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Joint Armaments Conference, Exhibition & Firing Demonstration

"21st Century Weapon Systems – Providing the Right Response"

Dallas, TX

17 – 20 May 2010

Agenda

Monday, May 17, 2010

TUTORIALS

- DOD Instruction 5000.2, Ms. Karen Byrd, LCSC Learning Assistant Program Manager, DAU
- International Traffic in Arms Regulations, Government and Corporate Perspectives:
  1. Mr. Larry Christensen, Member Miller & Chevalier Chartered
  2. Mr. Moses E. Lewis, Executive Consultant to EME
- De Mystifying Intellectual Property and Data Rights: Government & Industry Perspectives, Mr. Tim Ryan, Technology Transfer Program Manager ARDEC

Tuesday , May 18, 2010

KEYNOTE ADDRESS

- BrigGen Michael M. Brogan, USMC, Commander, Marine Corps Systems Command
- BG Peter N. Fuller, USA, Program Executive Officer (PEO) Soldier

DISTINGUISHED SPEAKER

- Mr. George Solhan, SES, Deputy Chief of Naval Research (ONR 30)

DISTINGUISHED SPEAKER

- Mr. Michael Mulligan, President, General Dynamics Armament & Technical Products (ATP)

DISTINGUISHED SPEAKER

- Mr. Jay Tibbets, Senior Vice President, Business Development, ATK

DISTINGUISHED SPEAKER

- Mr. Hans Hoeneveld, Senior Program Manager Ammunition, Netherlands Defense Materiel Organization

BREAKOUT SESSIONS

SMALL ARMS SYSTEMS

9880 – Joint Service Small Arms Synchronization Team (JSSAST) Panel

- COL Scott Flynn, USA, Chairman
- LTC Tom Henthorn, USA
- CDR Thomas Gajewski, U.S. Navy
- Mr. Randy Roth, USAF

- LtCol Mark Brinkman, USMC
- CAPT Michael Price, USCG
- Mr. Kevin Swenson, Joint Non-Lethal

PM SOLDIER WEAPONS

- COL Tamilio, PM Soldier Weapons

PM LEGAL ISSUES

- 10194 - ITAR: The International Trade in Arms Regulation: Changes and Updates Relevant to the Small Arms Community, Mr. Jason Wong, Firearms Law Group
- 10199 - International Efforts to Regulate or Prohibit Military Small Arms Ammunition, Mr. Hays Parks, DoD OGC (1A)

GUN & MISSILE SYSTEMS

PRECISION WEAPONS

- 10034 - Mortar Guidance Kit (MGK), Ms. Kelly Hanink, ATK
- 10146 - Precision Guidance Kit (PGK), Mr. Tom Bybee, ATK
- 10174 - Improving the Accuracy of Precision Guided Munitions with a GPS Ephemeris & Ionospheric Correction Sharing Service (GEISS), Mr. Charles Johnson, NAVSYS Corporation

KEYNOTE: *F-35 Weapon System Overview*

- Mr. Doug Hayward, Deputy Director F-35 Vehicle Systems, Lockheed Martin

PLATFORMS

- 9899 - MK 51 Modular Advanced Weapon System (MAWS), Mr. Steven Cannon, NSWC PHD Det Louisville
- 10595 - Gun Tube Wear Reduction for 105mm Artillery, Mr. Thomas Boncompain, General Dynamics, Ordnance and Tactical Systems Canada
- 10153 - Indirect Fires Precision and Lethality Enhancements through Digitization of Artillery and Mortar Weapon Systems, Mr. Victor Galgano, U.S. Army ARDEC
- 10190 - JSF Missionized Gun System, Mr. Douglas Parker, General Dynamics ATP
- 10235 - EFV 30mm Ammunition Feed System, Ms. Kim Perkins, General Dynamics ATP
- 10640 - Gun / Ammunition Acquisition Strategy for the EFV Program, Major Ian McDuffie, USMC, Head of Guns and Ammo APM-Mechanical Systems, PM AAA

REQUIREMENTS & PROGRAM TRENDS

- 10171 - Making Affordability Work, Mr. David Panhorst, U.S. Army ARDEC
- 10219 - Propulsion System Design in a Low Pressure Gun System, Mr. Carlton Adam, U.S. Army ARDEC

Wednesday, May 19, 2010

LUNCHEON WITH SPEAKER - Landmark CD BRIGADIER GENERAL STEPHEN VINCENT BENET (1827-1895) - HIS LIFE AND TIMES

- Dr. Stephen Small, JSSAP RDAR-EIJ, Picatinny Aresenal, NJ

BREAKOUT SESSIONS

SMALL ARM SYSTEMS

WEAPONS

- 10137 - Small Arms Weapon Integration on the Ramp of the V-22 Osprey, Mr. James Buechler, NSWC Crane
- The Kongsberg Common Remotely Operated Weapons Station: An Evolution in Capability for the Small Arms of Today to the Medium Cannon of Tomorrow, Mr. Westley “Bo” Barbour, Kongsberg Defence Systems
- 9915 - Advanced Remote/Robotic Armament System (ARAS), Mr. Robert Testa, U.S. Army ARDEC
- 9861 - Strategic Tripartite. Historic Opportunities for US and NATO Ground Combatants, Mr. Jim Schatz, Consultant

- 9863 - The Next Generation: The Case for a New NATO Rifle and Machine Gun Cartridge, Mr. Anthony Williams, Consultant

INTERNATIONAL

- 10690 - Is There a Problem With the Lethality of the 5.56 NATO Caliber, Mr. Per Arvidsson, NATO Weapons & Sensors Working Group
- 10000 - Grenade Launchers in China, Ms. Juanjuan Yang, China R&D Academy of Machinery
- 10055 - K11, Dual-Barrel Air-Burst Weapon, Dr. In Woo Kim, Agency for Defense Development, Korea
- 10136 - R&D Activities in Support of the Canadian Small Arms Replacement Project, Mr. Paul Harris, Defence Research and Development, Canada
- 10202 - Enhanced Warfighter Capability with Direct and Indirect Small Arms Ammunition, Mr. Jarl Eirik Straume, Nammo Raufoss AS, Norway
- 10201 - Developing IfraRed (IR) (Dim) Tracer Compositions for Reduced Signature, Mr. Peter Hedsand, Nammo Vanäsverken AB, Sweden
- 10200 - Developing Reduced Range Ammunition for Training and Urban Combat, Mr. Fredrik Erninge, Nammo Vanäsverken AB, Sweden

