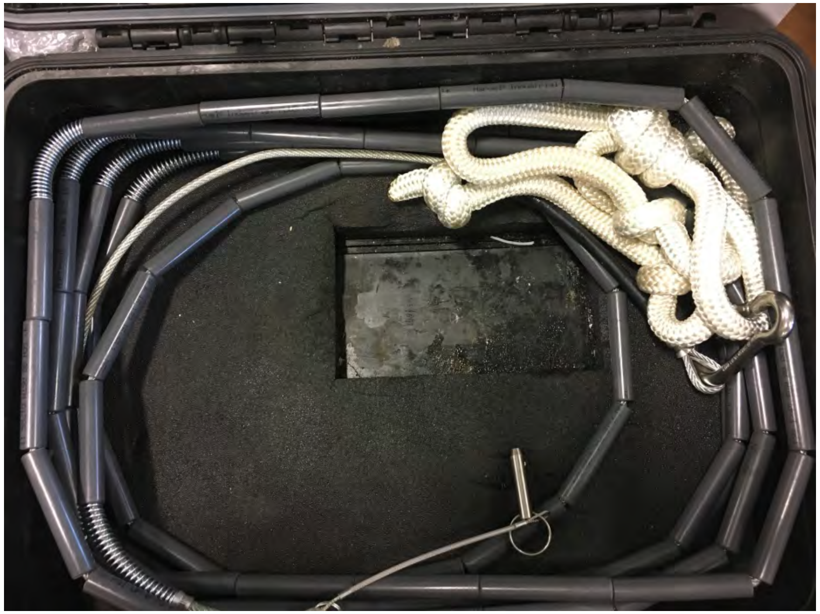
- Control swab diameter
  - Expandable swab mandrel enables finite adjustment



OTIS DEFENSE

Otis Large Bore Cleaning System Highlights

- Cable rigidity while feeding cable
  - Spring-loaded sleeves bias cable straight to enable the cable to be pushed down the tube to attach brush/swab section



OTIS DEFENSE

Otis Large Bore Cleaning System Highlights

- Feed cable from muzzle until loop extends beyond breech
- Attach swab with or without brush to cable
- Pull cable until swab exits muzzle

OTIS™ DEFENSE

Otis Large Bore Cleaning System

- Conclusion
  - Requires 2-4 people
  - Cleans with fewer passes than current rod system
  - Cost comparable with other manual systems
  - Less storage space required

- Future Development
  - Expand number of compatible weapon systems
  - Expand scope to include maintenance items

OTIS™ DEFENSE

Contact Information

James Brooker, VP of Engineering

Otis Technology

JBrooker@Otistec.com

315-348-4300

OTIS DEFENSE

USMC Small Arms Modernization Brief

Mr. Chris Woodburn

Deputy, Maneuver Branch

Marine Corps Capabilities Development Directorate

Summary

- CMC emphasis on the infantry
- Informed by operational lessons, technological maturity, industrial capabilities
- Guided by concepts and initiatives such as the Marine Corps Operating Concept, CMC guidance and Marine Expeditionary Rifle Squad
- Aligned with the Joint strategy for weapons modernization to improve accuracy, lethality and mobility
- Prioritizes selective modernization and sustainment of critical legacy capabilities in the short term (now – FY22)
- Mid-term goals will capitalize on technological advances to deliver modern replacements for critical weapon systems (FY23-32)

Weapons Strategy

- **Maintain current capabilities**
  - Implement improvements (accuracy, lethality, ergonomics and weight reduction) when technology and funding allow to keep small arms relevant
- **Improvements will be implemented on a much smaller scale, primarily to the <u>infantry</u>**
  - Expand to other combat arms when relevant and feasible
- **Future capabilities will be pursued via Joint efforts whenever possible**
- **End-State: Improved lethality while maintaining/improving the mobility of the individual Marine, the Marine Rifle Squad, and the MAGTF**

M27

- **Increased M27 Distribution**
  - Procuring additional M27s to support an increased distribution for the entire rifle platoon, which includes the Platoon Commander, Platoon Sergeant and remaining members of the rifle squad not already equipped.
  - Provides the greatest lethality, reliability and durability of weapon systems available to the platoon.
  - Procurements begin in FY18 and will be complete in FY20.
  - M4s from infantry battalions will be redistributed to replace remaining M16A4 in the GCE

Squad Small Arms Capabilities

- **Suppressors**
  - In the near-term, assessing suppressor technologies that reduce negative impacts to the rifle and shooter for M27s and M4 rifles for each member of the squad and other designated units with a close combat mission.
  - Follow on efforts to address medium machine gun suppressor requirements.
- **M38 Squad Designated Marksman Rifle**
  - M27 with a 2.5-8x variable power optic and suppressor
  - Currently fielding one per rifle squad as an organizational weapon for increased target identification and engagement to mitigate capability gaps.
- **Squad Rangefinder**
  - Fielding a weapon mounted rangefinder to increase first-shot probability of hit for organic weapon systems within the rifle squad
- **M320A1 Grenade Launcher Module**
  - Procuring to replace the legacy M203 grenade launcher and seeking increased lethality and range through munition improvements.

Small Arms Capabilities

- **Mk13 Mod 7 Long Range Sniper Rifle**
  – Procuring and fielding a limited quantity of Mk13s with a day scope and night vision capability
  – Provides an interim increased range engagement capability for snipers until Advanced Sniper Rifle is fully fielded in the early-20's.
- **.338 Light Weight Medium Machine Gun**
  – The Marine Corps is partnered with USSOCOM for requirements development and pursuit of a materiel solution to replace the M240B in the dismounted role and as a partial replacement for the .50 cal machinegun in the mounted role for some platforms (ground and air)
- **Next Generation Squad Weapons**
  – In keeping with Mid-Term goals, the Marine Corps is partnered with the Army for requirements and technology development to purse three capabilities: automatic rifle; individual carbine; and designated marksman.

QUESTIONS?

Always a Step Ahead
ARDEC
ARMAMENTS

ARDEC Small Caliber Barrel S&T Efforts

Presented by:
Mr. Adam L. Foltz, P.E.
US ARMY ARDEC

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& SOLUTIONS
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U.S. ARMY
U.S. ARMY RDECOM

U.S. ARMY ARMAMENT
RESEARCH, DEVELOPMENT
& ENGINEERING CENTER

U.S. ARMY RDECOM ARDEC

ARDEC Small Caliber Barrel S&T Efforts:

#20142 - Thermal Isolation/Barriers for Small Caliber Weapon Applications

#20143 - Development of Material Characterization Methods for Next Gen. Weapon Barrel Requirements

#20144 - Dynamic Physical Simulation of Small Caliber Barrel Steel at Elevated Temperatures

Thermal Isolation/Barriers for Small Caliber Weapon Applications (#20142)

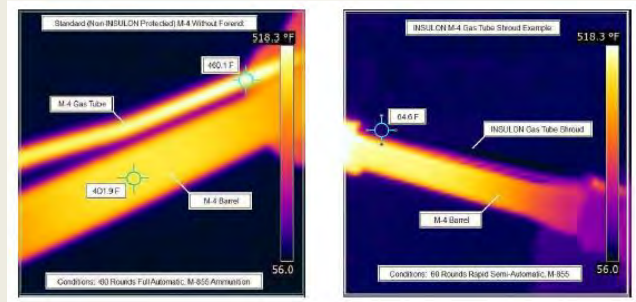
Mr. Adam L. Foltz, P.E.
US ARMY ARDEC
RDAR-WSW-F, B2

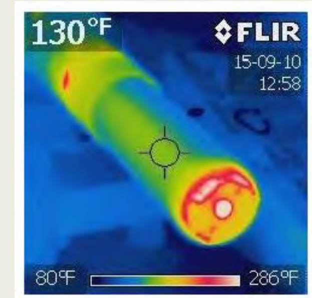
Dr. Laurie A. Florio
US ARMY ARDEC
RDAR-WSW-F, B8

Mr. Adam M. Jacob
US ARMY ARDEC
RDAR-WSW-F, B2

BACKGROUND

Aggressive firing rates result in extreme high temperatures in barrels and suppressors





Why it matters:

http://www.flir.com/flirone/ $199

http://www.flir.com/suas/vue/ $650

U.S. ARMY RDECOM

TECHNICAL APPROACH

ARDEC

Main Area of Interest:

- Vacuum insulation concepts

https://conceptgroupinc.com/

Conduction of 0.1mm Insulon:

40X more fiberglass

20X more expanded polystyrene

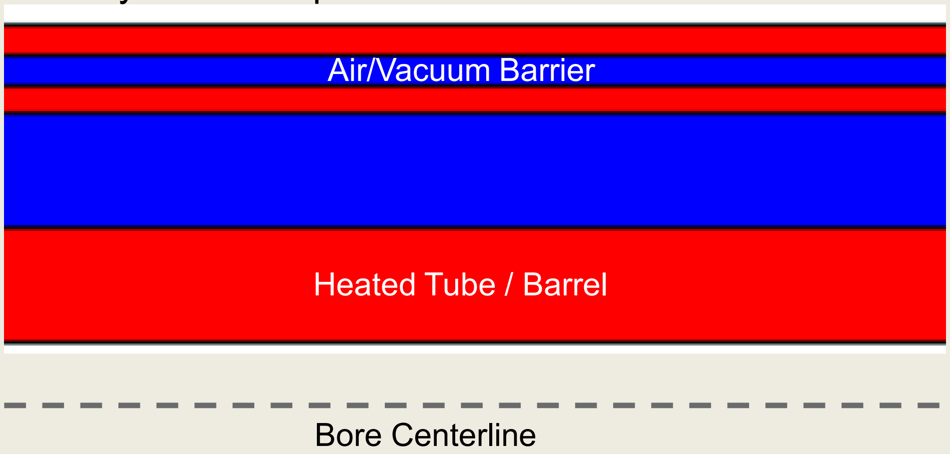
25X larger air gap

Technical Approach

- Modeling and Simulation

Model Setup

Axisymmetric representation

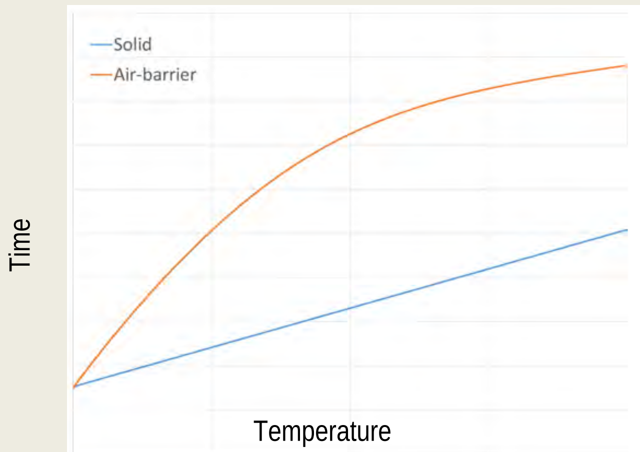


Study 1 - Constant heat flux, solid tube vs. air gap
Study 2 - Constant heat flux, emissivity influence
Study 3 - Constant heat flux, air gap vs. vacuum
Study 4 - Conditions for varied outer surface tube boundary conditions
Study 5 - Constant heat flux, forced cooling fluid between barrier/solid
Study 6 - Complex heat load to replicate live fire

Study 1 (constant heat flux, solid tube vs. air gap)

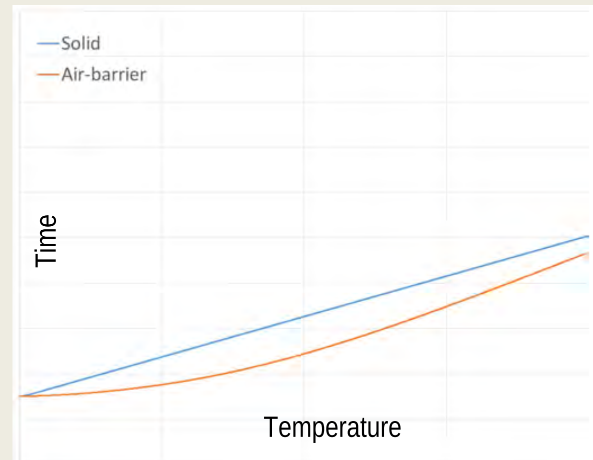
- Air gap decreases or delays the heat flow

Inner Surface



- ➢ Inner surface of air gap layer rises faster than all solid barrel at the same radial position.
- ➢ Reduced heat flow across air barrier

Outer Surface



- ➢ Temperature rise at outer surface delayed by air gap layer compared too all solid barrel

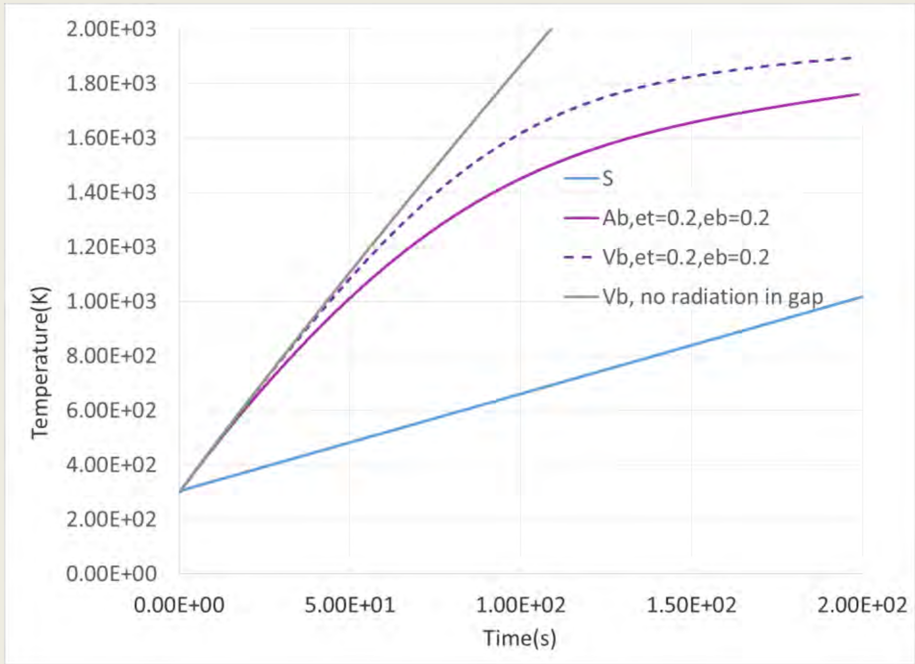
Study 2 (constant heat flux, emissivity influence)

- Emissivity – effectiveness in emitting energy as thermal radiation
- Lower reflectivity/higher emissivity results in a less effective barrier

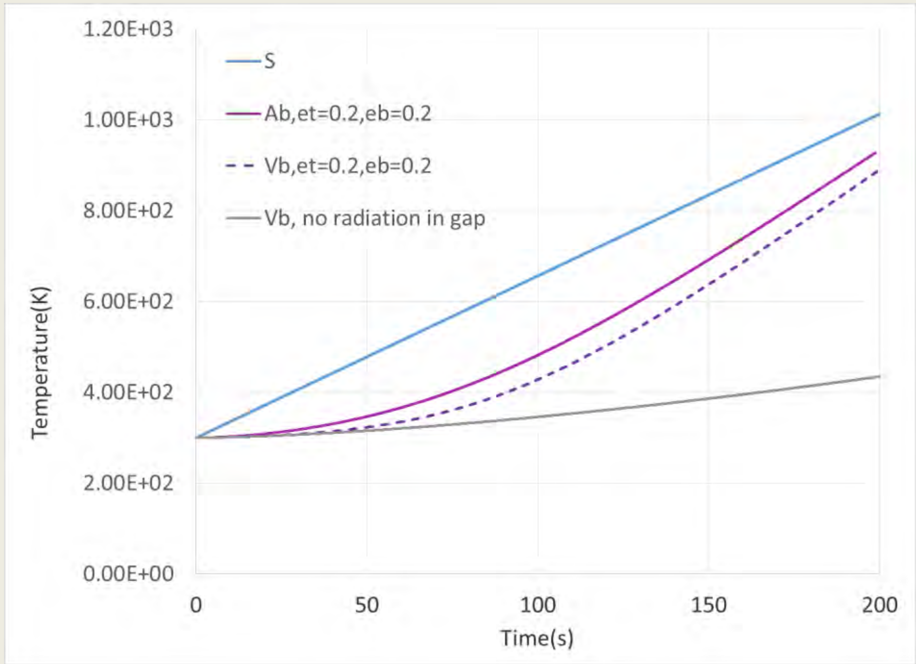
Study 3 (constant heat flux, air gap vs. vacuum)

- Vacuum barrier more effective than air gap, but higher interior temps reached (conservation of energy)

Inner Barrier Surface



Outer Barrier Surface

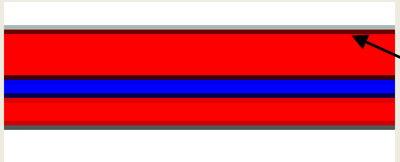


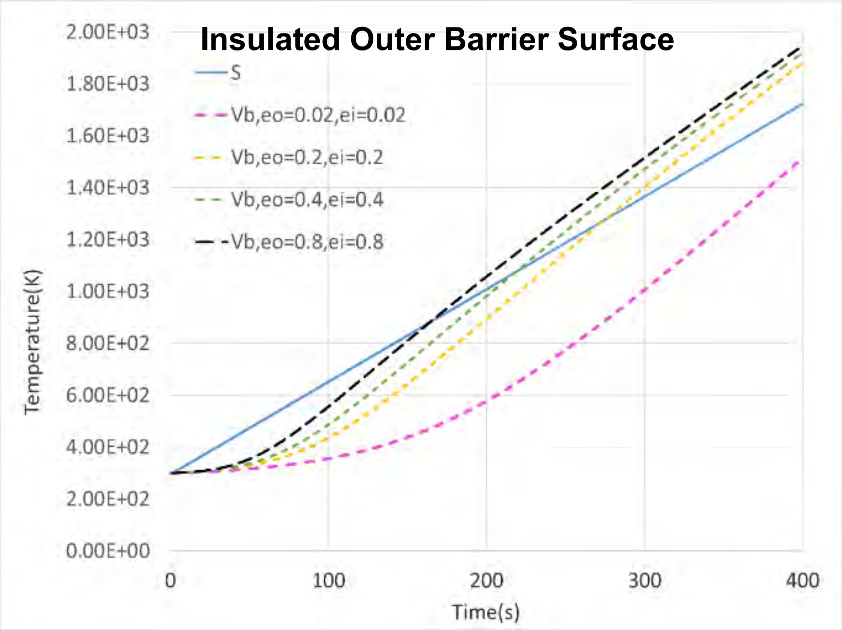
- ➢ Higher inner surface temperatures for vacuum barrier vs. air gap (resisting heat flow)
- ➢ No radiation represents upper bound of barrier performance