MODELING & SIMULATION

- 9898 - Application of IWARS in Small Arms Development, Mr. Alex Lee, U.S. Army ARDEC
- 9909 - Small Arms Modeling and Simulation, Mr. Clinton Fischer, U.S. Army RDECOM-ARDEC

NON-LETHAL

- 10070 - Advancements in Personnel Incapacitation Methodologies for Multiple Projectile Cartridges, Mr. Stephen Swann, Army Research Laboratory
- 10226 - Testing Non-lethals: Finding the Right Tools for the Job, Mr. Pascal Paulissen, TNO Defence, Security and Safety

AMMUNITION

- 9684 - Lethal Limited Range Round, Mr. Stephen McFarlane, U.S. Army
- 10004 - Small Caliber Propellant Solutions for the U.S. Military, Mr. Steve Faintich, St. Marks Powder, A General Dynamics Company
- 10149 - DARPA SCORPION Program Transition to Army Advanced Technology Objective Program: A Success Story, Mr. Andre Lovas, Georgia Tech Research Institute
- 10213 - Lightweight Small Caliber Ammuntion (LSCA) Lessons Learned From Prototype Fabrication to Full Production Rates, Mr. George Feghali, General Dynamics OTS-Canada, Inc. & Mr. Bill Dittrich, Fleximation, Inc.
- 10172 - Aluminum 5.56 Case Development: Continued Success with an Advanced Lightweight Material, Mr. Christopher Still, ATK
- 10170 - Case Weight Variation Reduction and Subsequent Ballistic Dispersion Improvements in M118LR, Ms. Dionne Dillon, ATK Small Caliber Systems
- 10183 - .50 Caliber Steel Case Development: Design and Development of a Lightweight Case Compatible with Modernized Production Processes at the Lake City Army Ammunition Plant, Mr. Christian Miller, ATK Small Caliber Systems
- 10195 - Effects of Barrel Length on Sound Measurement, Bore Pressure, and Bullet Velocity, Dr. Philip Dater, Gemtech
- 10186 - MEMS S&A for Munitions, Mr. Dale Spencer, Kaman Precision Products
- 10650 - Developments in Short Range Training Ammunition, Mr. Luis de Sousa, General Dynamics OTS, Simunition Operations

GUNS & MISSILE SYSTEMS

EMERGING TECHNOLOGIES

- 9894 - Design of an Intelligent Round Counter for Monitoring Ballistic Events Experienced by a Gun Barrel, Mr. Cory Mettler, American Science and Technology
- 10231 - The Rarefaction Wave Gun (RAVEN) Program, Mr. Mike Bixler, ARES, Inc.
- 9936 - “Lightening Strike”– An Indirect Fire Concept Utilizing Combustion Light Gas Gun (CLGG) Technology to Achieve Extreme Ranges, Mr. David Kruczynski, UTRON Inc. & Mr. Stephen Floroff, U.S. Army ARDEC
- 10135 - Hypersonic Plasma Particle Deposition Coating… Making 21st Century Weaponry Last into the 22nd, Mr. Daniel Fox, Rushford Hypersonic, LLC
- 10150 - Exo-atmosphere Propulsion for Hypersonic Projectiles, Dr. Wayne Sawka, DigitalSolid State Propulsion, LLC
- 10220 - Extended Area Protection and Survivability (EAPS) 50mm Cannon, Mr. Arthur Aeberli, U.S. Army ARDEC
- 10222 - Advanced Gun Barrel Technology Program, Background and Results, Mr. Bill Vezina, BAE Systems
- 10033 - Selectable Effects Warhead Technology Demonstration, Mr. Eric Volkmann, ATK

- 10151 - Ultrasonic Characterization of Explosively-Bonded Concentric Tubes, Mr. Chris Jerred, South Dakota State University
- 9910 - Magnelok™ Technology – Achieving High Torque-densities with a Novel Electromagnetically Actuated Band-brake, Mr. Scott Miller, LORD Corporation
- 9720 - Miniaturized ESAD Development, Mr. Ed Cooper, L-3 Fuzing and Ordnance Systems
- 9974 - Technology Trends in Fuzing and Munitions Power Sources, Mr. Oliver Barham, U.S. Army RDECOM-ARDEC
- 10143 - Low Volume, Negligible EMI Advanced Guided Bullet and Mortar Flight Control Actuators, Dr. Ron Barrett, University of Kansas

ENERGETICS

- 9878 - Unique Partnership to Provide Precision and Lethality to Tomorrow's Warfighter, Ms. Kelly Moran, ATK
- 9990 - High Performance BKNO3 Igniter Formulations, Dr. Eugene Rozumov, U.S. Army ARDEC
- 10006 - Medium and Large Caliber Propellant Solutions, Mr. Robert Pulver, St. Marks Powder, A General Dynamics Company
- 10176 - Development of a Solventless Propellant for Use in 120mm Tank Training Rounds, Mr. Jim Wedwick, ATK
- 10001 - Ageing Effects on Performance of Small and Medium Calibre Ammunition, Mr. Chris Van Driel, TNO Defence, Security and Safety
- 10229 - The 155MM M795 Artillery Shell Loaded with IMX-101, Mr. Anthony DiStasio, U.S. Army ARDEC & Mr. Michael Ervin, BAE Systems

DIRECT & INDIRECT FIRES

- 9848 - 25mm Non-Energetic Fragmenting Cartridge, Mr. Rick Wright, General Dynamics
- 9857 - 120 MM XM360 Gun Program – Test & Evolution, Mr. David Smith P.E., U.S. Army Benet Laboratories
- 9862 - Howitzer Digitization Engineering Issues, Mr. William Key, IXSEA, Inc.
- 9869/10148 - Modeling of Composite Wrapped Cannon Barrel/Non-Destructive Inspection & Design, Dr. Zhong Hu, South Dakota State University & Dr. Jikai Du, South Dakota State University
- 9945 - Super 40mm to 30mm Ammunition Comparison – Performance/Lethality, Mr. Rick Wright, General Dynamic
- 10032 - The Advance Case System (ACS) program for 120mm Tank Training Ammo, Mr. Jeff Berg, TK
- 10225 - Warfare Has Changed: Investigation of the Performance of Ammunition in Maritime & Urban Environments, Mr. Martin van de Voorde, TNO Defence, Security and Safety
- 10157 - Modular Design of Direct Fire Medium Caliber Gun Systems for Joint Operations, Mr. Andrew Bradick, Consultant

MODELING & SIMULATION

- 9708 - Simulation of Cellulose Nitration Reaction, Mr. Mohamed (Mo) Elalem, U.S. Army ARDEC
- 10179 - Automated Projectile Design Software, Mr. Mark Steinhoff, Arrow Tech Associates, Inc.
- 10158 - Pyrotechnic Shock Loading of the M82 Percussion Primer in the M777 Light Weight Howitzer Magazine Assembly, Ms. Kathryn Hunt, Marine Corps Systems Command
- 9908 - Numerical and Experimental Comparison of Muzzle Brake Impulse Reduction on a 120mm Cannon System, Mr. Robert Carson, Benet Laboratories, U.S. Army ARDEC
- 10350 - Scalable Lethality: 'Dial-a-Yield' Approach to Greater Precision Engagement, Mr. Henry Kerwein, U.S. Army ARDEC
- 9707 - Modeling of Fluid Energy Milling Process, Mr. Mohamed (Mo) Elalem, U.S. Army ARDEC

Thursday, May 20, 2010

SMALL ARMS SYSTEM

-

Session Chair: Chris Grassano, PM MAS

PM MAS

- An Overview of Non-Standard Ammunition, LTC Robert Dionisio
- Training Ammunition Safety Initiatives, LTC Robertson, Product Director
- 40MM Ammunition: Evolving and Emerging Requirements, MAJ Marc Meeker, Assistant Product Manager, Medium Caliber Ammunition
- Small Caliber Ammunition: Enhancing Capabilities, LTC Jeffrey Woods, Product Manager, Small Caliber Ammunition

JSSAP

- 9855 - Lightweight Small Arms Technologies, Mrs. Kori Phillips, U.S. Army ARDEC
- 10188 - JSSAP Futures 2012-2020, Dr. Barton Halpern, U.S. Army ARDEC

- 9895 - National Small Arms Center Update, Mr. Frank Puzycki, JSSAP Office, U.S. Army ARDEC
- 10193 - Advanced Lethal Armament Technology for Small Arms, Mrs. Sabbian Registe, ARDEC-RDECOM
- 9916 - Advanced Fire Control Technology for Small Arms Army Technology Objective (ATO), Mr. Terence F. Rice, U.S. Army ARDEC

GUNS & MISSILE SYSTEM

Distinguished Speaker: Mr. Edgar Fossheim, Nammo AS, Norway

TACTICAL MISSILES & ROCKETS

- 9714 - Demonstration and Validation of Lead-free Ballistic Modifier for Rocket Propellants, Dr. Sarah Headrick, ATK
- 10074 - Advanced Precision Kill Weapons System II, LCDR Nick Green, USN, Direct and Time Sensitive Strike Weapons PMA-242

JOINT INTEREST

- 10142 - Hovering Precision Weapons (HPW): Enabling Precise Surgical Strike and Collocated Close Air Support from Tactical to Strategic Distances, Dr. Ron Barrett, University of Kansas
- 10228 - CROWS II Vehicle Integration, Mr. Joseph Scheneck, PE, U.S. Army ARDEC
- 9827 - Environmentally Acceptable Alternatives to Lead Azide and Lead Styphnate, Dr. Michael Williams, Pacific Scientific EMC
- 10593 - Non-Incendiary Artillery Marking and Illumination Solutions, Mr. George Kurzik, General Dynamics – Ordnance and Tactical Systems & Mr. Ed Schmidt, Cyalume Technologies

NDIA
National Defense Industrial Association

PROMOTING NATIONAL SECURITY SINCE 1919

JOINT ARMAMENTS

CONFERENCE, EXHIBITION & FIRING DEMONSTRATION

"21st Century Weapon Systems - Providing the Right Response"

COMBINED PROGRAM ANNOUNCEMENT

GUN & MISSILE SYSTEMS

Precision and Lethality in Medium and Large Caliber

& SMALL ARMS SYSTEMS

Technology and Systems Sustaining and Evolving Small Arms Capability

HYATT REGENCY DALLAS ▸ DALLAS, TX

MAY 17-20, 2010

EVENT #0610

WWW.NDIA.ORG/MEETINGS/0610

MONDAY, MAY 17, 2010

8:00 am - 3:00 pm Exhibitor Move-in - Marsalis Hall

8:00 am - 6:30 pm Registration Open - Landmark Circle

1:00 pm - 2:45 pm **TUTORIALS**
- *Session Chair: Bob Glantz, ATK*

Cumberland A	Cumberland B
DOD Instruction 5000.2 *Ms. Karen Byrd, LCSC Learning Assistant Program Manager, DAU*	WSESRB Overview *Mr. Jim Gerber & Mr. Gary Vargo, NOSSA*

3:00 pm - 4:45 pm **TUTORIALS**

Cumberland A	Cumberland B
International Traffic in Arms Regulations, Government and Corporate Perspectives *Mr. Larry Christensen, Member Miller & Chevalier Chartered* *Mr. Moses E. Lewis, Executive Consultant to EME*	De Mystifying Intellectual Property and Data Rights: Government & Industry Perspectives *Mr. Tim Ryan, Technology Transfer Program Manager ARDEC, Mr. Carlton Chen, VP Compliance & Regulatory Affairs, Colt*