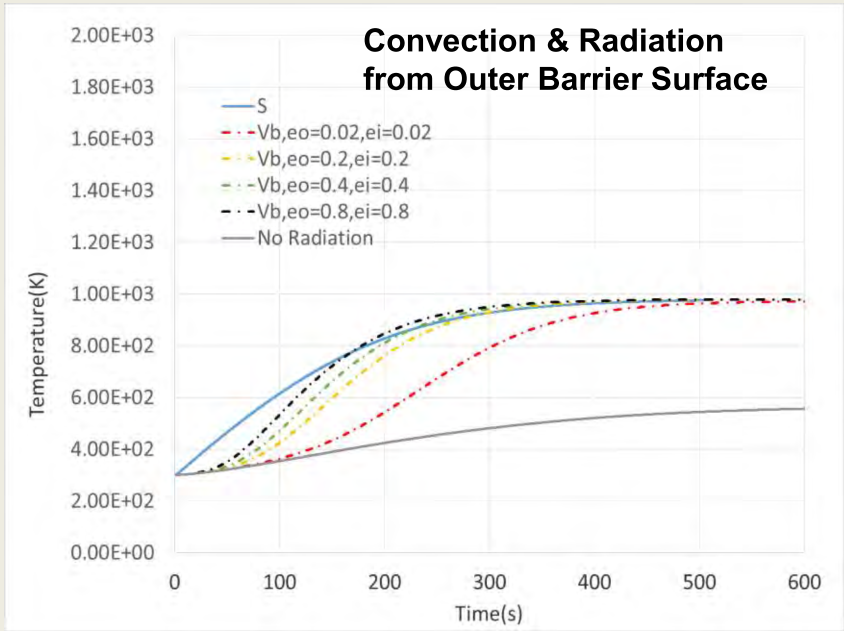
- ➢ Rate of increase in temperature for vacuum barrier eventually surpasses solid tube case (radiation)

Study 4 (varied outer surface tube boundary conditions)

- Insulated vs. convection/radiation





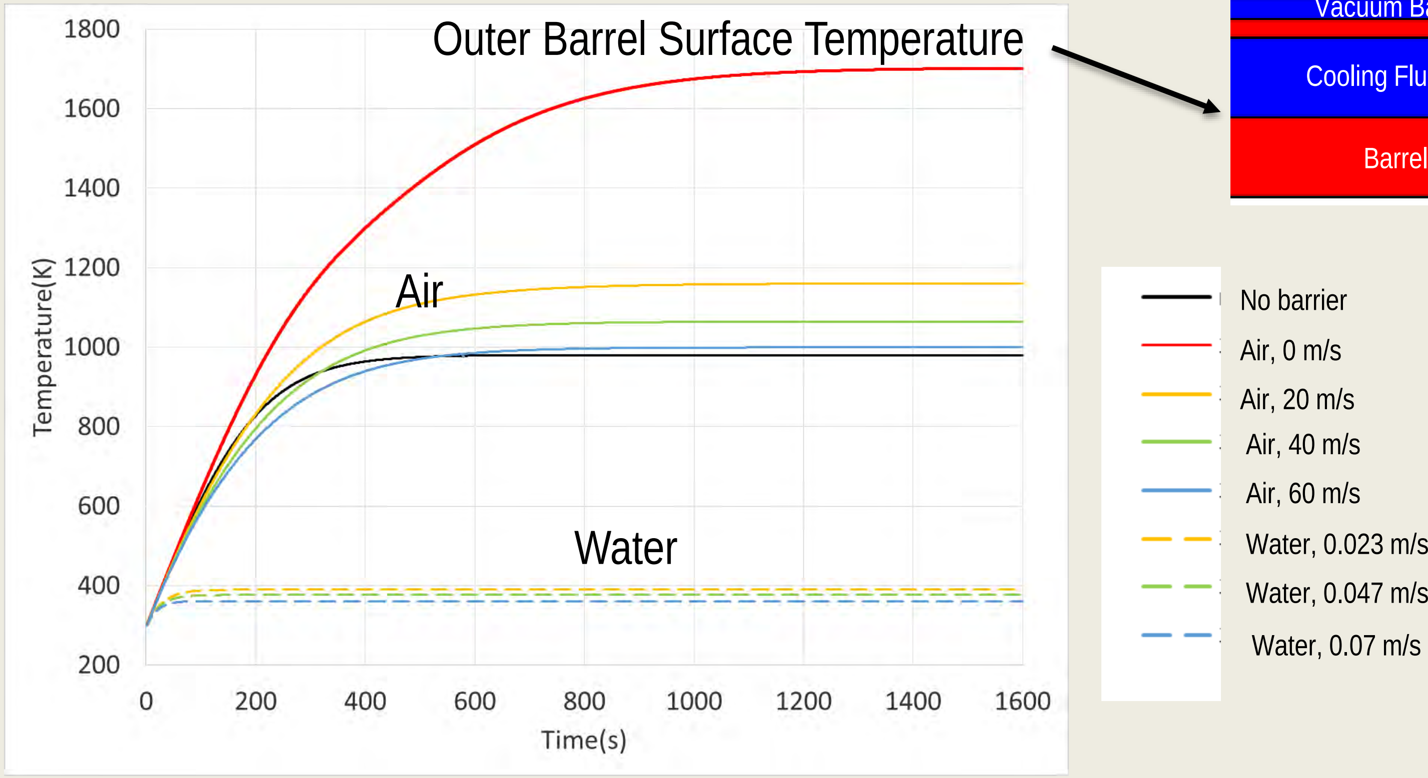


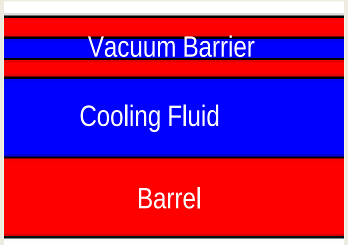
Outer boundary conditions studied represent likely extremes for heat removal

- Insulated – no heat flow, temperatures continue to rise
  - Negligible barrier benefits with long duration high heat load
- Convection/Radiation – sufficient heat removal, steady state temperatures do not vary significantly

Study 5 (constant heat flux, cooling fluid between barrier/solid)

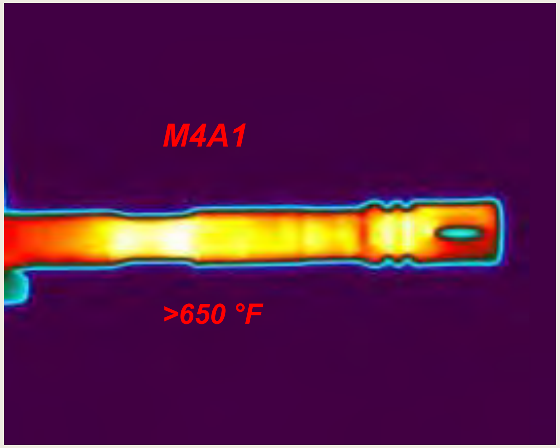
- Insufficient flow velocities/spacing increases heating
- Water more effective than air (4x heat capacity)

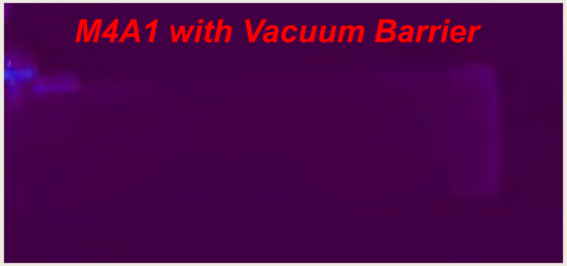


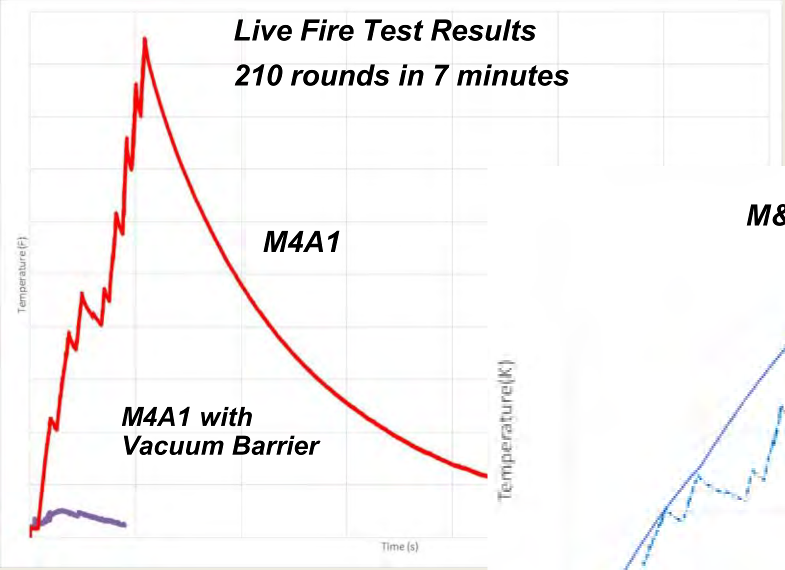


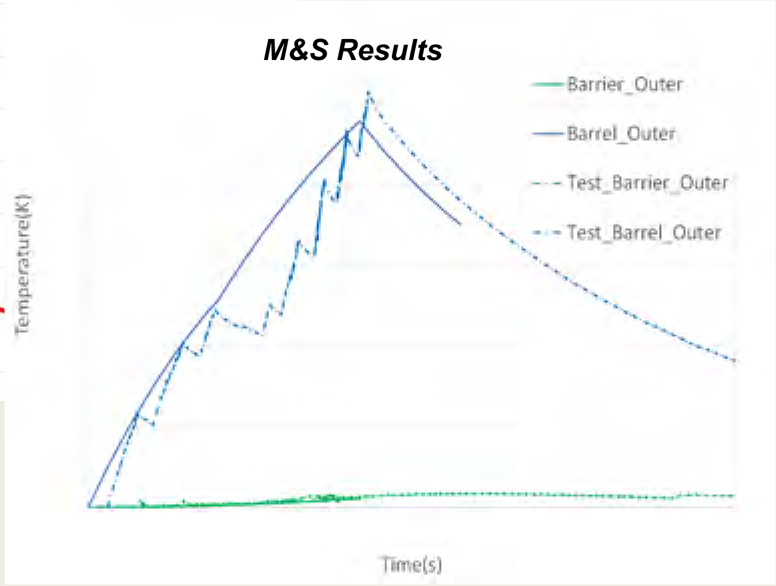
Study 6 (complex heat load, replicate live fire)

- Modeling results provide reasonable estimation of the thermal conditions that develop
  - * Good correlation between standard barrel test results and model results
  - * Good correlation between barrier test results and model results









Future Work

Possible Future Work:

- Additional live fire testing and model validation
- Active cooling optimization studies
  - Fluid type (Air / Water)
  - Flow velocity / flow spacing
  - Heat pipe concept

Results and tools developed can be directly applied toward supporting the development of next generation weapon system requirements

Development of Material Characterization Methods for Next Gen. Weapon Barrel Requirements (#20143)

Mr. Adam L. Foltz, P.E.
US ARMY ARDEC
RDAR-WSW-F, B2

Mr. Stephen B. Smith
US ARMY ARDEC
Benét Laboratories

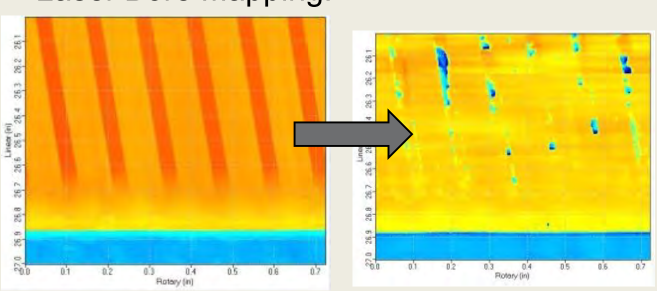
Background:

- Science and Technology (S&T) needs are repeatedly identified in the areas of increased barrel performance, including Improved Weapon Accuracy, Reduced Barrel Erosion, High Performance Alloys, Increased Barrel Life, Chrome Replacement Technologies

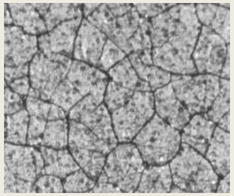
- Requirements generally related to:
  1) Mechanical strength at elevated temperatures
  2) Resistance to abrasive and adhesive wear
  3) Structural stability under thermal and chemical attack

- Vented Fixture Testing
  - Does not predict gun tube life, but does offer a low cost method for comparing the high-temperature, thermochemical erosion performance of the materials/coatings
  - To date, vented fixture testing has not been studied for small caliber barrel applications

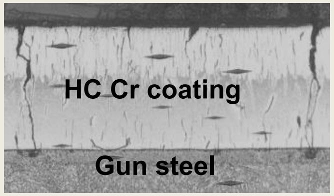
Laser Bore Mapping:



Thermal shock cracking

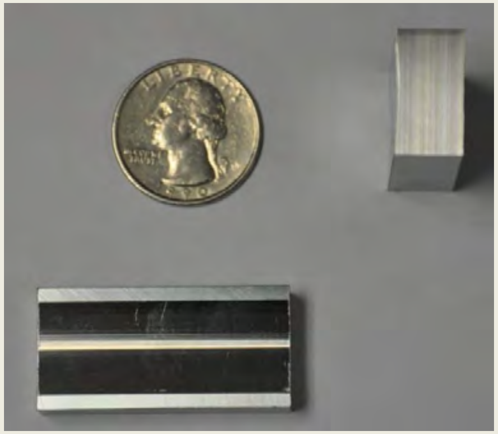


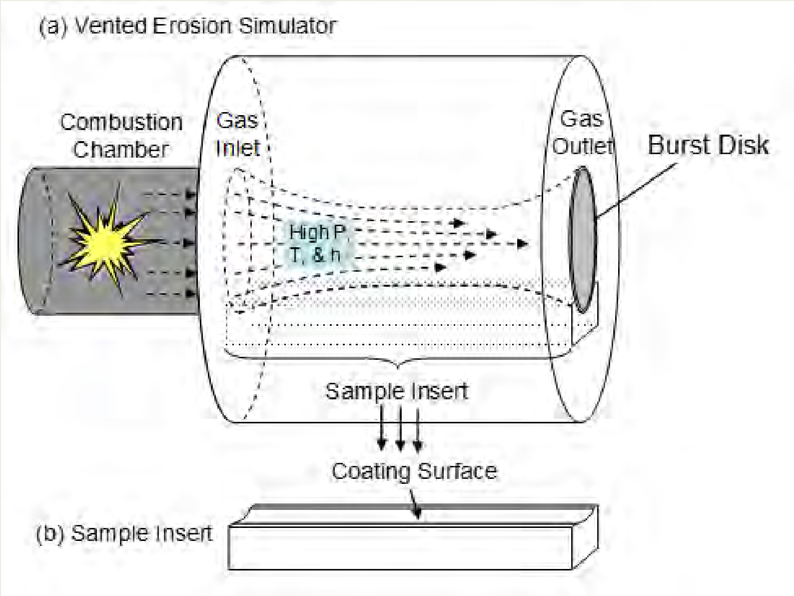
Thermo-chemical attack

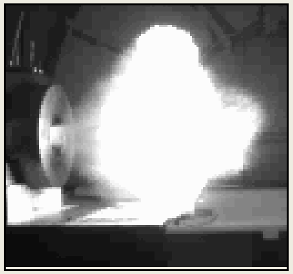


Purpose:

- Develop standardized protocols and bench scale testing procedures using a Vented Erosion Simulator (VES) to analyze barrel materials for increased barrel life
  - Develop fundamental understanding of chemical, thermal, mechanical erosion in small and medium caliber gun barrels
  - Identify and define critical material property characteristics directly associated with barrel performance
  - Investigate new steel alloys and help define the metrics and ROI necessary to justify material changes



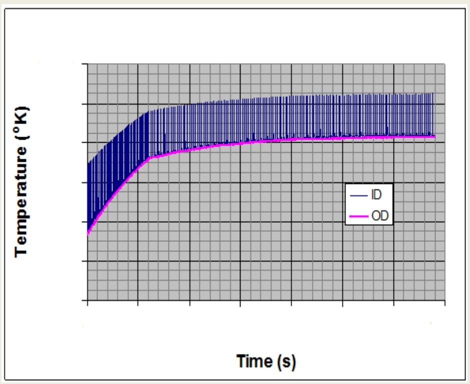




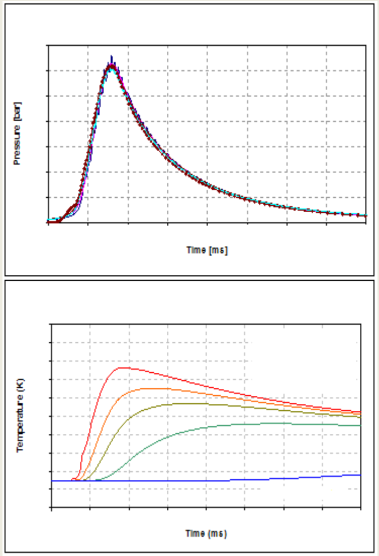
VES Process:

- Fast and cost effective screening tool
- Match thermo-mechanical and thermo-chemical barrel environment
- Modular design allows for customization of propellant load/type, burst disk, thickness/material, muzzle/sample design, etc.
- Removable sections of prototype bore materials and coatings are fitted to a converging/diverging nozzle

1. Weapon Model / Experimental Data

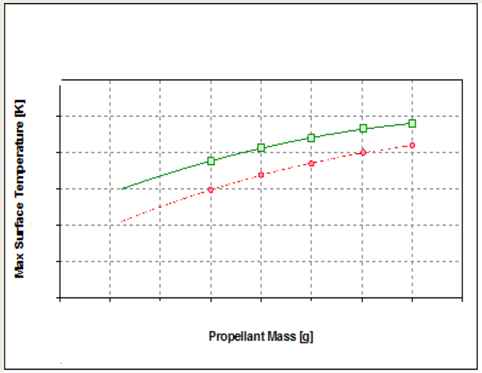


2. VES Model

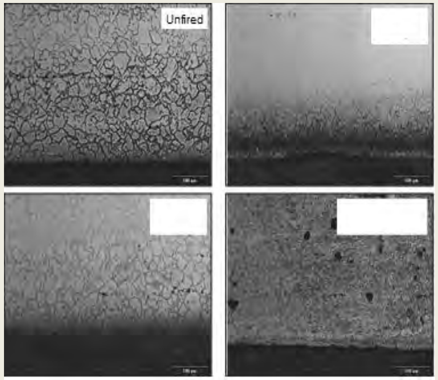


Modeling used to ensure VES can match barrel environment: load and location for pressure and temperature

3. VES Testing

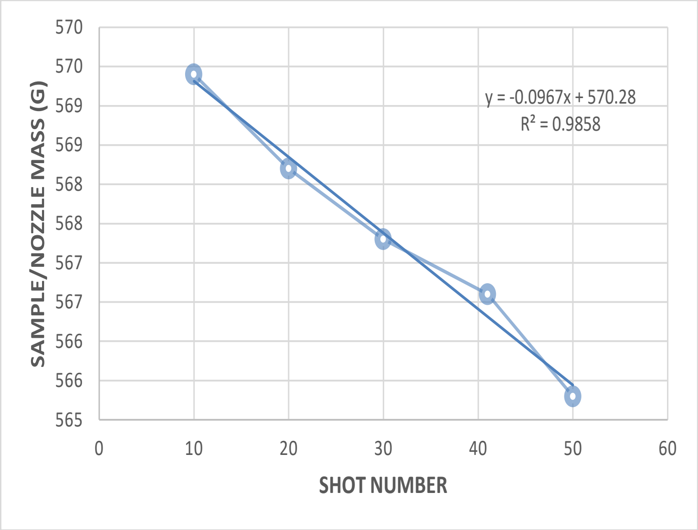


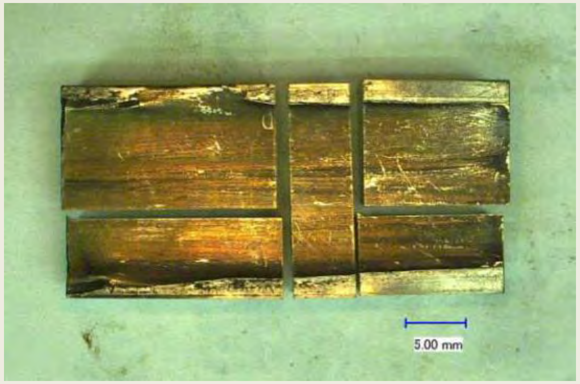
4. Material Characterization



VES Process:

- Setup validation completed one 2 samples (5 shots / 50 shots)
    - Linear regression analysis (ability to fire less shots)
    - Metallographic analysis post test



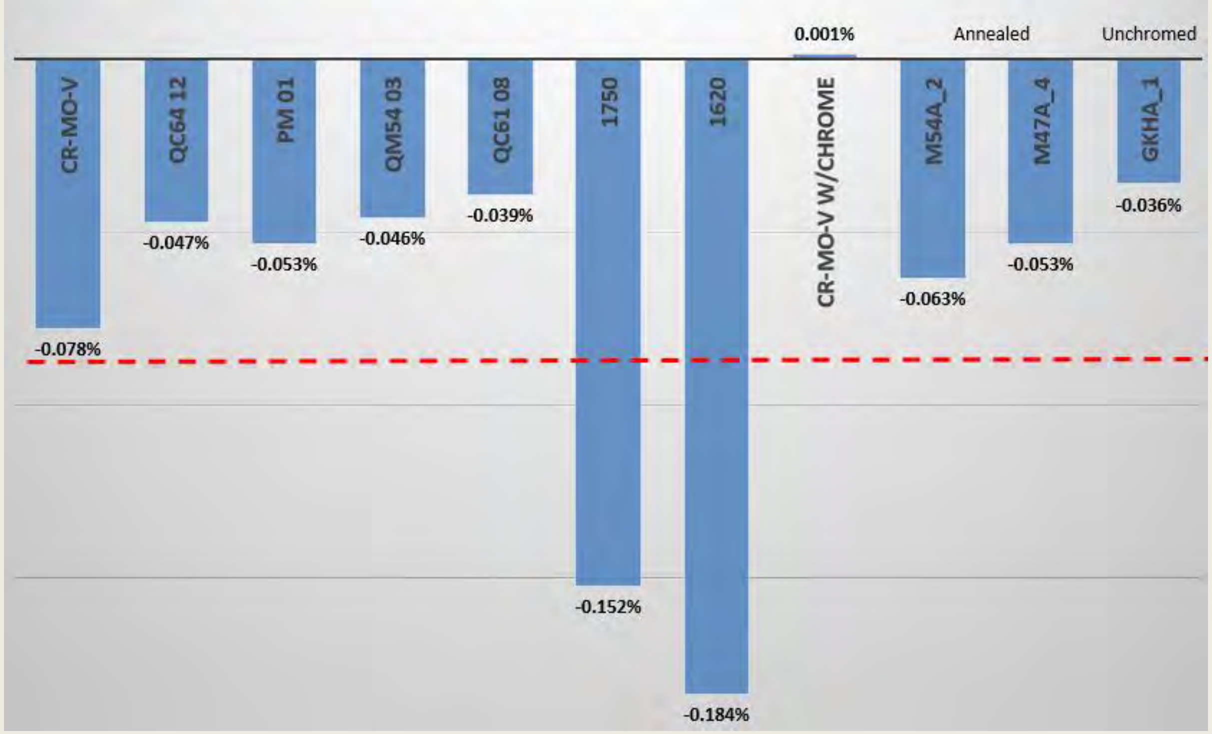


Analysis:
Micro-hardness analysis
Photographed with the light-optical microscope (LOM)
Energy dispersive spectroscopy (EDS) chemistry analysis
X-ray fluorescence (XRF) analysis

Results:

**Preliminary VES trials of selected candidate materials show improvements in material response compared to standard small caliber barrel material (Cr-Mo-V)*

Sample	Shots	Change in Mass per Shot (g)	Change in Mass per Shot (%)
Cr-Mo-V	***5***	***-0.04484***	***-0.078%***
QC64 12	5	-0.02774	-0.047%
PM 01	5	-0.0306	-0.053%
QM54 03	5	-0.02714	-0.046%
QC61 08	5	-0.0232	-0.039%
L605 1750F	5	-0.1041	-0.152%
L605 1620F	5	-0.12588	-0.184%
Cr-Mo-V *(Chromed)*	***5***	***0.0043***	***0.00086***
M54	5	-0.1888	-0.03776
M47	5	-0.1552	-0.03104
GKH	5	-0.1045	-0.0209



Additional planned materials to evaluate:

- GKH 33 CRMOV 12-10 (chromed)
- M47 (heat treated)
- M54 (heat treated)
- GKH ARMAD

Dynamic Physical Simulation of Small Caliber Barrel Steel at Elevated Temperatures (#20144)

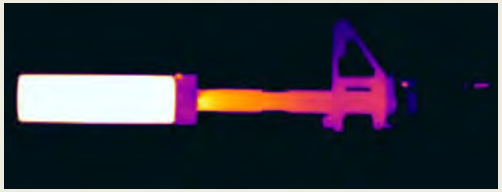
Mr. Adam L. Foltz, P.E.
US ARMY ARDEC
RDAR-WSW-F, B2

Mr. Stephen F. Bartolucci, Ph.D.
US ARMY ARDEC
Benét Laboratories

Background:

- Dynamic material responses due to impulse loading can vary greatly from static responses when considering the stresses induced by pressurization and thermal loading

- For numerous small caliber barrel applications a paradox exists relative to the strength and stress of the tube based on the extremely high temperatures experienced from repeated firing.
    - Barrels and suppressors can reach temperatures above 1500°F, where static yield strengths of the steel tubes can drop far below the allowable equivalent stress, yet catastrophic failure does not occur, demonstrating the variation in dynamic vs. static material response.



    - Gun tube thermal management is essential in determining the effects of rapid fire scenarios on the physical and mechanical properties.
        - Short breaks in the firing cadence can reduce the peak temperatures on the barrel internal bore surface, but the bulk temperature of the barrel is relatively unaffected.

- Limited data exists with very specific correlations to relevant environments for small caliber weapon applications

Approach:

- Conducted experimental research was conducted on small caliber barrel steel using both steady state test methods and physical simulation dynamic test methods in order to characterize mechanical strengths at varying strain rates to determine thermal impacts associated with aggressive firing scenarios of small caliber gun barrel applications

Gleeble System:

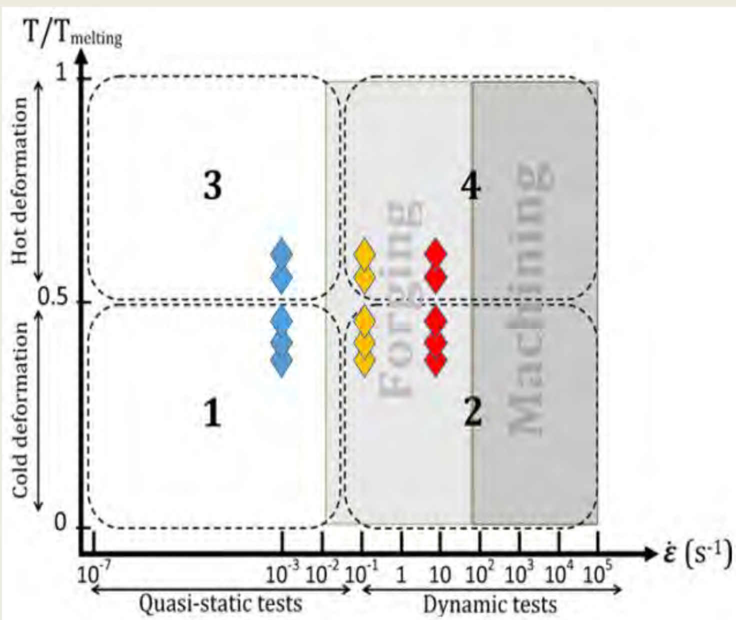
- Gleeble® system (advanced thermal-mechanical testing)
  - Provides precise control of the energy input to create the physical simulation necessary to replicate the small caliber gun barrel environment.

  - Heating rates of 10,000°C per second, stroke rates exceeding 1,000 mm per second and 22,000 lbs. of tension and compression force (Gleeble® 3500)

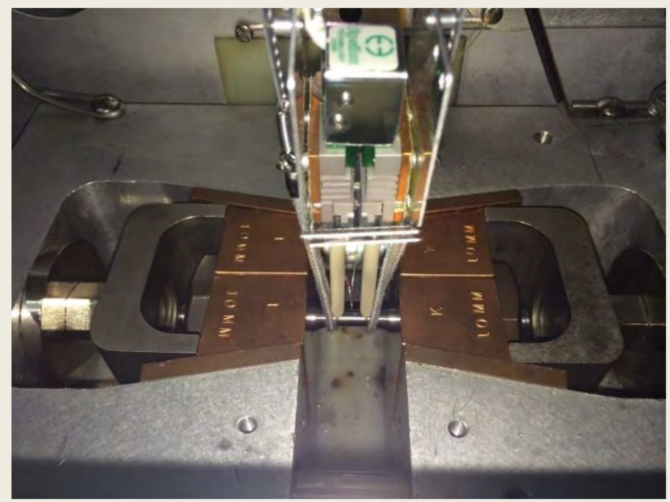
Gleeble system

Test Matrix:

- 30 minute temperature soak (static)
- 10 minute temperature soak (static)
- Non-linear heating (based on experimental live fire data)
    - Strain rates: $0.001 s^{-1}$ (quasi-static) and $0.1\ s^{-1}$ (dynamic)
- Linear heating
    - Strain rates: $0.001 s^{-1}$ (quasi-static), $0.1\ s^{-1}$ (dynamic) and $10 s^{-1}$ (dynamic)



Quasi-static vs. Dynamic



Gleeble system

Test Results:

- Static Results (30 min soak)

Temperature (°F)	Yield (KSI)	Tensile (KSI)	% Elong
72	143	153	19
400	120	143	18
800	99	117	21
900*	81	98	
1200	28	42	55
1300	12	22	95

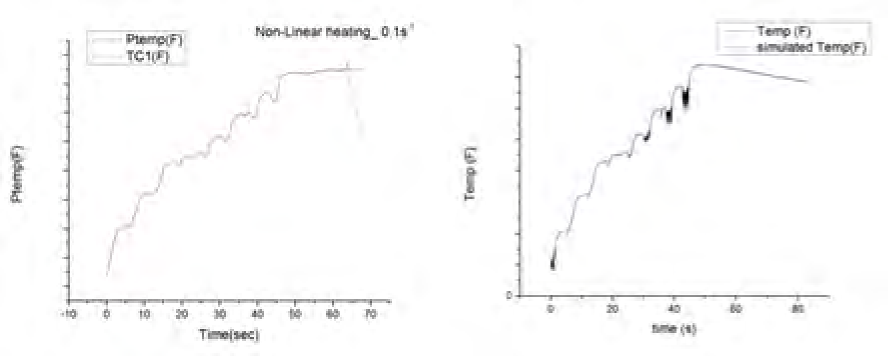
- Static Results (10 min soak)

Temperature (°F)	Yield (KSI)	Tensile (KSI)	% Elong
900	94	127	19
	98	124	21
	92	128	24
	96	125	21
Ave	95	126	21

Yield and tensile strengths as expected are only slightly higher (~10-15%) than interpolated results from the 30 minute soak at the same temperature

Test Results:

- Linear vs. Non-Linear

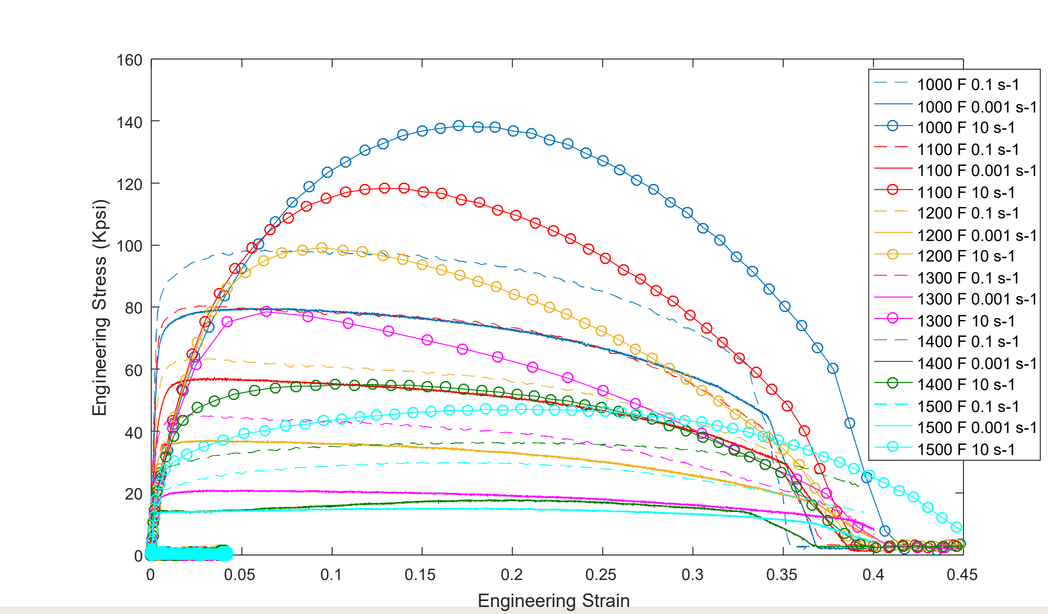


Temperature (°F)	Strain Rate (s^{-1})	Heat Rate	Yield (KSI)	Tensile (KSI)	% Elong
72	0.001	N/A	124.8	144.6	18.3
750	0.10	Non-Linear	97.0	120.4	18
	0.10	Linear (45s)	94.4	120.9	17.0
	0.001	Non-Linear	93.0	114.5	18.2
	0.001	Linear (45s)	92.9	116.1	20.1

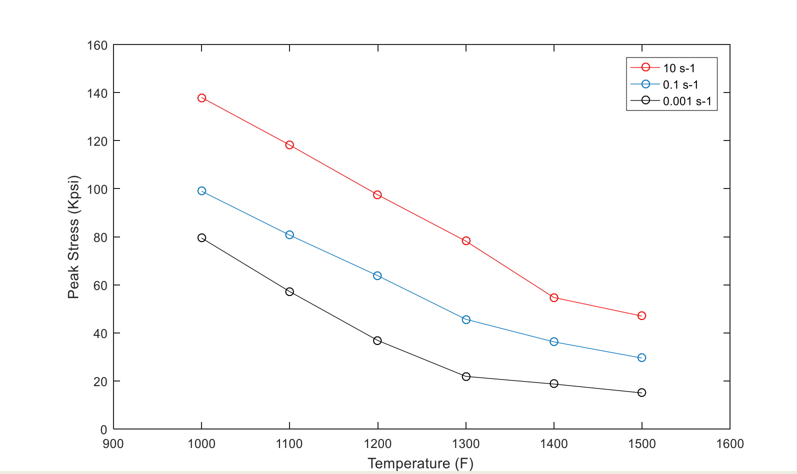
- Results show expected trends;
  - Higher strengths at room temperature
  - Higher strengths at high strain rates
  - Non-linear results nearly identical to the linear results
  - Minor differences between static and dynamic responses of the material at 750 F

Test Results:

- Dynamic
  - 0.001s^{-1}(quasi-static), 0.1 s^{-1} (dynamic), 10s^{-1}(dynamic)



Stress vs. Strain



Peak Stress vs. Temp

*Future studies planned at higher strain rates and with additional materials of interest

Point of contact:

Mr. Adam L. Foltz, P.E.
US ARMY ARDEC
RDAR-WSW-F, B2
Picatinny Arsenal, NJ 07806
Phone: 973-724-7096
Email: adam.l.foltz.civ@mail.mil

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Characterization of Machine Gun Barrel Temperature and Stress Conditions Through Correlation of Testing and Numerical Methods

Presented at:

NDIA Armament Systems Forum

Indianapolis, IN

May 2018

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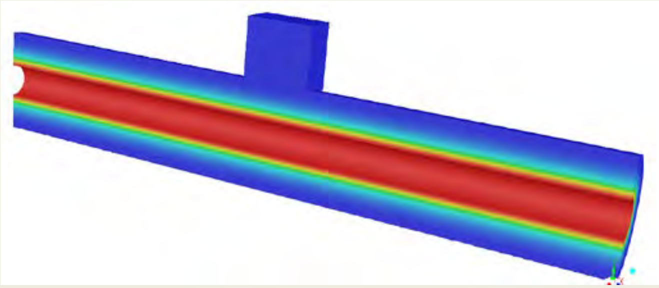
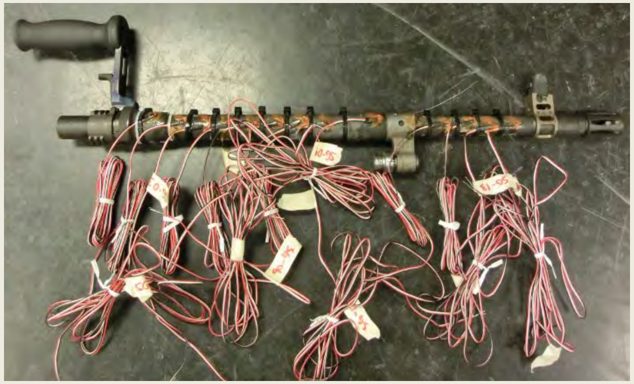
Agenda

- Purpose
- Thermal Characterization
  - Test Methodology
  - Test Observations
  - Numerical Methods
  - Results / Discussion
- Stress / Strain Characterization
  - Test Methodology
  - Test Observations
  - Numerical Methods
  - Results / Discussion
- Thermal Stress
- Conclusions, Takeaways, Recommendations
- Questions

Purpose

- Background
  - More complete understanding of bore thermal and structural behavior is desired in order to produce higher performing, lighter weight barrels
  - It is known that many barrels will survive conditions in which they are predicted to fail
  - AMCP 706-252[1] used for numerical stress analysis – based on Lame's thick walled cylinder calcs, assumes steady state, elastic. Others also developed.
  - Multiple analytical methods for barrel temperature developed over the years, CFD being the most sophisticated
  - Little work done in validating analytical/ numerical methods – stress and temperature at the bore surface are difficult to measure
- Purpose
  - Characterize the temperature and stress in a 7.62mm, M240L long machine gun barrel during various live fire events
  - Correlate and validate analytical / numerical solutions
  - Research potential alternate analysis methods

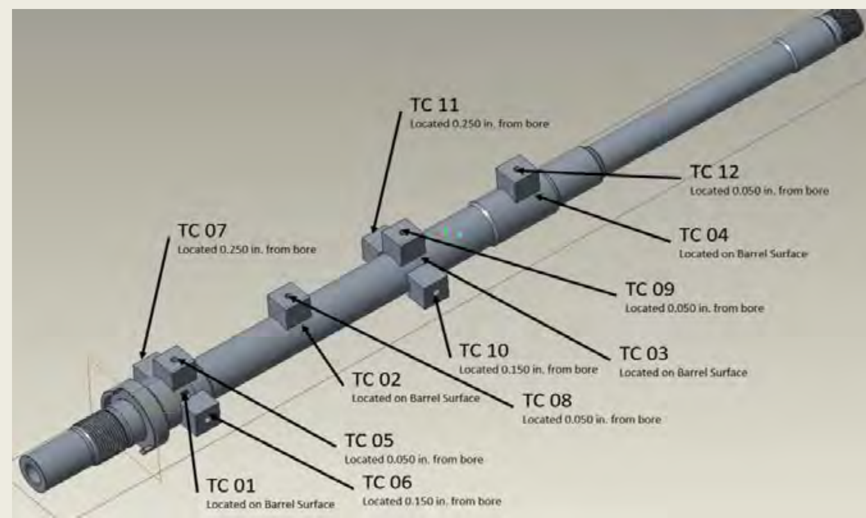




[1] AMC Engineering Design Handbook: Gun Tubes, AMCP 706-252, U.S. Army Materiel Command, 1964.