5:00 pm - 6:30 pm **RECEPTION IN MARSALIS HALL**

TUESDAY, MAY 18, 2010

7:00 am - 5:30 pm Registration Open - Landmark Circle

7:00 am - 8:00 am Continental Breakfast - Landmark Ballroom Foyer

8:00 am - 8:30 am **WELCOME & ADMINISTRATIVE ANNOUNCEMENTS** - Landmark AB
- MG Barry Bates, USA (Ret), *Vice President, Operations, NDIA*
- Mr. David Broden, *Broden Resource Solutions; NDIA Armaments Division Chairman*
- Mr. Brian Tasson, *Director of Mechanical Design, ATK; Gun & Missile Committee Chairman*
- Mr. Brian Berger, *Vice President and General Manager, General Dynamics-OTS Canada; Small Arms Committee Chairman*

8:30 am - 9:00 am **KEYNOTE ADDRESS**
- MG Michael S. Repass, USA, *Commanding General, USASFC (Airborne) - Cancelled*

9:00 am - 9:45 am **KEYNOTE ADDRESS**
- BrigGen Michael M. Brogan, USMC, *Commander, Marine Corps Systems Command*
- BG Peter N. Fuller, USA, *Program Executive Officer (PEO) Soldier*

9:45 am - 10:15 am Morning Break in Marsalis Hall

10:15 am - 10:45 am **DISTINGUISHED SPEAKER**
- Mr. George Solhan, SES, *Deputy Chief of Naval Research (ONR 30)*

10:45 am - 11:15 am **DISTINGUISHED SPEAKER**
- Mr. Michael Mulligan, *President, General Dynamics Armament & Technical Products (ATP)*

11:15 am - 11:45 am **DISTINGUISHED SPEAKER**
- Mr. Jay Tibbets, *Senior Vice President, Business Development, ATK*

11:45 am - 12:15 pm **DISTINGUISHED SPEAKER**
- Mr. Hans Hoeneveld, *Senior Program Manager Ammunition, Netherlands Defense Materiel Organization*

12:15 pm - 1:30 pm **AWARDS LUNCHEON** - Landmark CD

- CHINN AWARD presented to Mr. Frank Puzycki, U.S. Army ARDEC
  Presented by Mr. Joel Goldman, U.S. Army ARDEC
- HATHCOCK AWARD presented to Mr. Jeff Hoffman
  Presented by Mr. Brian K. Sain on behalf of American Snipers
- NDIA PROFESSIONAL SERVICE AWARD presented to Mr. Hays Parks
  Presented by Mr. Brian Berger, General Dynamics
- TRIFILETTI AWARD presented to Mr. Frank Bone
  Presented by Mr. Brian Tasson, ATK

1:30 pm - 2:50 pm **BREAKOUT SESSIONS**

- Joint Service Small Arms Synchronization Team (JSSAST)
  Session Chair: COL Karl Scott Flynn, USA, Chairman, JSSAST
- Precision Weapons
  Session Chairs: Rob Brewer, NAVAIR & Jeff Siewert, Arrow Tech Associates, Inc.
- Platforms
  Session Chairs: Anthony Gabriele, U.S. Army, RDECOM-ARDEC & Matt Diehl, General Dynamics
- Requirements & Program Trends
  Session Chairs: Mark Serben, U.S. Army RDECOM - ARDEC & Steve Kelly, BAE Systems

	Small Arms Systems	Gun & Missile Systems		
Time	Landmark B	Cumberland A-C	Landmark A	Reunion GH
	JSSAST			
1:30	9880 - JSSAST Panel • *COL Scott Flynn, USA, Chairman* • *LTC Tom Henthorn, USA* • *CDR Thomas Gajewski, U.S. Navy* • *Mr. Randy Roth, USAF* • *LtCol Mark Brinkman, USMC* • *COL James Smith, USSOCOM* • *CAPT Michael Price, USCG* • *Mr. Kevin Swenson, Joint Non-Lethal*		**Keynote:** F-35 Weapon System Overview *Mr. Doug Hayward, Deputy Director F-35 Vehicle Systems, Lockheed Martin*	
		Precision Weapons	**Platforms**	**Requirements & Program Trends**
2:10		9886 - Characterizing Performance of Precision Projectiles *Mr. Jon Peoble, Raytheon Missile Systems*	9899 - MK 51 Modular Advanced Weapon System (MAWS) *Mr. Steven Cannon, NSWC PHD Det Louisville*	
2:30		9896 - NavFire Guidance System – Integrated GPS and Mission Computer for Future Navigation Solutions *Mr. Walter Trach Jr., Rockwell Collins*	10595 - Gun Tube Wear Reduction for 105mm Artillery Mr. Thomas Boncompain, *General Dynamics, Ordnance and Tactical Systems Canada*	10171 - Making Affordability Work *Mr. David Panhorst, U.S. Army ARDEC*

2:50 pm - 3:30 pm Afternoon Break in Marsalis Hall

3:30 pm - 5:30 pm **BREAKOUT SESSIONS**

- PM Soldier Weapons
  Session Chair: COL Douglas Tamilio, USA, PM Soldier Weapons
- PM Legal Issues
  Session Chairs: Charles Buxton, Small Arms Ammunition and Testing (JXNN)
- Precision Weapons
  Session Chairs: Rob Brewer & Jeff Siewert, Arrow Tech Associates, Inc.