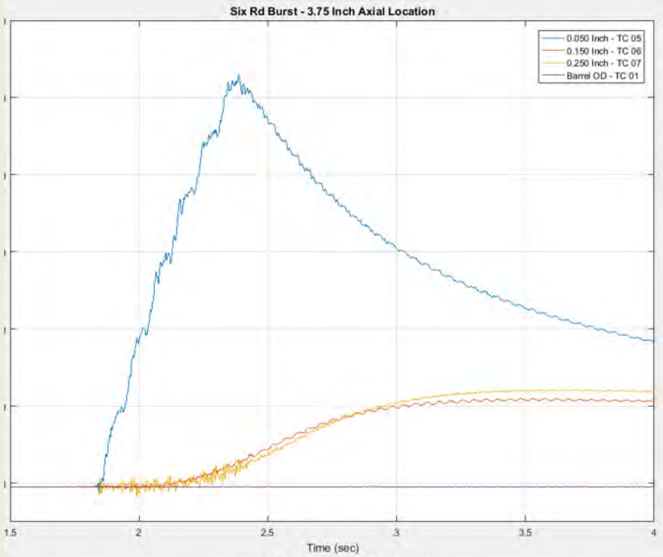
Temperature Characterization – Test Methodology

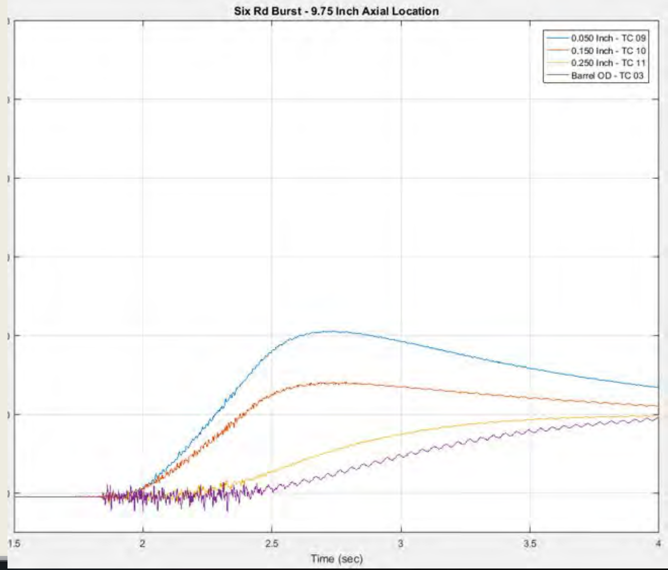
- Modified Barrel to Mount In Wall Thermocouples (IWTCs) from Veritay Technology, Inc.
- 3 inch spacing, IWTC's placed at groove location
- Thermocouples throughout barrel wall (0.050, 0.150, 0.250, barrel surface)
- Sampled at 10kHz
- Firing scenarios – Single, 6rd, 12rd, Sustained, Rapid, Final Defensive, Cyclic



Temperature Characterization – Test Observations

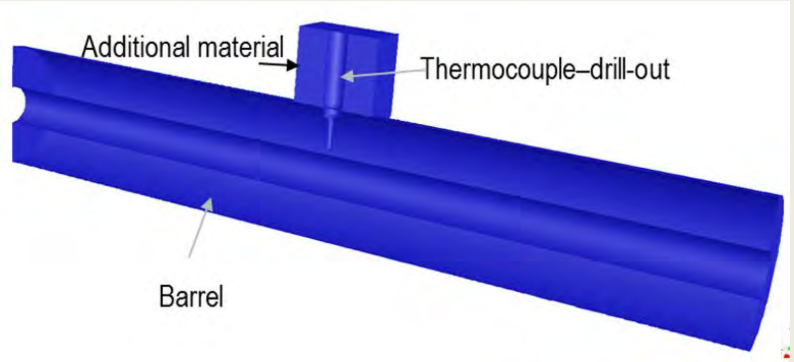
- IWTCs were very sensitive to installation
  - Position (tip depth)
  - Lift off if not tight enough
  - Damaged tip if too tight – resulted in bad readings if contact made on shaft of tip
- Bottom of mounting hole – 0.043” diameter
  - Several drills broke during machining
  - Had to use a bushing at the bottom of the hole to get the 0.043 dia
- Zero Shift – steady state not the same for all thermocouples
  - Resulted in bad measurements



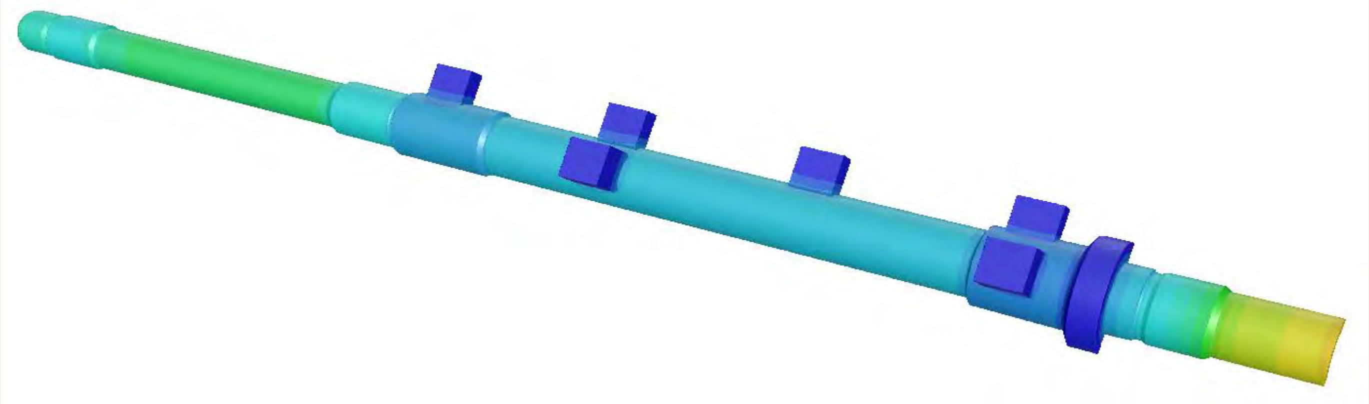


Temperature Characterization – Numerical Methods

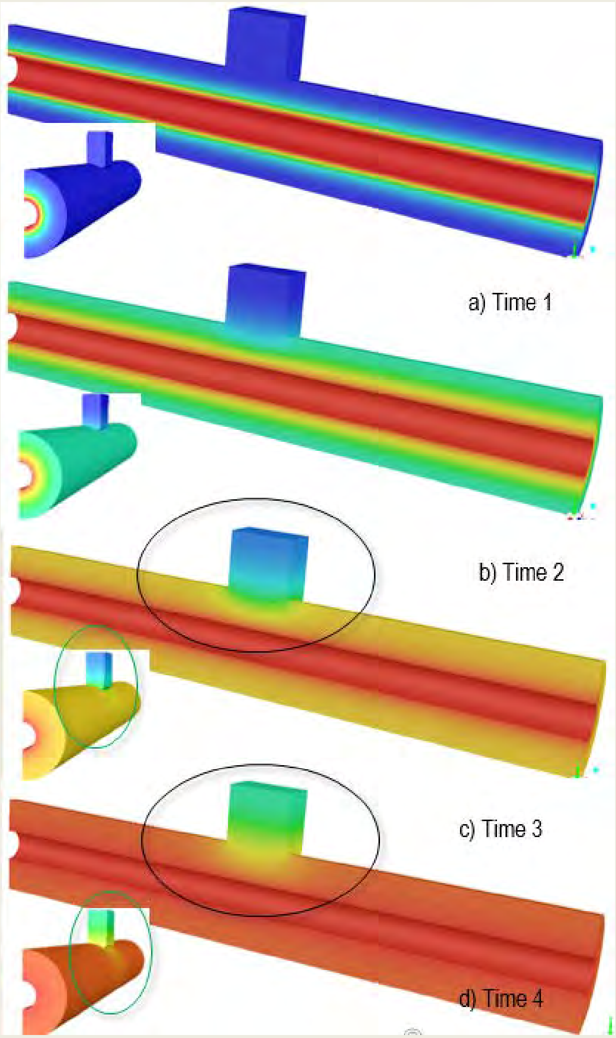
- Computational Fluid Dynamics (CFD)
- Uses propellant burn model
  - Generates propellant gas conditions
  - Drives fluid flow, heat transfer, bullet motion
  - Uses solid barrel and chamber
- Heat is input each shot with time and spatial variation



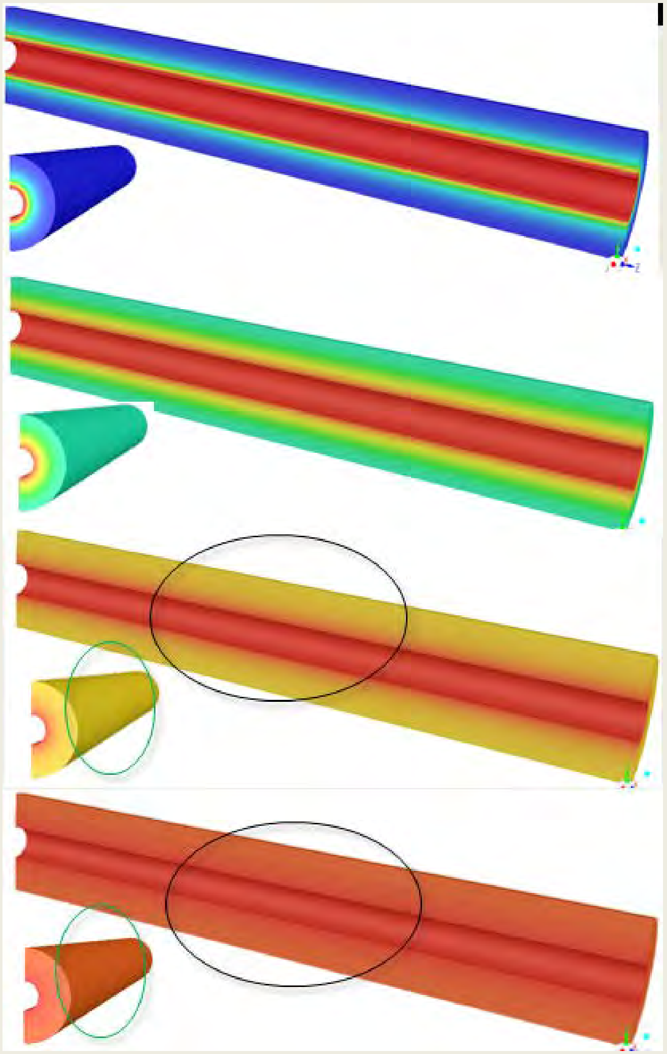
- Understanding of the differences between the test barrel and the real M240 barrel is crucial
  - Added material for IWTC mounting, and machined holes and IWTCs themselves will change behavior
  - First step is to understand the differences between the standard barrel and the modified barrel



Temperature Characterization – Numerical Methods



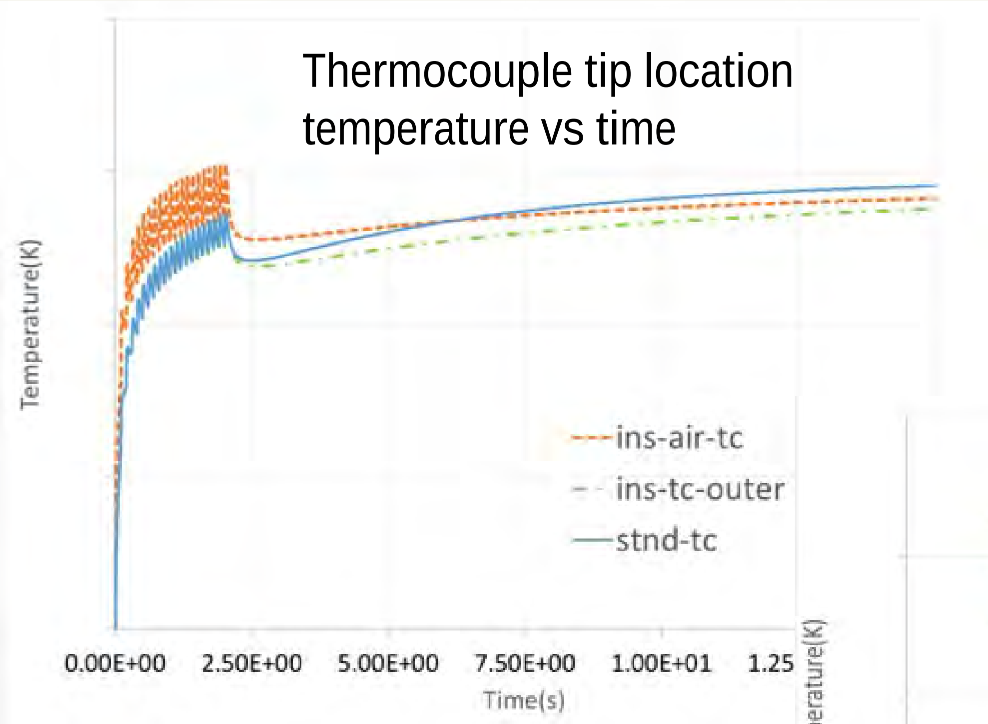
As the energy moves through the barrel over time, the cooling effect due to the additional mass of the test fixture components is more noticeable.



Temperature Test-Fixture Air Filled (ins-air)

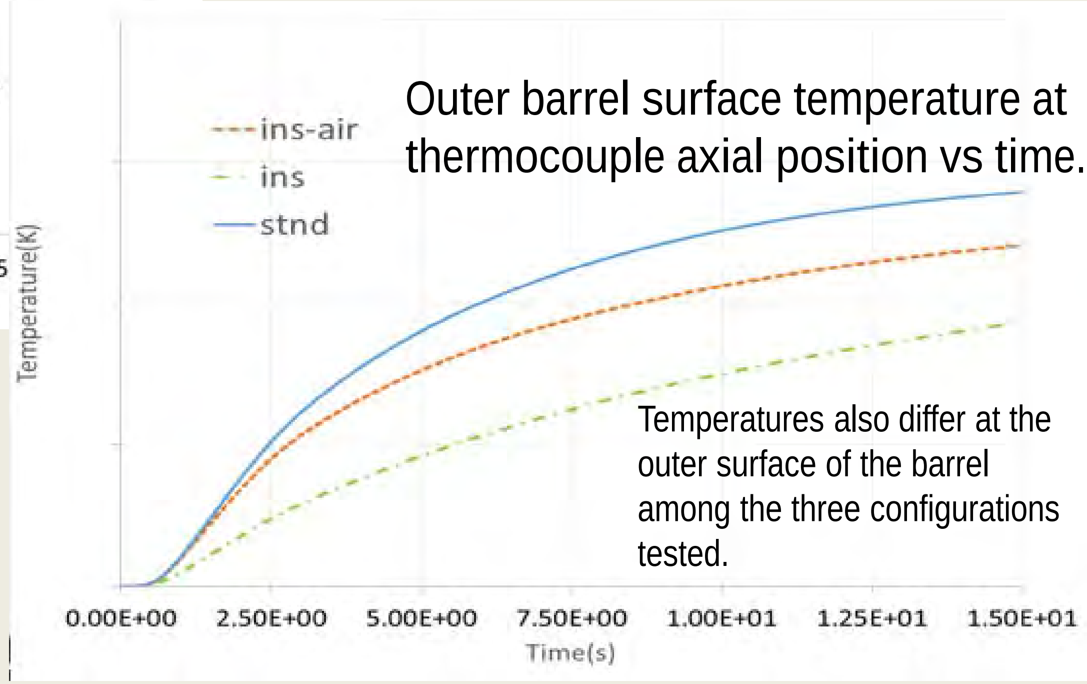
Temperature Standard(ins)

Temperature Characterization – Numerical Methods

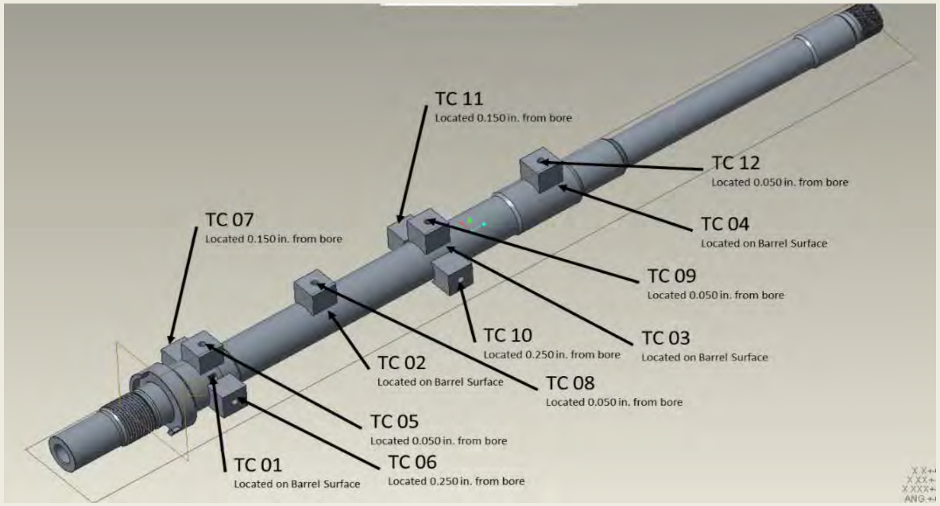


Thermocouple tip location temperature data show the differences in the peak temperatures during “firing” and then later differences in the temperatures as the heat moves through the system for the standard barrel (stnd), an air filled thermocouple geometry (ins-air) and a thermocouple geometry that is insulated(ins).

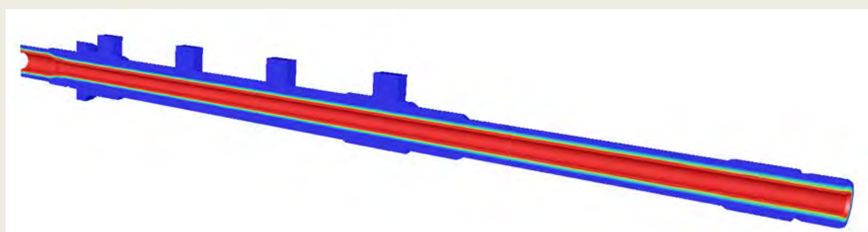
The localized effect of the test fixture geometry can also be found at the outer barrel surface, where for the time studied the temperatures for the three configurations deviate over time.

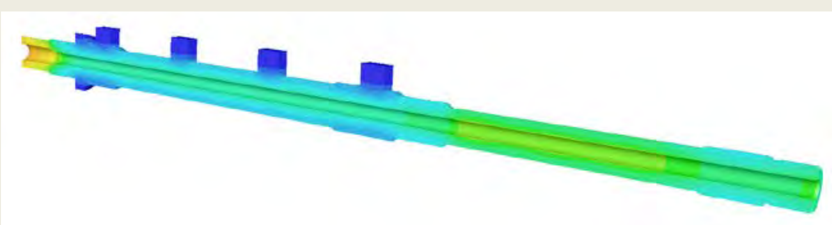


Temperature Characterization – Results



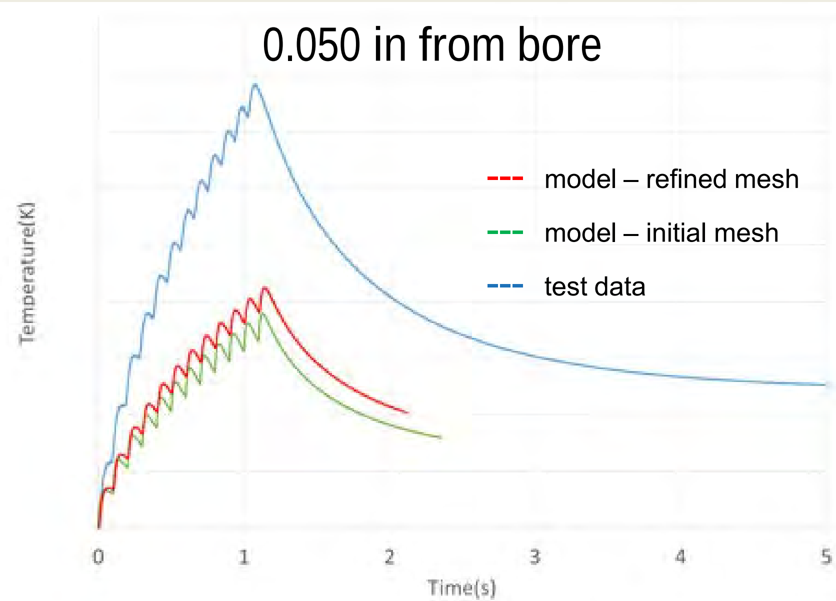
High temperature gradients develop near the bore. The gradients drop as the energy moves through more of the barrel material. The “cooling” effect as the test fixture components are heated can be seen.



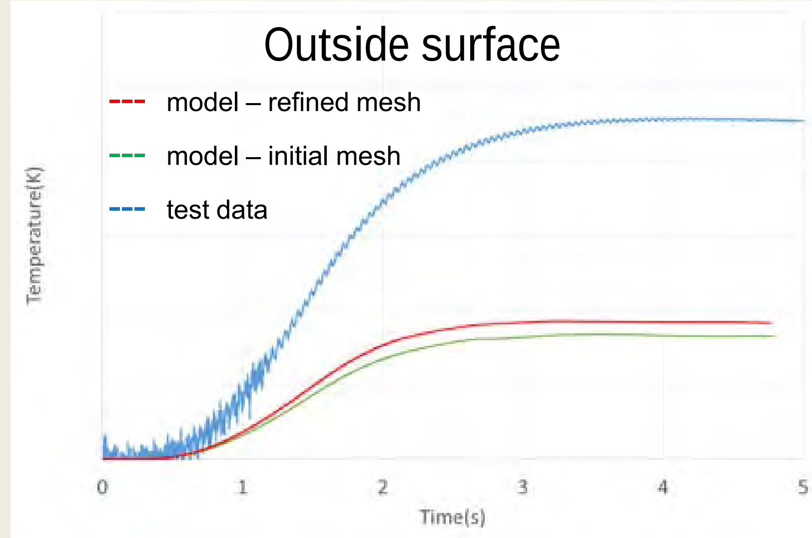


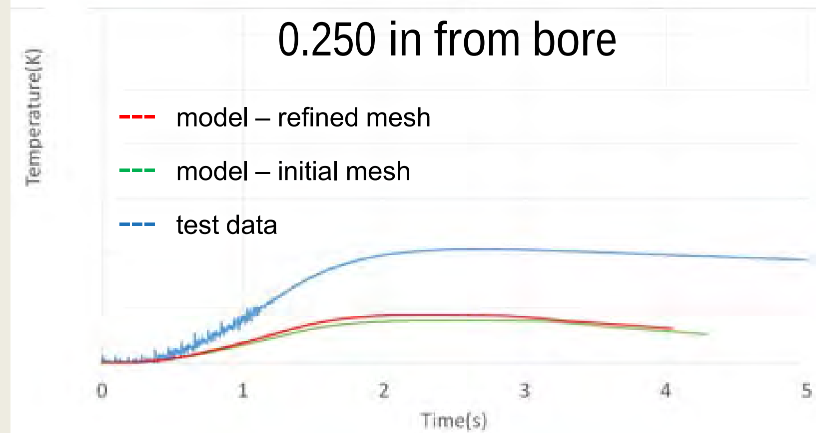
Temperature contours as one round is fired

Temperature Characterization – Results



The model and test data temperatures both show similar trends and timing of the temperature as a function of time. The test data consistently reports higher temperatures than the model results. Possible causes for this have been identified.





Temperature Standard(ins)

Temperature Characterization – Potential Reasons for Discrepancies

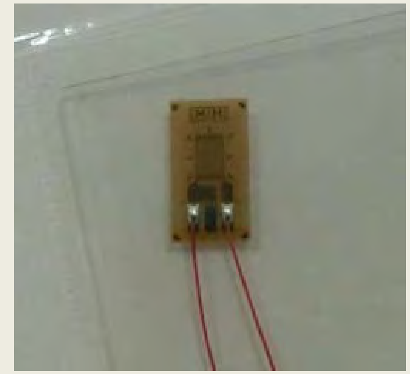
- Thermocouple components and materials are not included in the model.
- Any contact resistance between the barrel and test fixture components is neglected in the model.
- Variations in the heat input conditions between the model and the particular ammunition used in the testing may exist.
- Thermocouple tip locations may have variation from those used in the model.
- Anomalies in the thermocouple positioning or attachment may be present in the physical test system.
- The radial positioning of the thermocouple in the system with the high radial temperature gradients over a short time duration may affect the readings.
- Noise or oscillations in the measured temperatures, even at ambient, may influence readings.

Temperature Characterization – Benefits

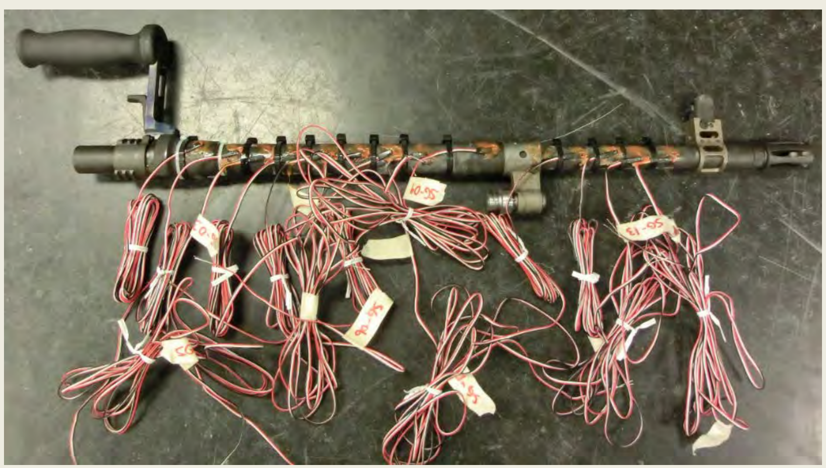
- Trends in the variation of temperatures with different radial locations can be clearly identified from both testing and numerical experiments.
- The effects of multiple rounds fired on the temperature distribution can be found from the physical testing and the numerical experiments.
- Comparisons of the data can reveal potential issues with the experimental set up: Switched wires, loose thermocouples, or different thermocouple positioning in the system.
- Models can serve as a test-bed for comparison of the thermal performance of a new design or design modification to the performance in a baseline configuration to reduce the number of physical tests that need to be conducted.

Stress/Strain Characterization – Test Methodology

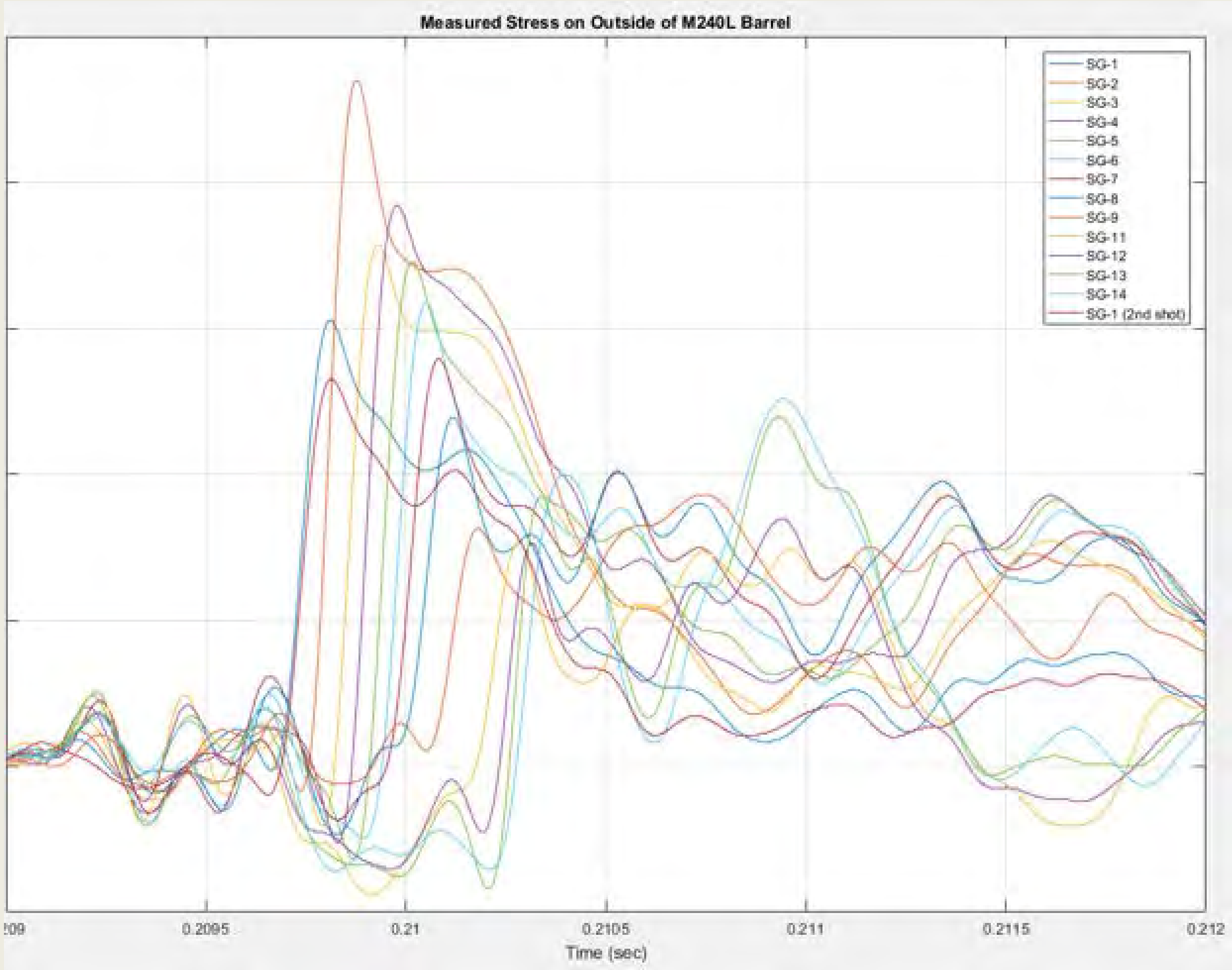
- Strain gages placed at every inch down the length of the barrel
- Single axis strain gages – hoop direction only
- Sampled at 500kHz – maximum possible
- Firing scenarios
  - Single, 3rd burst, 6rd burst
- Data filtered with Keiser low pass filter and stopband frequency of 10kHz



Vishay Precision Group
C2A-06-062LW-350



Stress/Strain Characterization – Test Observations

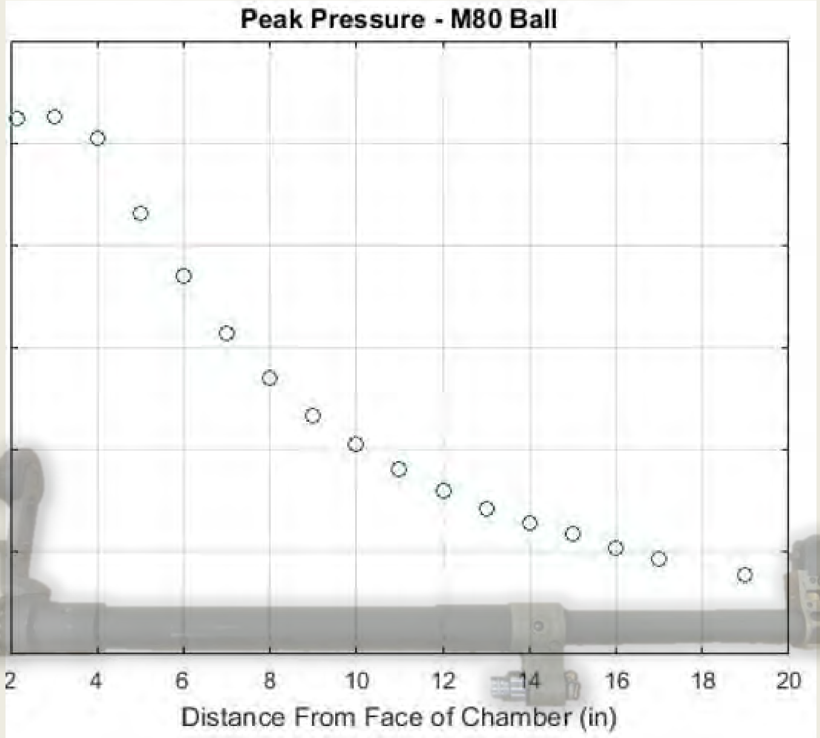


Stress/Strain Characterization – Numerical Methods

- Stress as a result of pressurization can be calculated at any point on the barrel using Lame's thick walled cylinder stress calculations, outlined in AMCP 706-252
- Tangential stress is focus for this study

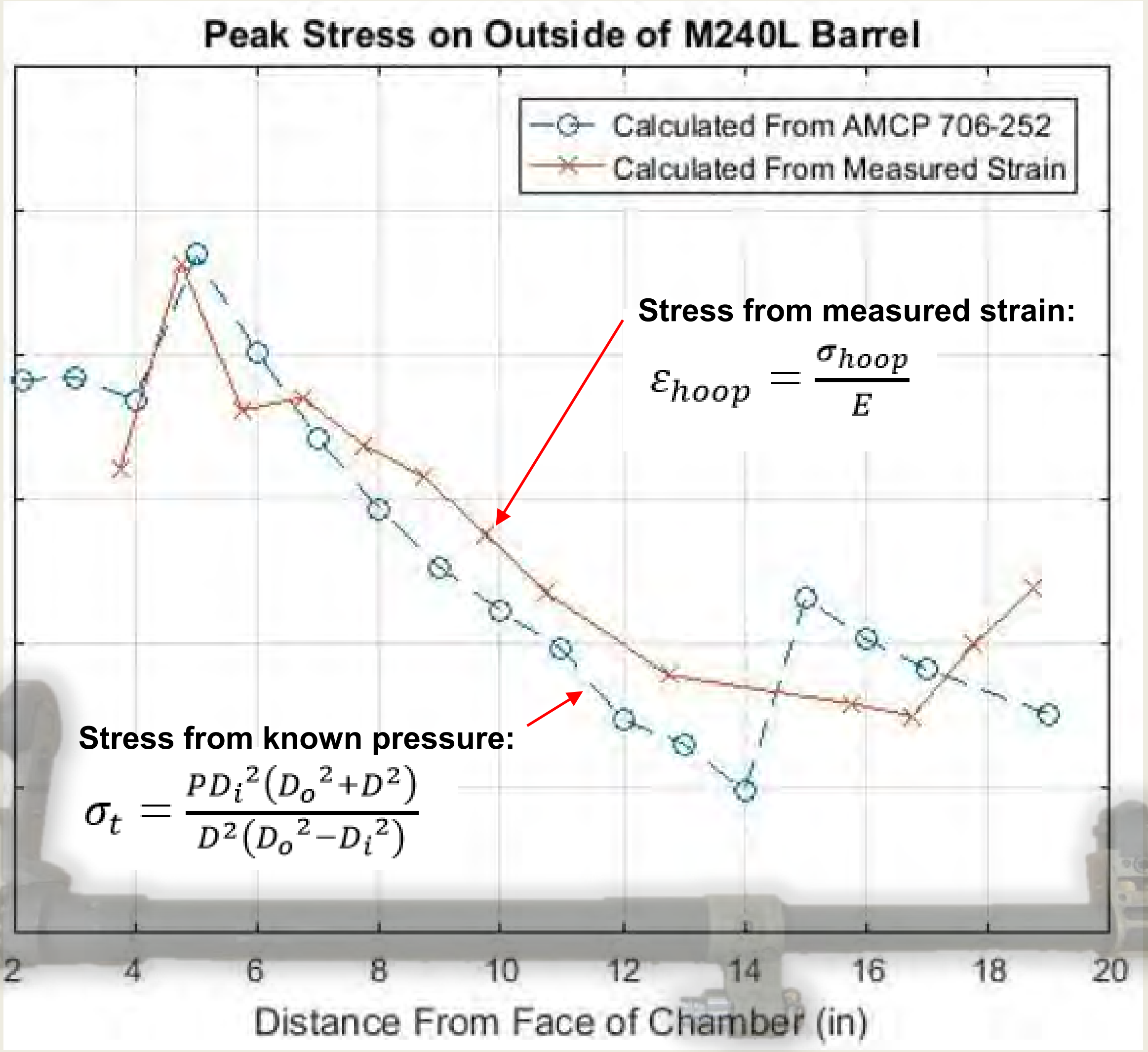
$$\sigma_t = \frac{PD_i^2(D_o^2+D^2)}{D^2(D_o^2-D_i^2)}$$

- AMCP 706-252[1] makes the following assumptions, which are only valid for specific cases in a machine gun barrel:
  - Elastic regime
  - Steady state, uniform temperature
- For our purposes, these are relatively valid assumptions, but for more advanced models, this would not give accurate results[2]
- Additionally, high strain rate material properties would better suit this type of analysis



[1]AMC Engineering Design Handbook: Gun Tubes, AMCP 706-252, U.S. Army Materiel Command, 1964.
[2]Chu, Shih-Chi, et al, "Gun Barrel Technology at Weapons Laboratory, Rock Island," Rock Island Arsenal, Rock Island, IL, 1968-1971.