- Platforms
  Session Chairs: Anthony Gabriele, U.S. Army, RDECOM-ARDEC & Matt Diehl, General Dynamics
- Requirements & Program Trends
  Session Chairs: Mark Serben, U.S. Army RDECOM - ARDEC & Steve Kelly, BAE Systems

	Small Arms Systems	**Gun & Missile Systems**		
Time	**Landmark B**	**Cumberland A-C**	**Landmark A**	**Reunion GH**
	PM Soldier Weapons	**Precision Weapons**	**Platforms**	**Requirements & Program Trends**
3:30	**Panel Discussion** *COL Tamilio, PM Soldier Weapons* *LTC Chris Lehner, Individual Weapons Update* *LTC Michael Ascura, Crew Served Weapons Update*	10034 - Mortar Guidance Kit (MGK) *Ms. Kelly Hanink, ATK*	10021 - Remote Guardian System(TM) Defensive Weapon System *Mr. Adrian Gorsline, BAE Systems*	10219 - Propulsion System Design in a Low Pressure Gun System *Mr. Carlton Adam, U.S. Army ARDEC*
3:50		10049 - 5-Inch Long Range Land Attack Projectile (LR-LAP) *Mr. Brandon Engle, BAE Systems*	10153 - Indirect Fires Precision and Lethality Enhancements through Digitization of Artillery and Mortar Weapon Systems *Mr. Victor Galgano, U.S. Army ARDEC*	
4:10		10146 - Precision Guidance Kit (PGK) *Mr. Tom Bybee, ATK*	10190 - JSF Missionized Gun System *Mr. Douglas Parker, General Dynamics ATP*	
	PM Legal Issues			
4:30	10194 - ITAR: The International Trade in Arms Regulation: Changes and Updates Relevant to the Small Arms Community *Mr. Jason Wong, Firearms Law Group*	10174 - Improving the Accuracy of Precision Guided Munitions with a GPS Ephemeris & Ionospheric Correction Sharing Service (GEISS) *Mr. Charles Johnson, NAVSYS Corporation*	10235 - EFV 30mm Ammunition Feed System *Ms. Kim Perkins, General Dynamics ATP*	
4:50	10199 - International Efforts to Regulate or Prohibit Military Small Arms Ammunition *Mr. Hays Parks, DoD OGC (1A)*		10640 - Gun / Ammunition Acquisition Strategy for the EFV Program *Major Ian McDuffie, USMC, Head of Guns and Ammo APM-Mechanical Systems, PM AAA*	

5:30 pm - 7:00 pm **RECEPTION IN MARSALIS HALL**

Promotional Partner: ATK

WEDNESDAY, MAY 19, 2010

7:00 am - 5:10 pm Registration Open - Landmark Circle

7:00 am - 8:00 am Continental Breakfast - Landmark Ballroom Foyer

8:00 am - 9:20 am **BREAKOUT SESSIONS**

- Weapons
  Session Chair: Rick Adams, FNH USA LLC
- Ammunition
  Session Chair: Bruce Webb, Nammo Talley, Inc.
- Emerging Technologies
  Session Chairs: Jay Brannam, ATK & Michael Thornton, NSWC
- Direct & Indirect Fires
  Session Chairs: Dave Wallestad, Wallestad & Associates, LLC & Joe McPherson, USMC

	Small Arms Systems		Gun & Missile Systems	
Time	Landmark B	Cumberland A-C	Landmark A	Reunion GH
	Weapons	Ammunition	Emerging Technologies	Direct & Indirect Fires
8:00	10137 - Small Arms Weapon Integration on the Ramp of the V-22 Osprey *Mr. James Buechler, NSWC Crane*	9684 - Lethal Limited Range Round *Mr. Stephen McFarlane, U.S. Army*		9848 - 25mm Non-Energetic Fragmenting Cartridge *Mr. Rick Wright, General Dynamics*
8:20	10144 - The 0.50 Caliber Multi-Mode Machine Gun and Family of Enhanced Ammunition: A Complete Weapon System for Remote Mounts, Fighting Vehicles and Aircraft *Mr. Brian Sullivan, PMP, American Rheinmetall Munitions, Inc.*	10004 - Small Caliber Propellant Solutions for the U.S. Military *Mr. Steve Faintich, St. Marks Powder, A General Dynamics Company*	9894 - Design of an Intelligent Round Counter for Monitoring Ballistic Events Experienced by a Gun Barrel *Mr. Cory Mettler, American Science and Technology*	9857 - 120 MM XM360 Gun Program – Test & Evolution *Mr. David Smith P.E., U.S. Army Benet Laboratories*
8:40	10084 - GAU-21 CDWS Platform Integration *Mr. Bruce Richards, NSWC Crane*	10149 - DARPA SCORPION Program Transition to Army Advanced Technology Objective Program: A Success Story *Mr. Andre Lovas, Georgia Tech Research Institute*	10231 - The Rarefaction Wave Gun (RAVEN) Program *Mr. Mike Bixler, ARES, Inc.*	9862 - Howitzer Digitization Engineering Issues *Mr. William Key, IXSEA, Inc.*
9:00	The Kongsberg Common Remotely Operated Weapons Station: An Evolution in Capability for the Small Arms of Today to the Medium Cannon of Tomorrow *Mr. Westley "Bo" Barbour, Kongsberg Defence Systems*	10213 - Lightweight Small Caliber Ammuntion (LSCA) Lessons Learned From Prototype Fabrication to Full Production Rates *Mr. George Feghali, General Dynamics OTS-Canada, Inc.* *Mr. Bill Dittrich, Fleximation, Inc.*	9936 - "Lightening Strike"– An Indirect Fire Concept Utilizing Combustion Light Gas Gun (CLGG) Technology to Achieve Extreme Ranges *Mr. David Kruczynski, UTRON Inc.* *Mr. Stephen Floroff, U.S. Army ARDEC*	9869/10148 - Modeling of Composite Wrapped Cannon Barrel/Non-Destructive Inspection & Design *Dr. Zhong Hu, South Dakota State University* *Dr. Jikai Du, South Dakota State University*

9:20 am - 10:00 am Morning Break in Marsalis Hall

10:00 am - 12:00 pm **BREAKOUT SESSIONS**

- Weapons
  Session Chair: Rick Adams, FNH USA LLC
- Ammunition
  Session Chair: Bruce Webb, Nammo Talley, Inc.
- Emerging Technologies
  Session Chairs: Jay Brannam, ATK & Michael Thornton, NSWC
- Direct & Indirect Fires
  Session Chairs: Dave Wallestad, Wallestad & Associates, LLC & Joe McPherson, USMC
- International
  Session Chair: John Edwards, U.S. Army ARDEC

	Small Arms Systems		Gun & Missile Systems	
Time	Landmark B	Cumberland A-C	Landmark A	Reunion GH
	Weapons	Ammunition	Emerging Technologies	Direct & Indirect Fires
10:00	9915 - Advanced Remote/ Robotic Armament System (ARAS) *Mr. Robert Testa, U.S. Army ARDEC*	10172 - Aluminum 5.56 Case Development: Continued Success with an Advanced Lightweight Material *Mr. Christopher Still, ATK*	10135 - Hypersonic Plasma Particle Deposition Coating… Making 21st Century Weaponry Last into the 22nd *Mr. Daniel Fox, Rushford Hypersonic, LLC*	10140 - 30mm x 113mm Traced Target Practice (TP-T) Munition *Mr. Kyle Nerison, ATK Integrated Weapon Systems*
10:20	9861 - Strategic Tripartite. Historic Opportunities for US and NATO Ground Combatants *Mr. Jim Schatz, Consultant*	10170 - Case Weight Variation Reduction and Subsequent Ballistic Dispersion Improvements in M118LR *Ms. Dionne Dillon, ATK Small Caliber Systems*	10150 - Exo-atmosphere Propulsion for Hypersonic Projectiles *Dr. Wayne Sawka, Digital Solid State Propulsion, LLC*	9945 - Super 40mm to 30mm Ammunition Comparison – Performance/ Lethality *Mr. Rick Wright, General Dynamics*
10:40	9863 - The Next Generation: The Case for a New NATO Rifle and Machine Gun Cartridge *Mr. Anthony Williams, Consultant*	10183 - .50 Caliber Steel Case Development: Design and Development of a Lightweight Case Compatible with Modernized Production Processes at the Lake City Army Ammunition Plant *Mr. Christian Miller, ATK Small Caliber Systems*	10160 - Use of Non-metallic Materials in Gun-Launched Artillery Projectiles *Mr. John Tilling, QinetiQ*	9946 - The 30mm x 173 PELE: The Single Shot Solution for Combat Vehicles and Surface Combatants *Mr. Stephan Kerk, American Rheinmetall Munitions, Inc.*
	International			
11:00	10690 - Is There a Problem With the Lethality of the 5.56 NATO Caliber *Mr. Per Arvidsson, NATO Weapons & Sensors Working Group*	10195 - Effects of Barrel Length on Sound Measurement, Bore Pressure, and Bullet Velocity *Dr. Philip Dater, Gemtech*	10220 - Extended Area Protection and Survivability (EAPS) 50mm Cannon *Mr. Arthur Aeberli, U.S. Army ARDEC*	10032 - The Advance Case System (ACS) program for 120mm Tank Training Ammo *Mr. Jeff Berg, ATK*
11:20	10000 - Grenade Launchers in China *Ms. Juanjuan Yang, China R&D Academy of Machinery*	10186 - MEMS S&A for Munitions *Mr. Dale Spencer, Kaman Precision Products*	10222 - Advanced Gun Barrel Technology Program, Background and Results *Mr. Bill Vezina, BAE Systems*	

	Small Arms Systems		Gun & Missile Systems	
11:40	10055 - K11, Dual-Barrel Air-Burst Weapon *Dr. In Woo Kim, Agency for Defense Development, Korea*	10650 - Developments in Short Range Training Ammunition *Mr. Luis de Sousa, General Dynamics OTS, Simunition Operations*	10141 - LW25 High Explosive Dual Purpose (HEDP) Munition *Mr. Kyle Nerison, ATK Integrated Weapon Systems*	9905 - 25mm x 137 APEX Aircraft Ammunition *Ms. Eva Friis, Nammo Raufoss AS, Norway*

12:00 pm - 1:30 pm **LUNCHEON WITH SPEAKER -** Landmark CD
BRIGADIER GENERAL STEPHEN VINCENT BENET (1827-1895) - HIS LIFE AND TIMES
- Dr. Stephen Small, *JSSAP RDAR-EIJ, Picatinny Arsenal, NJ*

1:30 pm - 2:50 pm **BREAKOUT SESSIONS**
- International
  Session Chair: John Edwards, U.S. Army ARDEC
- Energetics
  Session Chair: Enrico Mutascio, Esterline Defense Technologies & Matt Solverson, General Dynamics
- Emerging Technologies
  Session Chairs: Jay Brannam, ATK & Michael Thornton, NSWC
- Direct & Indirect Fires
  Session Chairs: Dave Wallestad, Wallestad & Associates, LLC & Joe McPherson, USMC
- Modeling & Simulation
  Session Chairs: Mike Stankus, EG&G Technical Services, Inc. & Steve Piper, Piper Pacific International

	Small Arms Systems	Gun & Missile Systems		
Time	Landmark B	Cumberland A-C	Landmark A	Reunion GH
	International	Energetics	Emerging Technologies	Direct & Indirect Fires
1:30	10136 - R&D Activities in Support of the Canadian Small Arms Replacement Project *Mr. Paul Harris, Defence Research and Development, Canada*	9878 - Unique Partnership to Provide Precision and Lethality to Tomorrow's Warfighter *Ms. Kelly Moran, ATK*	10033 - Selectable Effects Warhead Technology Demonstration *Mr. Eric Volkmann, ATK*	10225 - Warfare Has Changed: Investigation of the Performance of Ammunition in Maritime & Urban Environments *Mr. Martin van de Voorde, TNO Defence, Security and Safety*
1:50	10202 - Enhanced Warfighter Capability with Direct and Indirect Small Arms Ammunition *Mr. Jarl Eirik Straume, Nammo Raufoss AS, Norway*	9990 - High Performance BKNO3 Igniter Formulations *Dr. Eugene Rozumov, U.S. Army ARDEC*	10151 - Ultrasonic Characterization of Explosively-Bonded Concentric Tubes *Mr. Chris Jerred, South Dakota State University*	10157 - Modular Design of Direct Fire Medium Caliber Gun Systems for Joint Operations *Mr. Andrew Bradick, Consultant*
				Modeling & Simulation
2:10	10201 - Developing IfraRed (IR) (Dim) Tracer Compositions for Reduced Signature *Mr. Peter Hedsand, Nammo Small Arms Division, Sweden*	10006 - Medium and Large Caliber Propellant Solutions *Mr. Robert Pulver, St. Marks Powder, A General Dynamics Company*	9910 - Magnelok™ Technology – Achieving High Torque-densities with a Novel Electromagnetically Actuated Band-brake *Mr. Scott Miller, LORD Corporation*	9708 - Simulation of Cellulose Nitration Reaction *Mr. Mohamed (Mo) Elalem, U.S. Army ARDEC*