Stress/Strain Characterization – Results



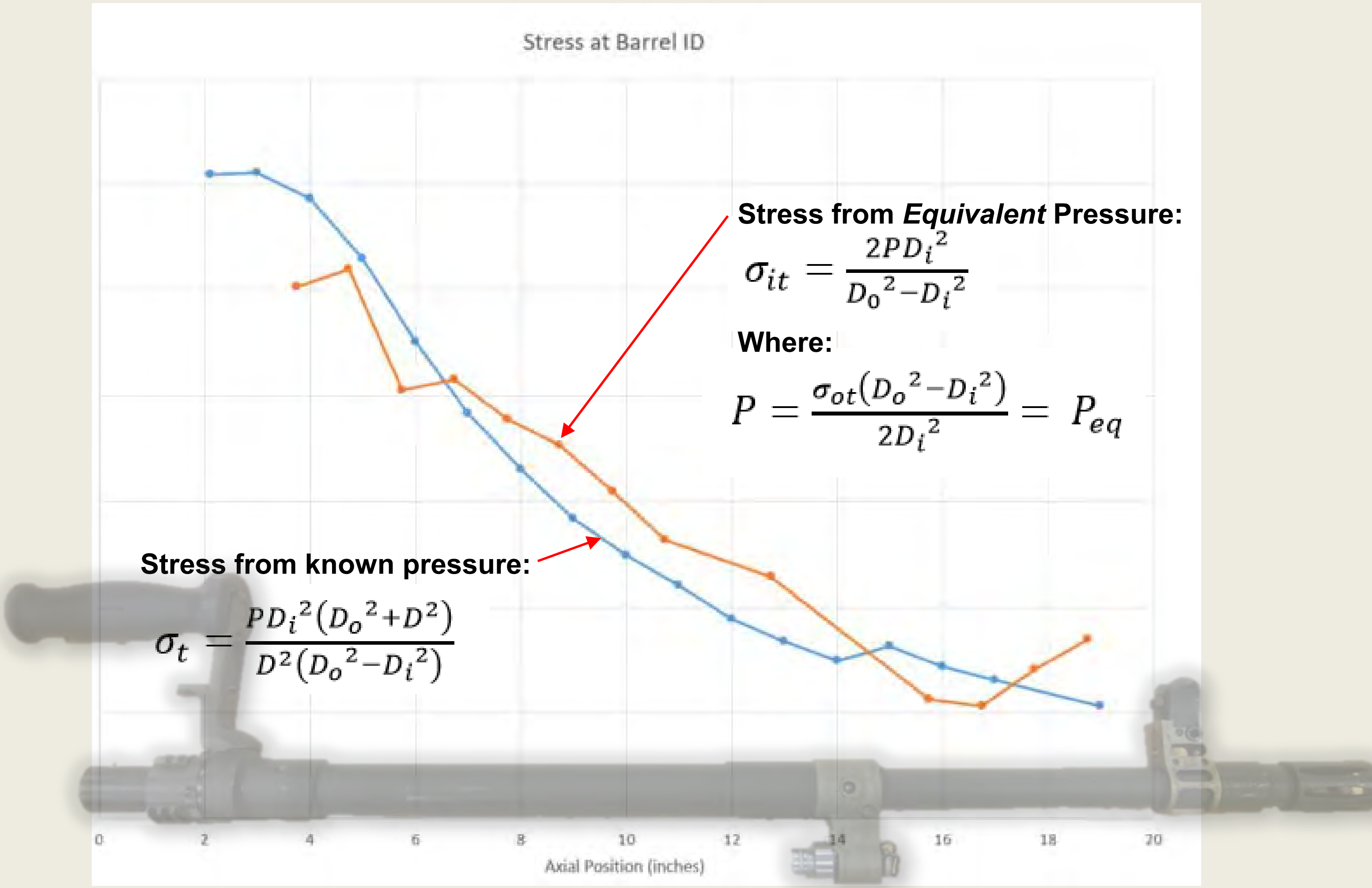
Stress from measured strain:

$$\varepsilon_{hoop} = \frac{\sigma_{hoop}}{E}$$

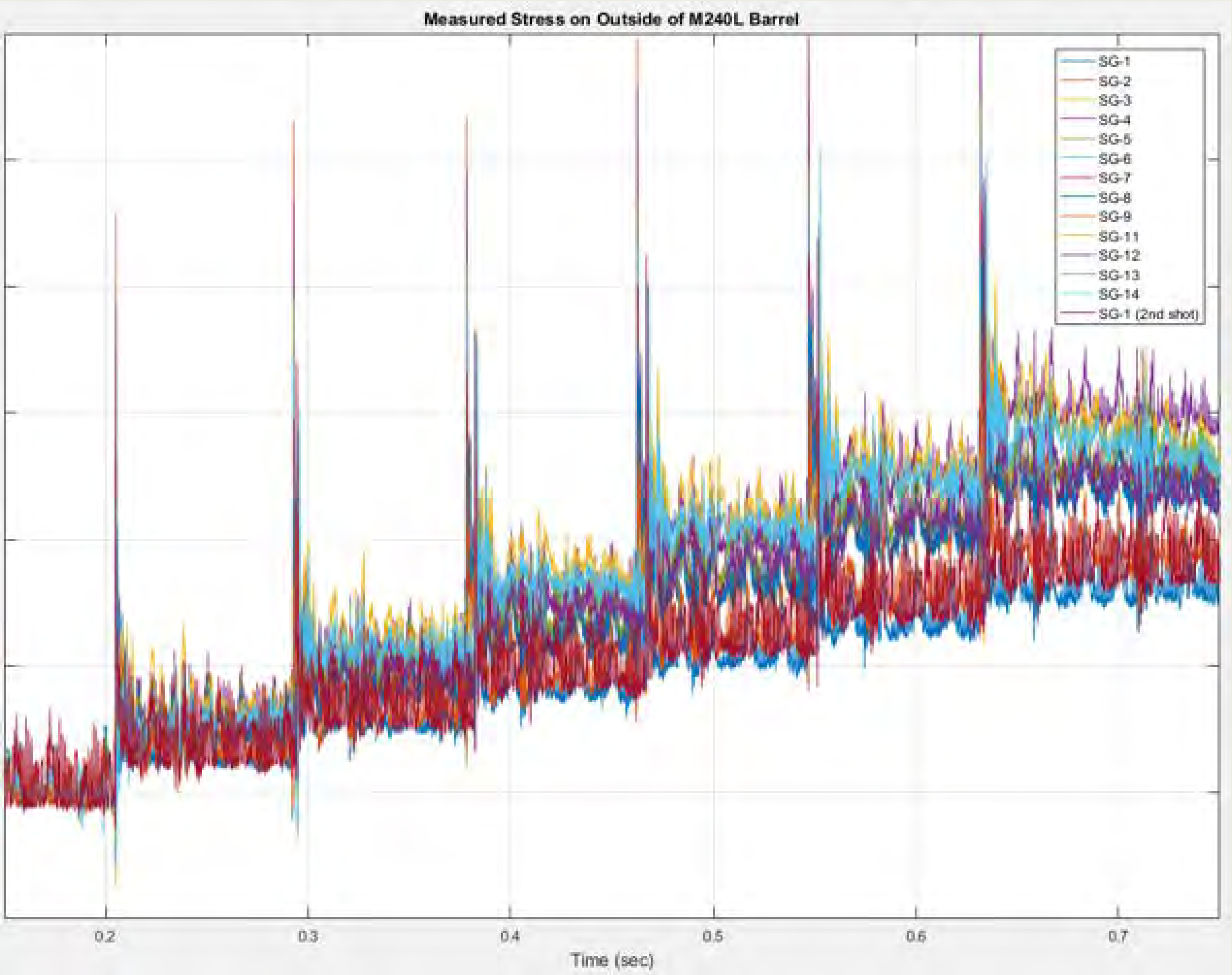
Stress from known pressure:

$$\sigma_t = \frac{PD_i^2(D_o^2 + D^2)}{D^2(D_o^2 - D_i^2)}$$

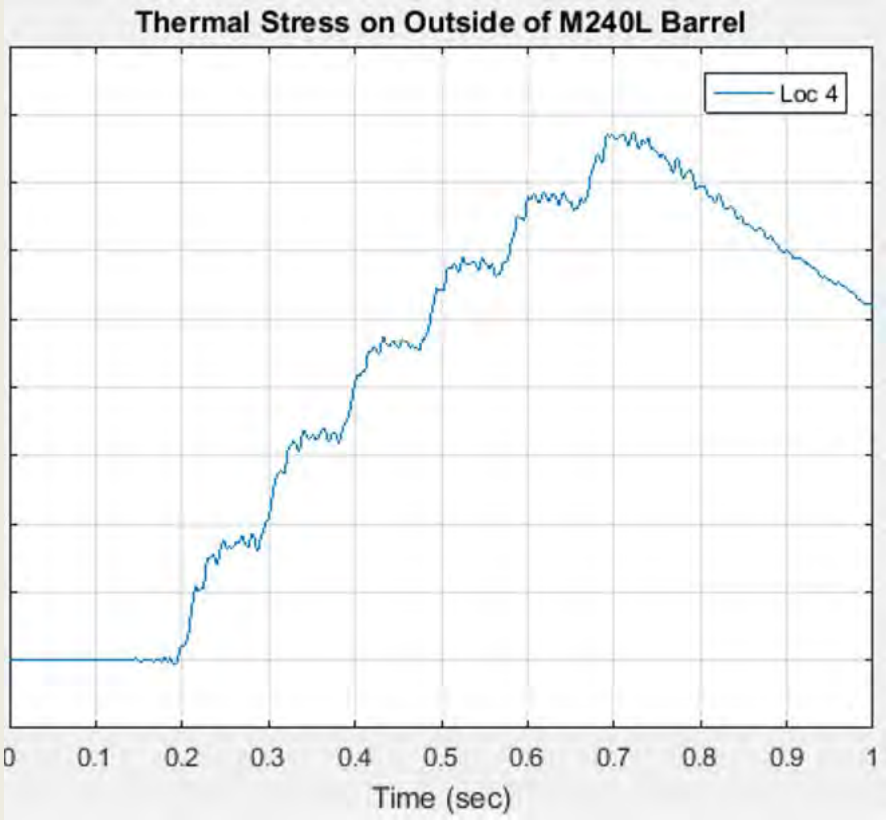
Stress/Strain Characterization – Results

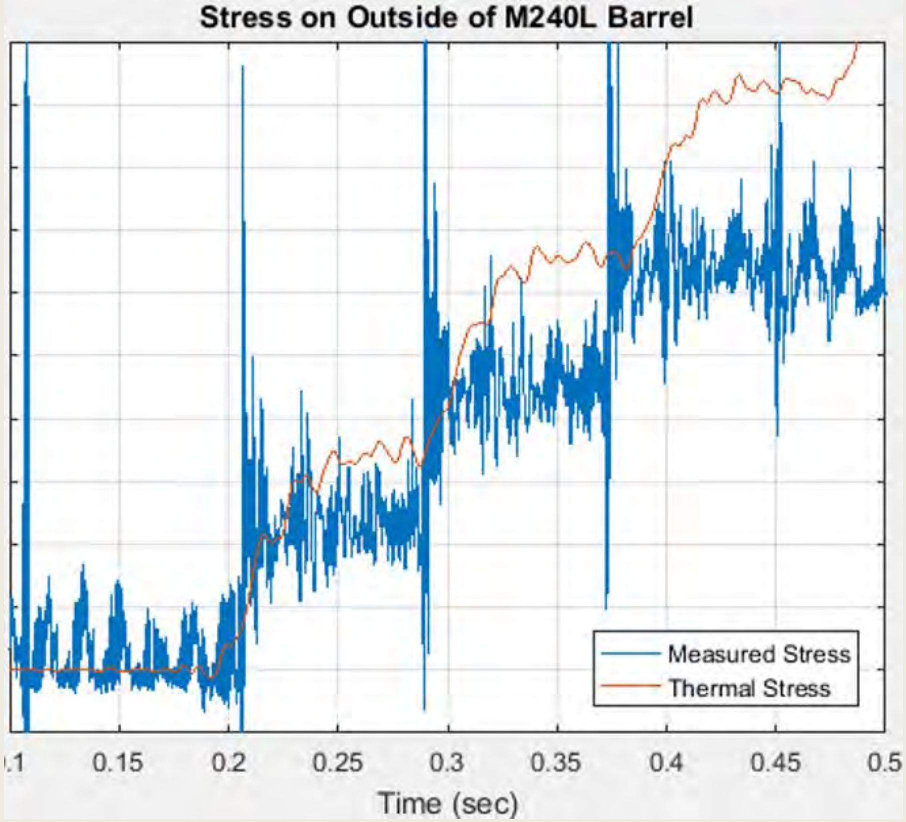


Stress/Strain Characterization – Thermal Stress



Stress/Strain Characterization – Thermal Stress





Conclusions, Takeaways, and Recommendations

Thermal Characterization

- IWTCs are powerful tools, but do have some drawbacks
- Possibly look at other measurement methods
- CFD models and test data showed good correlation in timing of events, but the overall temperature increase showed larger differences
- There are a variety of reasons for the differences between test and models
- More research is recommended to find the sources of differences, and show better correlation between test and modeling
- Models can serve as a test-bed for comparison of the thermal performance of a new design or design modification to the performance in a baseline config. to reduce the number of physical tests that need to be conducted.

Stress/Strain Characterization

- There are no known methods to measure strain at the bore surface
- Future testing should experiment with the use of multi-axis, high temperature strain gages
- Methods to calculate strain at the outside of the barrel using the AMCP 706-252 correlate well with test data, assuming steady state and elastic regime
- Elastoplastic theory should be further studied for more advance solutions
- Advanced FEA methods that account for elastoplasticity, temperature dependent material properties, and high strain rate material properties should be pursued
- Thermal stress is measured and shows general correlation to calculations, but more advanced methods that account for non-linearity should be pursued

Questions

Mr. Adam M. Jacob, U.S. Army, ARDEC

Dr. Laurie Florio, U.S. Army ARDEC

Mr. Adam L. Foltz, U.S. Army ARDEC

Special thanks to Mr. Jin Choi and Mr. Jacob Michalson, U.S. Army ARDEC, for their work on the project.

Always a Step Ahead

ARDEC ARMAMENTS

Precision Munition Technology

Abstract #20231

Presented by:

Christopher Parisi

&

Michael Cataldi

UNPARALLELED COMMITMENT & SOLUTIONS

Act like someone's life depends on what we do.

U.S. ARMY

U.S. ARMY RDECOM

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER

Emerging/Evolving Threat Spectrum

- Quicker engagements
- Longer ranges

ARDEC Precision Small Caliber Munitions

Higher Probability of Hit ($P_{(h)}$) at extended ranges through:

- Higher velocity
- Lower deceleration
- Flatter trajectory
- Less wind sensitivity
- Less user aim error

→ ***Better accuracy***

Design Methodology

- Higher sectional density
  - Use of novel/dense materials

- Efficiently packaged projectile mass
  - Low parasitic mass sabots (5%)
    - Minimize KE loss
    - Larger pressure area on projectile base
  - Optimized launch mass
    - Higher muzzle velocity for a given muzzle energy

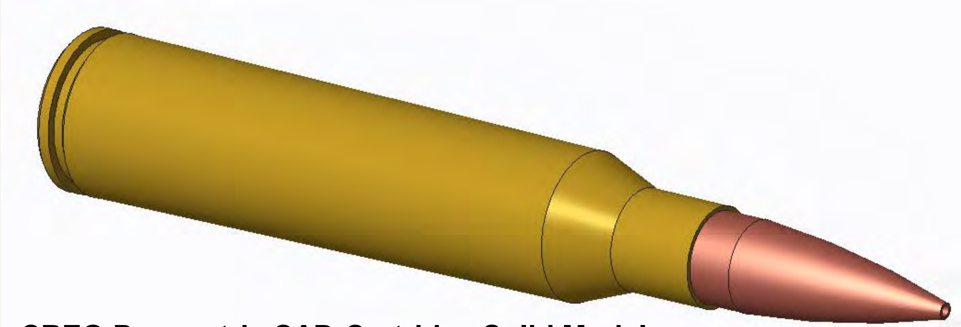
- VLD (Very-low-drag)
  - Optimized drag shape

- Scalable/Caliber-agnostic

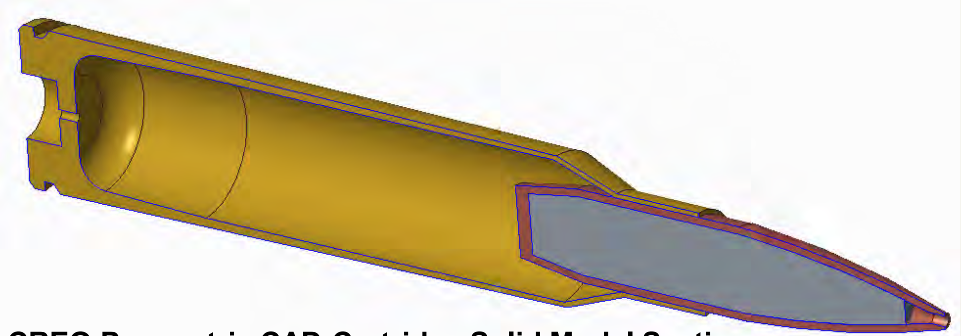
Modeling & Simulation

CREO (CAD)

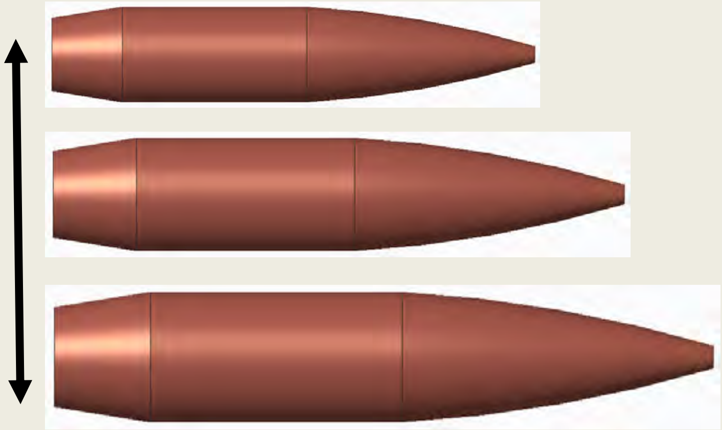
- Scalable geometry
- Efficient design optimization



CREO Parametric CAD Cartridge Solid Model



CREO Parametric CAD Cartridge Solid Model Section

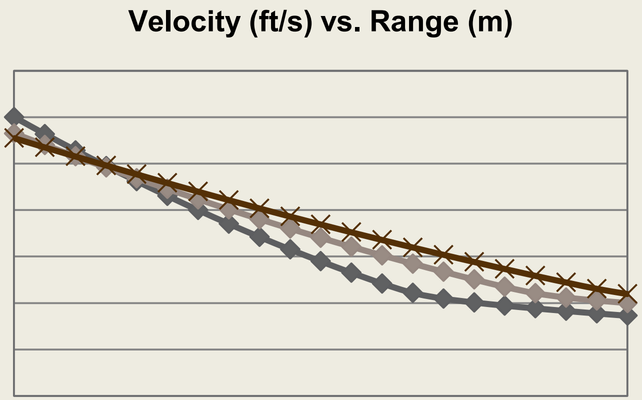


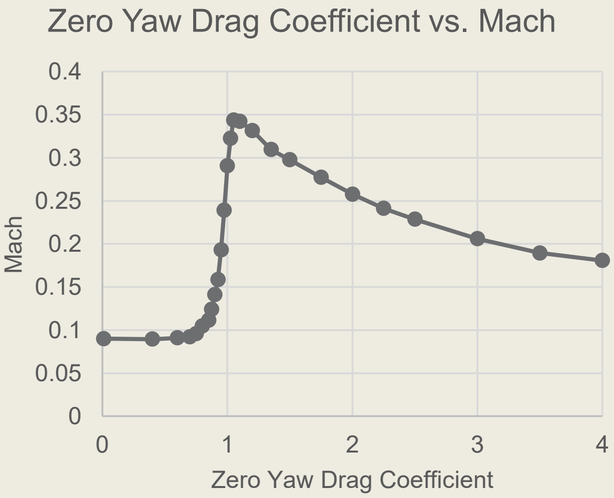
Scaled solid models by caliber using CREO

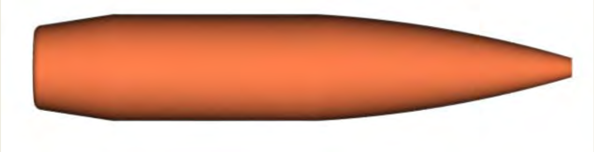
Modeling & Simulation

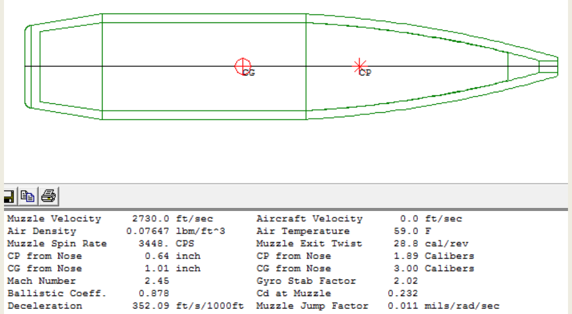
PRODAS (Empirical Aeroballistics)

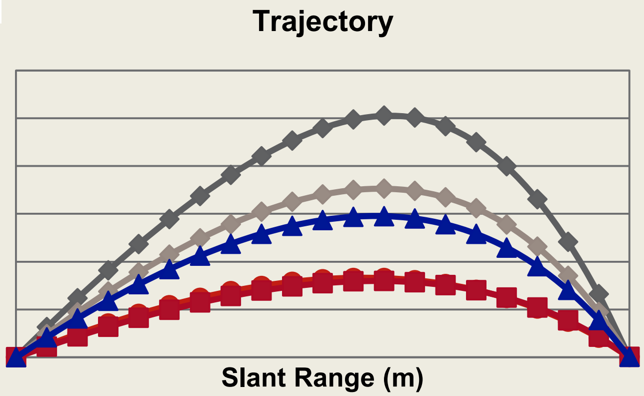
- Ballistics/stability/drag/trajectories
- Change gun parameters





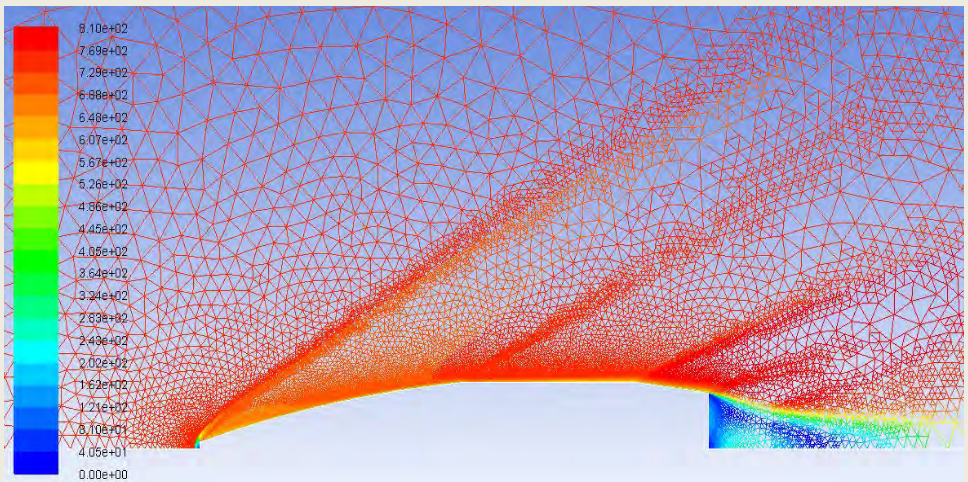




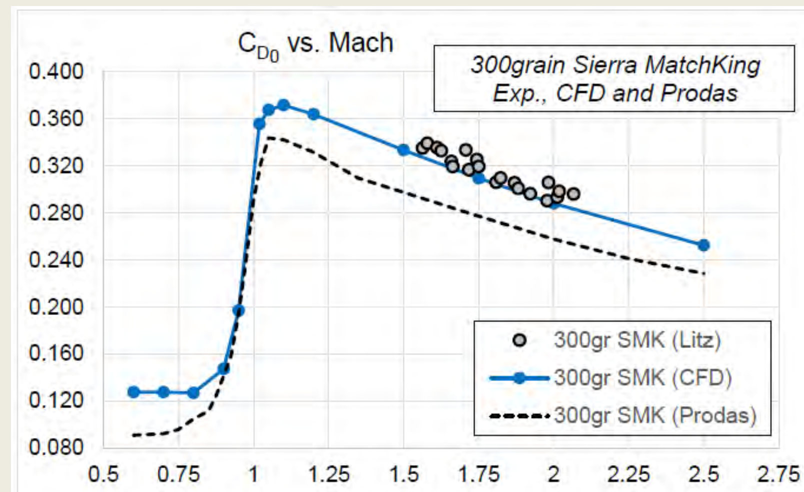


Modeling & Simulation

ANSYS Fluent CFD (Computational Fluid Dynamics)



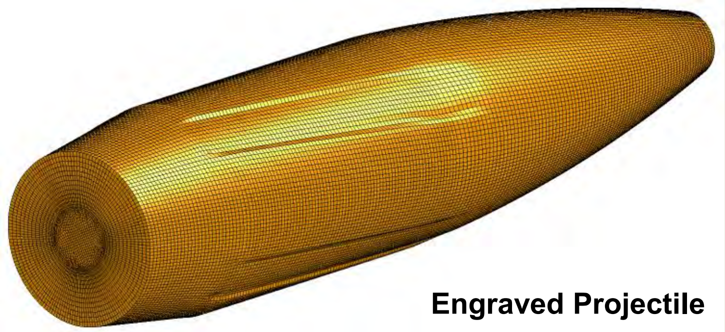
Contours of Velocity on a G7 Shape at Mach 2.2



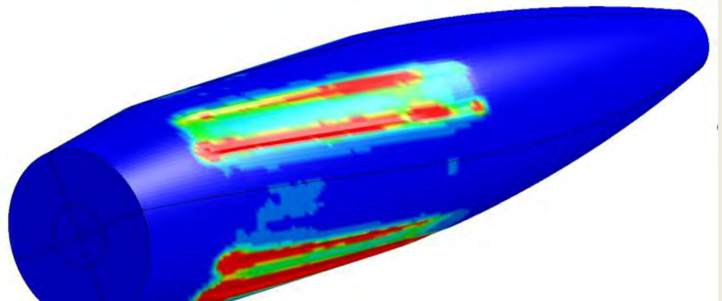
Modeling & Simulation

ANSYS LS DYNA (Explicit Finite Element Modeling)

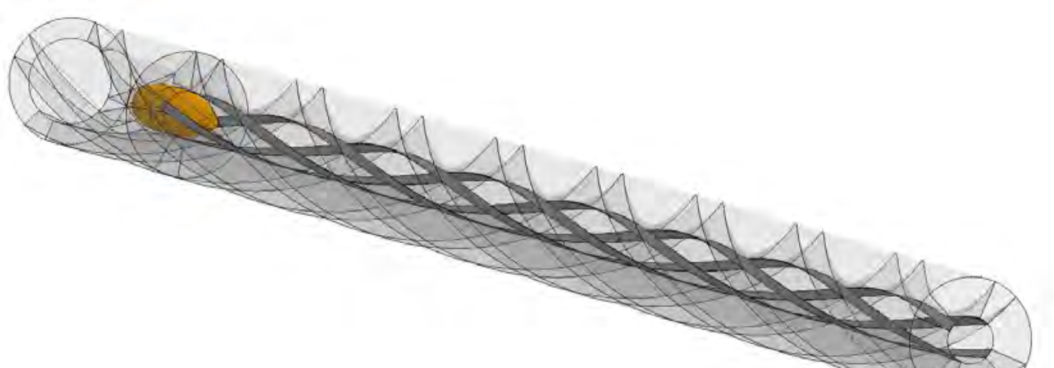
- Launch models
  - Structural survivability
  - Estimate and verify muzzle velocity



Engraved Projectile



Plastic Strain on Engraved Projectile



Structural Launch Model in LS DYNA

Materials

- High performance plastics
    - Withstand extreme temperatures
    - Survive gun launch
    - Minimize parasitic mass

- Specialty alloys
    - Achieve target density
    - Scalable target effects

Manufacturing

- Metal injection molding
  - Near net shape with final machining
  - Continued technology push
  - Custom materials
- Plastic injection molding
- 3D Printing
- Unconventional jackets
- Wire EDM, CNC, grinders, Swiss screw machines
- Loading optimization
  - Custom die sets
  - Precision measuring tools

Testing

EPVAT

- Propellant charge establishment/optimization
- Structural integrity

Radar

- Capture velocity/deceleration
- PRODAS simulation validation

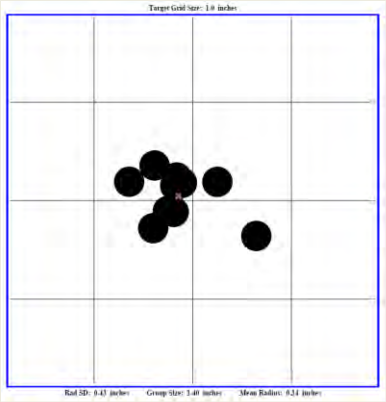
High Speed Video

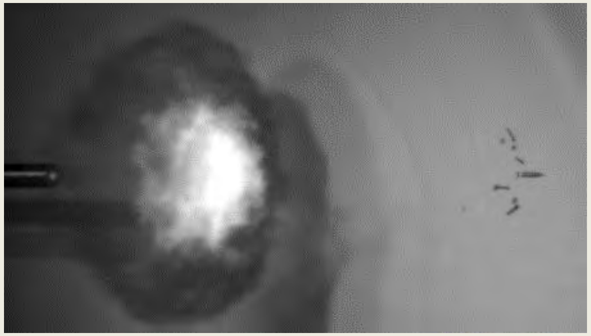
- Launch survivability
- Yaw cycle

Accuracy

- Validate ballistics
- Verify overall system effectiveness

Pressure (psi) vs. Time (s)





Performance

- Accuracy → 50% reduction in Average Mean Radius
- Deceleration → Sonic range increased by 90%
- Trajectory → 35m less bullet drop @ 2000m range
- Time to Target → 33% less time to 2000m range

CONTACT INFORMATION

QUESTIONS?

Christopher Parisi
ARDEC Project Officer
US Army ARDEC
RDAR-MEM-I, Bldg 65N
Picatinny Arsenal, NJ 07806
christopher.c.parisi.civ@mail.mil
973-724-9878

Michael Cataldi
Mechanical Engineer
US Army ARDEC
RDAR-MEM-I, Bldg 65N
Picatinny Arsenal, NJ 07806
michael.cataldi.civ@mail.mil
973-724-6074

LEAD-FREE PRIMER
Panel Discussion

Nammo

Sweden

Lina Norum, R&D Manager SAA

07 May 2018

NDIA Armament Conference / Small Arms Division Themes
"Armament System Response to the Evolving Threat Spectrum"
"Small Arms Technology Which Creates Asymmetric Operational Advantage for Soldiers, Sailors, Airmen and Marines"

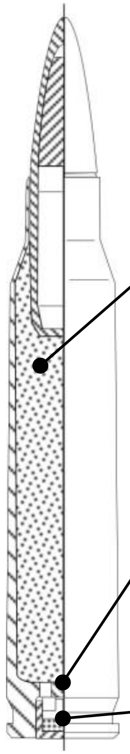
Nammo's roadmap of lead-free technology

- History
  - 1996 Sweden specifies lead-free ammunition
  - 1999 Nammo Initial Production for Sweden
  - 2001 Norway adopts the lead-free technology
  - 2004 lead-free 5.56 mm Ball and 7.62 Ball – NATO Qualified
  - At present, Nammo makes lead free ammunition in four (4) calibres
    - 4.6 x 30 mm Ball (for MP-7)
    - 5.56 x 45 mm Ball, Tracer, IR-Tracer, Frangible, Blank
    - 7.62 x 51 mm Ball, Tracer, IR-Tracer, Frangible, Reduced Range, Armor Piercing
    - 9 x 19 mm Ball, Frangible

- Technology - Challenges
  - Reliable powder ignition by the lead-free primer at all temperatures
  - Copper build-up in the barrels

Nammo's roadmap of lead-free technology

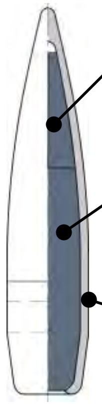
- Cartridge design for 5.56 mm and 7.62 mm
  - Production in standard machinery



Powder - Adapted for lead free primer and projectile

Ignition Chain - Optimized for lead free system

Lead free primer



Hardened steel penetrator - Optimized for maximal penetration

Steel core - Optimized for reduced driving force, reduced barrel erosion and reduced copper fouling

Gilding metal jacket - Optimized for reduced driving force, reduced barrel erosion, reduced copper fouling and to avoid projectile fragmentation

VISTA OUTDOOR | SHOOTING SPORTS

Lead-free Primer Strategy

May 2018

Joel Sandstrom
Senior Chemist
Federal Cartridge Company

Small Caliber Percussion Primer

- 200 Year Evolution

- Primer Ignition – heat transfer into the propellant bed

- Flame	DDNP + pyrotechnic system
- Fuel	chlorates, phosphorus
- Slag	fulminates, azides, lead styphnate

- Federal Gold Medal Primer
  - Low overpressure
  - No PETN
  - Primary heat transfer via high heat capacity metal

Catalyst Primer Technology

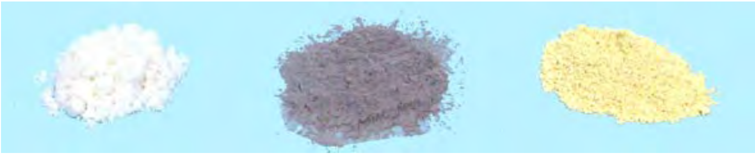
Primer Components and Manufacturing Consistent with Federal Gold Medal Primer Standards

The Catalyst primer employs nitro-thermite technology producing high sustained heat. The bismuth/aluminum thermite reaction creates excellent heat transfer into the propellant bed

Conventional Primer Cup

Catalyst Pyrotechnic

NITROCELLULOSE ALUMINUM BISMUTH OXIDE



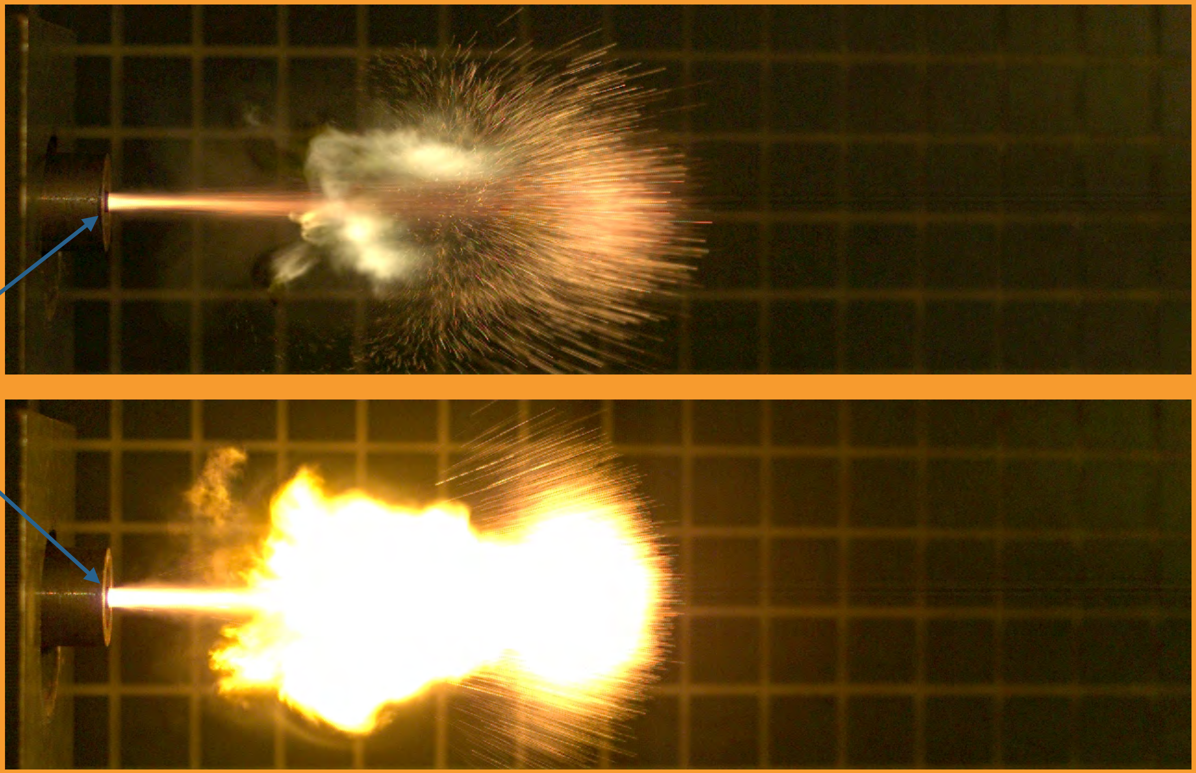
Conventional Boxer Anvil

Catalyst Thermal Output

U.S. Mil
No.41 Primer

Case
mouth

Catalyst
No.41 Primer

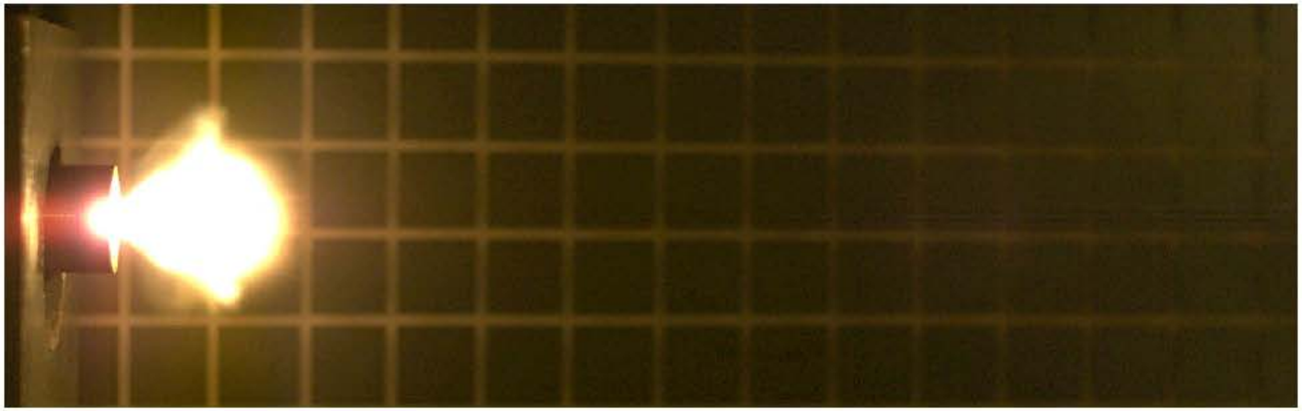


Primed 5.56mm case
Same No.41 cup / anvil
Catalyst No.41 primer charge weight is <u>37% lower</u> than U.S. Mil No.41 primer