	Small Arms Systems	Gun & Missile Systems		
2:30	10200 - Developing Reduced Range Ammunition for Training and Urban Combat *Mr. Fredrik Erninge, Nammo Vanäsverken AB, Sweden*		9720 - Miniaturized ESAD Development *Mr. Ed Cooper, L-3 Fuzing and Ordnance Systems*	10179 - Automated Projectile Design Software *Mr. Mark Steinhoff, Arrow Tech Associates, Inc.*

2:50 pm - 3:30 pm Afternoon Break in Marsalis Hall

3:30 pm - 5:10 pm **BREAKOUT SESSIONS**

- Small Arms Modeling & Simulation
  Session Chair: Mr. Matthew Cilli, U.S. Army ARDEC
- Non-Lethal
  Session Chair: Mr. Kevin Swenson, NLWS Directorate, MCSC, Quantico
- Energetics
  Session Chairs: Enrico Mutascio, Esterline Defense Technologies & Matt Solverson, General Dynamics
- Emerging Technologies
  Session Chairs: Jay Brannam, ATK & Michael Thornton, NSWC
- Gun & Missile Modeling & Simulation
  Session Chairs: Mike Stankus, EG&G Technical Services, Inc. & Steve Piper, Piper Pacific International

	Small Arms Systems	Gun & Missile Systems		
Time	Landmark B	Cumberland A-C	Landmark A	Reunion GH
	Modeling & Simulation	Energetics	Emerging Technologies	Modeling & Simulation
3:30	9961/9962 - 40mm Low & Medium Velocity Munitions *Mr. Cheng Hok Aw, Singapore Technologies Kinetics*	10176 - Development of a Solventless Propellant for Use in 120mm Tank Training Rounds *Mr. Jim Wedwick, ATK*	9974 - Technology Trends in Fuzing and Munitions Power Sources *Mr. Oliver Barham, U.S. Army RDECOM-ARDEC*	10158 - Pyrotechnic Shock Loading of the M82 Percussion Primer in the M777 Light Weight Howitzer Magazine Assembly *Ms. Kathryn Hunt, Marine Corps Systems Command*
3:50	9898 - Application of IWARS in Small Arms Development *Mr. Alex Lee, U.S. Army ARDEC*	10001 - Ageing Effects on Performance of Small and Medium Calibre Ammunition *Mr. Chris Van Driel, TNO Defence, Security and Safety*		9908 - Numerical and Experimental Comparison of Muzzle Brake Impulse Reduction on a 120mm Cannon System *Mr. Robert Carson, Benet Laboratories, U.S. Army ARDEC*
4:10	9909 - Small Arms Modeling and Simulation *Mr. Clinton Fischer, U.S. Army RDECOM-ARDEC*	10229 - The 155MM M795 Artillery Shell Loaded with IMX-101 *Mr. Anthony DiStasio, U.S. Army ARDEC & Mr. Michael Ervin, BAE Systems*	10143 - Low Volume, Negligible EMI Advanced Guided Bullet and Mortar Flight Control Actuators *Dr. Ron Barrett, University of Kansas*	10350 - Scalable Lethality: 'Dial-a-Yield' Approach to Greater Precision Engagement *Mr. Henry Kerwien, U.S. Army ARDEC*
	Non-Lethal			
4:30	10070 - Advancements in Personnel Incapacitation Methodologies for Multiple Projectile Cartridges *Mr. Stephen Swann, Army Research Laboratory*		10224 - Warfare Has Changed – So Should Have Methods: Experimental Investigation of the Performance of Modern Medium and Large Calibre Ammunition in Urban Terrain *Mr. Theo Verhagen, TNO Defence, Security and Safety*	9707 - Modeling of Fluid Energy Milling Process *Mr. Mohamed (Mo) Elalem, U.S. Army ARDEC*

	Small Arms Systems	Gun & Missile Systems		
4:50	10226 - Testing Non-lethals: Finding the Right Tools for the Job *Mr. Pascal Paulissen, TNO Defence, Security* and Safety			

5:10 pm **CONFERENCE ADJOURNED FOR THE DAY**

THURSDAY, MAY 20, 2010

7:00 am - 11:00 am Registration Open - Landmark Circle

7:00 am - 8:00 am Continental Breakfast - Landmark Ballroom Foyer

8:00 am - 9:40 am **BREAKOUT SESSIONS**

- PM MAS
  Session Chair: Chris Grassano, PM MAS
- JSSAP
  Session Chair: Joel Goldman, U.S. Army ARDEC
- Tactical Missiles & Rockets
  Session Chairs: Ed DePasqual, Nammo Talley, Inc. & John Bednarz, Raytheon Company
- Joint Interest
  Session Chairs: Doug Wong, PM MAS & Mike Stankus, EG&G Technical Services, Inc.