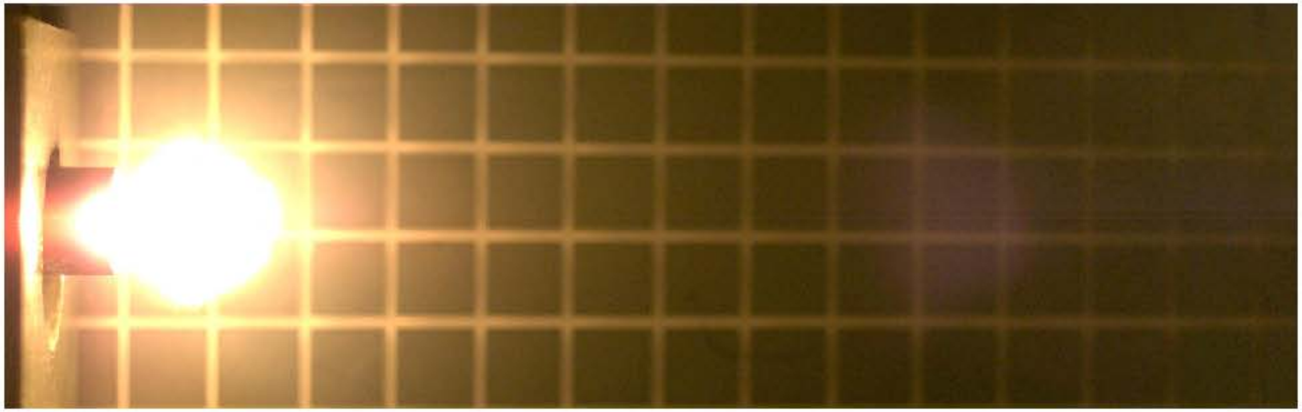
Ignition Progression

5.56mm Primed Brass

U.S. Mil
No. 41

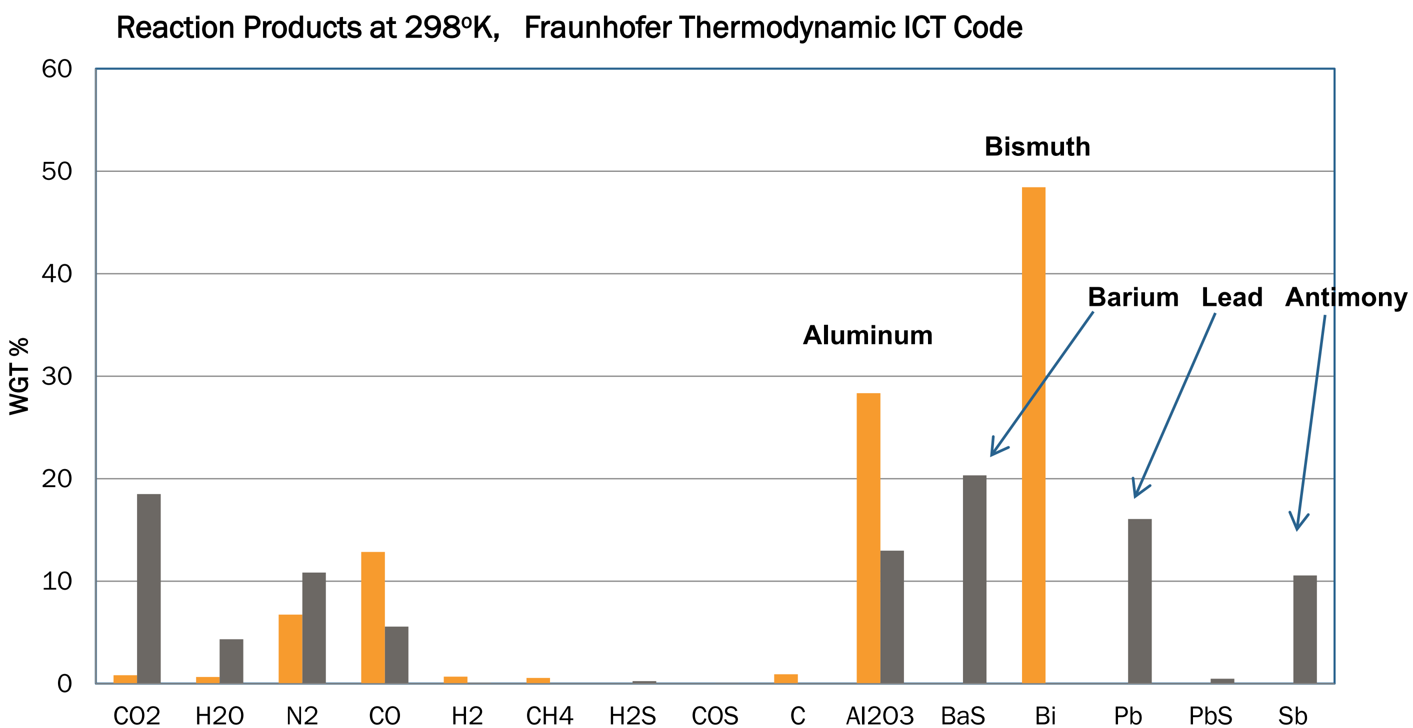


Composite
No. 41



Non-Toxic Exhaust Products

Condensed Phase Exhaust Products: Catalyst vs Lead



Catalyst primer exhaust is free of Lead, Barium, and Antimony

Ballistics Example

GM308M, 168 gr Gold Medal Match test date 4/23/2018

Primer	Velocity / Std Dev	Pressure / Std Dev
GM210M	2631 / 5	56,595 / 777
GM210NX	2620 / 7	59,524 / 763

notes:

NX pellet charge weight was higher than GM210M pellet charge for this sample

NX primed brass sample was not load adjusted

Session: 20148

JSSAP Science and Technology Advisory Council

2018 ARMAMENT SYSTEMS FORUM

May 9th, 2018

Marc Ritt

Joint Service Small Arms Program (JSSAP)

Today’s Agenda

- Purpose
- Mission of the JSSAP Organization – JSTAC Intersection
- JSSAP Science and Technology Advisory Council
- The Joint Small Arms Technology Development Strategy (JSATDS)
  - Technical Challenges
  - The Strategy
- Key Takeaways

Joint Small Arms Synchronization Team Framework

Mission

The JSSAST Charter identifies 5 principal areas of responsibility:

1. Intensive Management of the DoD Small Arms Tech Base
2. Harmonization of Requirements
3. Transition to Project Managers for Engineering and Manufacturing Development
4. Long Range Plans and Strategies
5. Influence of International Small Arms Activities

Navy
Marines
SOCOM
Army PM SW
Army PM SSL
Army PM MAS
Army CERDEC
USN PMSA
ONR

Chairman ARDEC Mil Dep

Principal Members
Associate Members

Army
Air Force
Coast Guard
USMC PMIW
USMC PM Combat Optics
USMC PM Ammo
JNLWD
Army ARDEC
ARL

AAE

GO/SES S&T Council (Annually)

Joint Service Small Arms Synchronization Team (JSSAST) - Council of Colonels (Semiannually)

Joint Service Small Arms Requirements Integration (JSSARI) (Monthly)

Joint Service Small Arms Program Science & Technology Advisory Council (JSTAC) (Monthly)

Service Input

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Joint Service Small Arms Program Science and Technology Advisory Council (JSTAC) Update

JSTAC Approved for Execution on June 11, 2014 by the JSSAST

JSTAC Charter Mission Essential Tasks

1. **Establish a process for the timely exchange of Science & Technology information**
2. **Develop and maintain a Joint Service Small Arms Technology Development Strategy (JSATDS)**
3. **Maintain an awareness of the small arms Science & Technology portfolio**
4. **Maintain an awareness of both domestic and foreign technology and identify areas of possible exploitation**
5. **Recommend to the JSSAST prioritized plans, programs and strategies semi annually**

JSTAC Participants

1. **Army (ARCIC, ARDEC, ARL, ASA ALT, CERDEC, MCoE, PM MAS, PM SSL, PM SW, PEO Soldier, PEO Ammunition, RDECOM RFEC)**
2. **Navy (ONR, Navy Small Arms Programs, Naval Surface Warfare Center Crane)**
3. **Air Force (USAF HQ Security Forces Center)**
4. **Marines (PM MERS, PM IWS, S &T lead MARCORSYSCOM, USMC Capabilities Development Directorate)**
5. **Coast Guard (Specialized Capabilities CG-721)**
6. **SOCOM (SORDAC S&T, SOF AT&L, PEO-SW)**
7. **Other Agencies: JNLWD, CTTSO**

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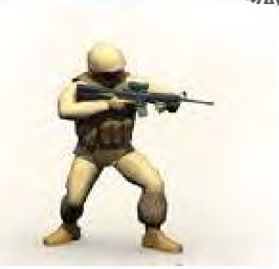
JSSAP Small Arms Systems R&D Strategy



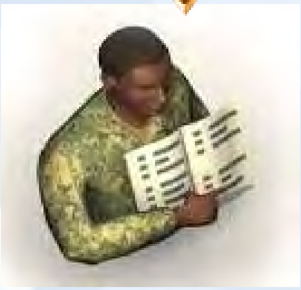
Futures Conferences

Small Arms Capability Based Assessments

Documented Requirements

Soldier Lethality Cross Functional Team

TRADOC Gaps Warfighter Outcomes



JOINT SMALL ARMS TECHNOLOGY
DEVELOPMENT STRATEGY
FOR
JOINT SERVICE SMALL ARMS
SCIENCE AND TECHNOLOGY
INVESTMENTS

Supporting POM 20-24

04 October 2017

Technology Information Exchanges

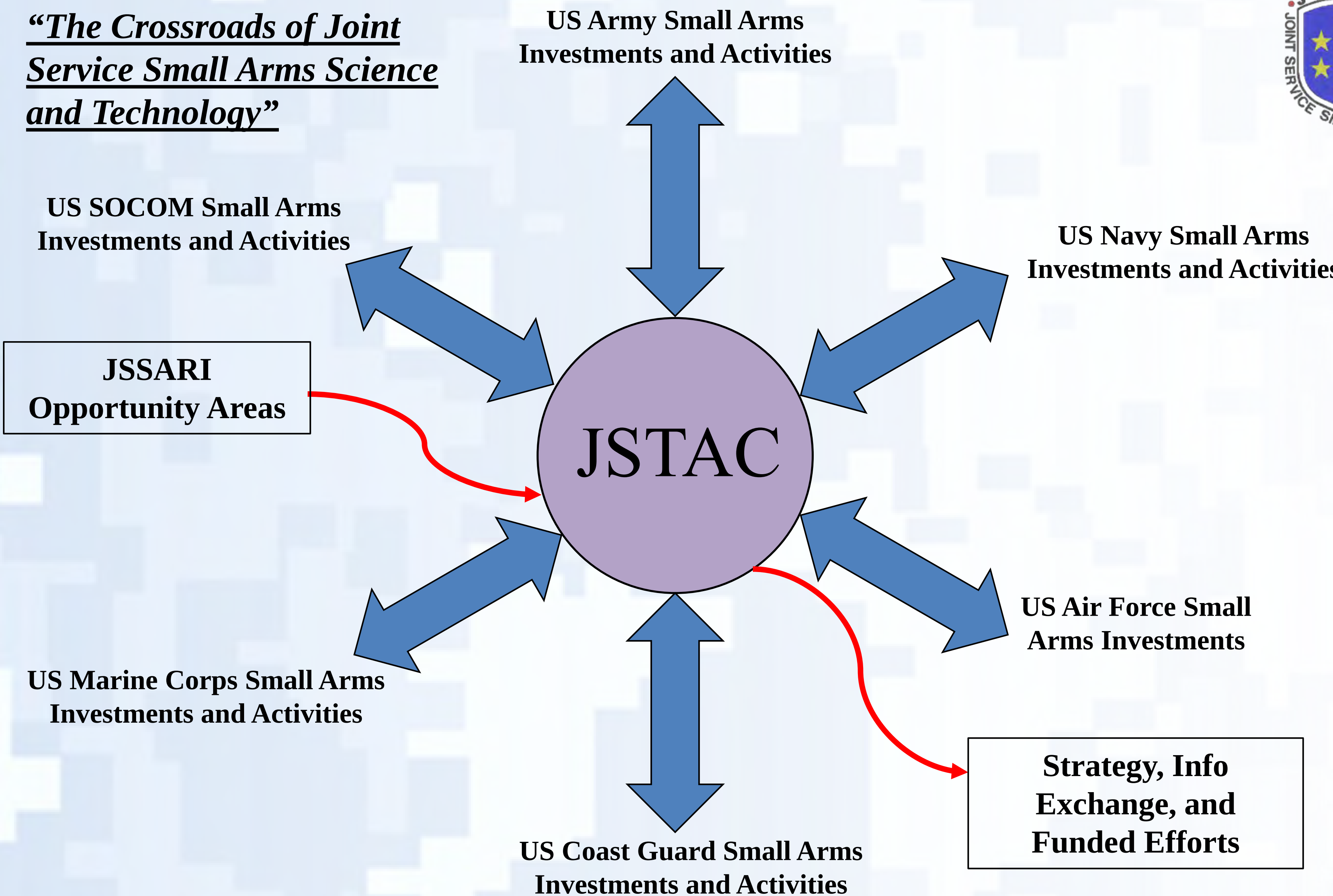
International Small Arms Activities

JSSAST Priorities

The National Armaments Consortium

Joint Small Arms Technology Development Strategy

“The Crossroads of Joint Service Small Arms Science and Technology”



JSTAC Battle Rhythm (2018)

January – Post POM Submission Review

February – Soldier Lethality CFT Updates

March – Canada Program Agreement Meeting Prep

April – Prep for Spring JSSAST

May – NGIC Threat Briefing

June – Opportunity Area Analysis and Decomposition

July – Roadmapping, House of Quality for FY19 Project Selection, FY 21-25 POM Formulation

August – Tech Development Strategy Review and Update

September – Project Selection Voting Session

October – NATO Meeting Update

November – Prep for Fall JSSAST

December – Prepare Annual DOTC Input

*** In addition to other technical happenings within the joint small arms community

Joint Small Arms Technology Development Strategy (JSATDS) - Synergistic S&T Investments - Small Arm Weapon Systems

- **V6 (DIST F) Briefed to JSSAST June 2015**
- **V6 Used as the basis of POM 18-22 submission August 2015**
- **V7 (DIST F) created with Lead/Shape/Watch justifications to support POM 18-22**
- **Distribution A v1 version created Jan 2016**
- **V8 (DIST F) created to support POM 19-23 June 2016**
- **V9 (DIST F) created to support POM 20-24 October 2017**

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JOINT SMALL ARMS TECHNOLOGY
DEVELOPMENT STRATEGY
FOR
JOINT SERVICE SMALL ARMS SCIENCE AND TECHNOLOGY INVESTMENTS

Supporting POM 20-24

04 October 2017

Version 9

JSATDS- Version 9 Distribution to US Government Only - FOUO Page 1

Weapon System Enablers	ARDEC
Ammunition	ARL
Optics & Fire Control	ONR
Scalable Effects	JNLWD
Training & Human Perf.	USMC
System Integration & Demo	JSSAP
Deep Future	JSSAP
International	JSSAP/RDECOM

Foundational Strategies in BA 6.2 and 6.3 That Will Lead To Dominant Future Capabilities

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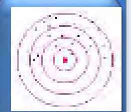
Joint Small Arms Technology Technical Challenges

BA 6.2: Weapon Systems and Enablers	• Weapon systems, as a whole, must be designed as a system • Most significant contributor to the weapon error budget is operator induced aim error • Higher recoil energies • Higher operating pressures and more muzzle energy often come with increased weapon signature and weight
BA 6.2 Ammunition	• Higher muzzle velocities and muzzle energies are needed for improvement in accuracy, range, and lethality • Lack of knowledge regarding levels of noise, flash, IR signatures, and what levels these signatures result in detections • Seeker navigation that allows the munition to adjust while in flight
BA 6.2 Optics & Fire Control	• Positive threat Identification at Range night/day • Low SWaP-C sensors integrated across all of or parts of the visual, near-short-mid-long wavelength infrared (Vis-NIR-SWIR-MWIR-LWIR) range of frequencies • Biometric sensors for Human Tagging, Marking, and Tracking
BA 6.2 Scalable Effects	• Desired operational impact with increased range – multi mission/ multi effects • Miniaturization of Directed Energy Technologies for Small Arms • Sensors and non-lethal weapons
BA 6.2 Training & Human Performance	• Cognitive Burden of S&T investments on the Soldier as a System • Objective system to measure and analyze the performance of the soldier together with his/her weapon, equipment, ammunition, and training
BA 6.3 System Integration and Demonstration	• Integration of 6.2 key enablers onto applicable platforms, and demonstrate them in relevant environments as in integrated system
BA 6.2 Deep Future Plans	• Advanced Propulsion • Electromagnetic Launch • Battery Tech – High Density. Lightweight, Fast Charging
International Strategy	• Avoiding Technological Surprise

Joint Small Arms Technology Development Strategy (JSATDS) - Synergistic S&T Investments - Small Arm Weapon Systems

BA 6.2 S&T Investment Areas (Ranked 1-N)

Weapon System/ Enablers



1. Accuracy / Controllability
2. Advanced Weapon Operation
3. Signature Reduction
4. Maintenance and Reliability
5. Enabling Weapon Technology Areas
6. Remote Weapon Technologies
7. Deep Futures

Ammunition

1. Advanced Weapon Operation
2. Signature Reduction
3. Propulsion
4. GNC for defilade kill
5. Improved Projectiles
6. Reduced Range Training Ammo
7. Deep Futures

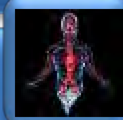
Optics & Fire Control

1. Optics Sensors, Imagers, & Displays
2. Deformable Visible Optics
3. Enhanced Ballistic Computer
4. Active Barrel Stabilization
5. Human Tagging, Marking, and Tracking
6. Wind and Environmental Sensing
7. Steerable Range Finding
8. Ballistic Trajectory Shaping and Off-path Lethality
9. Deep Futures

Scalable Effects

1. Multi mission/ Multi effects
2. Adjustable range and velocity
3. Directed Energy Miniaturization
4. Embedded Sensors
5. Deep Futures

Training & Human Performance



1. Adapt LEAP - A to characterize task/ condition/ standards parametric data for small arm Soldier in the Loop Performance
2. Human Factor Studies - reduction of training for operations, reduction in cognitive burden

Deep Future Plans

1. Advanced Propulsion
2. Electromagnetic Launch
3. Advanced Fire Control System
4. Future Studies
5. Increased S&T Exchanges w/ Research Labs , DARPA & Depart of Energy Labs
6. Dedicated 10% of 6.2 Investments

BA 6.3 S&T Investment Areas

SI&D

1. Integrated Fire Control
2. Weapons & Ammo for NGSWT
3. Ammunition
4. Smart Munitions
5. Scalable Effects

International Strategy

1. Create additional agreements with NATO Allies and Partners for Peace
2. NATO Leadership
3. Leverage RDECOM RFEC

Foundational Strategies in BA 6.2 and 6.3 That Will Lead To Dominant Future Capabilities

Final Thoughts

The JSATDS provides a great example of the Success of the JSSAP Organization and Stakeholders.

Key Takeaways:

1. **JSSAP continues to fulfill its mission through a series of strategic engagements (JSSAST, JSSARI and JSTAC) with key stakeholders at multiple echelons at the service component level.**
2. **JSATDS section leads were provided from ARDEC, ARL, USMC, JSSAP, JNLWD, and ONR creating a Joint document from inception. This document serves as a partnership with shared accountability (creation and financial), with joint engagement, joint learning and decision making. The JSATDS supports the tenets of the chartered mission of the Joint Service Small Arms Program (JSSAP) office.**
3. **JSATDS summarizes by investment taxonomy and Army Budget Activity dollars, associated investments necessary to mitigate the JSSAST Top 50 Opportunity Areas, Supports Program Objective Memorandum FY20-24 submission to support the Dismounted Warfighter, portrayed through the lens of the Soldier Modernization Deep Dive.**
4. **The resultant POM 20-24 Strategy requires a significant increase in budget activity funds 6.2 & 6.3 to support near term product improvements as directed by the Soldier Lethality Cross Functional Team and far term revolutionary investments in order to Maintain and Achieve Joint Warfighter Overmatch.**