	Small Arms Systems	Gun & Missile Systems	
Time	Landmark B	Landmark A	Reunion GH
	PM MAS		
8:00	• An Overview of Non-Standard Ammunition *LTC Robert Dionisio*	Distinguished Speaker: *Mr. Edgar Fossheim, Nammo AS, Norway*	
8:30	• Training Ammunition Safety Initiatives *LTC Robertson, Product Director* • 40MM Ammunition: Evolving and Emerging Requirements *MAJ Marc Meeker, Assistant Product Manager, Medium Caliber Ammunition* • Small Caliber Ammunition: Enhancing Capabilities *LTC Jeffrey Woods, Product Manager, Small Caliber Ammunition*	Distinguished Speaker: *Mr. Patrick (Kevin) Peppe, Vice President, Naval Weapon Systems, Raytheon Company*	
	JSSAP	Tactical Missiles & Rockets	Joint Interest
9:00	9855 - Lightweight Small Arms Technologies *Mrs. Kori Phillips, U.S. Army ARDEC*		10142 - Hovering Precision Weapons (HPW): Enabling Precise Surgical Strike and Collocated Close Air Support from Tactical to Strategic Distances *Dr. Ron Barrett, University of Kansas*

	Small Arms Systems	Gun & Missile Systems	
9:20	10188 - JSSAP Futures 2012-2020 *Dr. Barton Halpern, U.S. Army ARDEC*	9714 - Demonstration and Validation of Lead-free Ballistic Modifier for Rocket Propellants *Dr. Sarah Headrick, ATK*	10228 - CROWS II Vehicle Integration *Mr. Joseph Scheneck, PE, U.S. Army ARDEC*

9:40 am - 11:00 am **BREAKOUT SESSIONS**

- JSSAP
  Session Chair: Joel Goldman, U.S. Army ARDEC
- Tactical Missiles & Rockets
  Session Chairs: Ed DePasqual, Nammo Talley, Inc. & John Bednarz, Raytheon Company
- Joint Interest
  Session Chairs: Doug Wong, PM MAS & Mike Stankus, EG&G Technical Services, Inc.

	Small Arms Systems	Gun & Missile Systems	
Time	Landmark B	Landmark A	Reunion GH
	JSSAP	Tactical Missiles & Rockets	Joint Interest
9:40	9895 - National Small Arms Center Update *Mr. Frank Puzycki, JSSAP Office, U.S. Army ARDEC*	*Morning Break - Landmark Ballroom Foyer*	
10:00	10193 - Advanced Lethal Armament Technology for Small Arms *Mrs. Sabbian Registe, ARDEC-RDECOM*	10074 - Advanced Precision Kill Weapons System II *LCDR Nick Green, USN, Direct and Time Sensitive Strike Weapons PMA-242*	10175 - Experimentation in Integrated Weapons Solutions for Unmanned Systems – Getting Past the Demonstration *Mr. Paul Balutis, iRobot*
10:20	9916 - Advanced Fire Control Technology for Small Arms Army Technology Objective (ATO) *Mr. Terence F. Rice, U.S. Army ARDEC*		9827 - Environmentally Acceptable Alternatives to Lead Azide and Lead Styphnate *Dr. Michael Williams, Pacific Scientific EMC*
10:40	9539 - Integrated Rifle Barrel Reference Sensor with Position Compensating Reticle *Mr. Slobodan Rajic, Oak Ridge National Laboratory*		10593 - Non-Incendiary Artillery Marking and Illumination Solutions *Mr. George Kurzik, General Dynamics – Ordnance and Tactical Systems* *Mr. Ed Schmidt, Cyalume Technologies*

11:00 am - 6:00 pm **CONTRACTOR FIRING DEMONSTRATION** **Promotional Partner:** LaRue Tactical

- *Session Chair: Sal Fanelli, U.S. Marine Corps*

11:00 am - 11:30 am Board Buses for Firing Demonstration - Hotel Lobby

11:30 am - 12:40 pm Buses En Route for Firing Range

12:40 pm - 1:40 pm Texas BBQ Lunch Provided by LaRue Tactical

1:40 pm - 4:30 pm Firing Demonstration - Spartan Tactical

3:30 pm - 4:45 pm Buses En Route for Hotel (first bus departs at 3:30 pm; last bus departs at 4:45 pm)

POSTER PRESENTATIONS

The following posters will be displayed in Marsalis Hall throughout the conference. Authors will be available for discussion during morning and afternoon breaks, as listed in the agenda. Posters will be displayed in numerical order.

▸ *Session Chairs: Mr. Steve French, BAE Systems & Mr. Matt Ohlson, ATK*

9893 - Development of a Nondestructive Testing Field Inspection Vehicle Designed to Scan Cylindrical Structures
Mr. Cory Mettler, American Science and Technology

9925 - Case Studies for Improved Sustainment of Bullet and Bullet Assembly Machines
Mr. Michael Coventry, Bliss Clearing Niagara Technical Services

10005 - Fire Control Systems for Heavy Machine Guns: Winning the Current Fight while Simultaneously Modernizing for the Future
Mr. Richard Hollen, VingTech Corporation

10100 - Liquid Ceramic Coatings for Signature Reduction in Small Arms
Dr. Leah Leavitt, NIC Industries, Inc.

10126 - New Power, Lightweight Materials, and Sustainable Design Tools for Small Arms Systems
Mr. Blase Leven, Kansas State University

10128 - Using Triboluminescence to Detect Impacts for Defense Applications
Dr. William Hollerman, University of Louisiana at Lafayette

10138 - FEM Analysis of a Barrett M99 0.50 Caliber Rifle Barrel
Dr. Gary Anderson, South Dakota State University

10145 - Determining Residual Stress of Ta Alloy Gun Tube
Dr. Tao Huang, South Dakota State University

10155 - Characterization of the Emergent Flame and Transient Pressure History of the M299 Ignition Cartridge at 70°F and -50°F
Mr. Jon Conner, National Technical Systems (NTS)

10168 - Individual Airburst Weapon System (IAWS)
Mr. Ryan Hurt, ATK

10192 - Miniature Integrated Capacitive Discharge Unit for Detonation and Ignition
Mr. Frank Duva, Novacap, Inc.

10236 - Analysis of Requirements for Engaging Defilade Targets with 40mm Grenades
Dr. Kevin Massey, Georgia Tech Research Institute

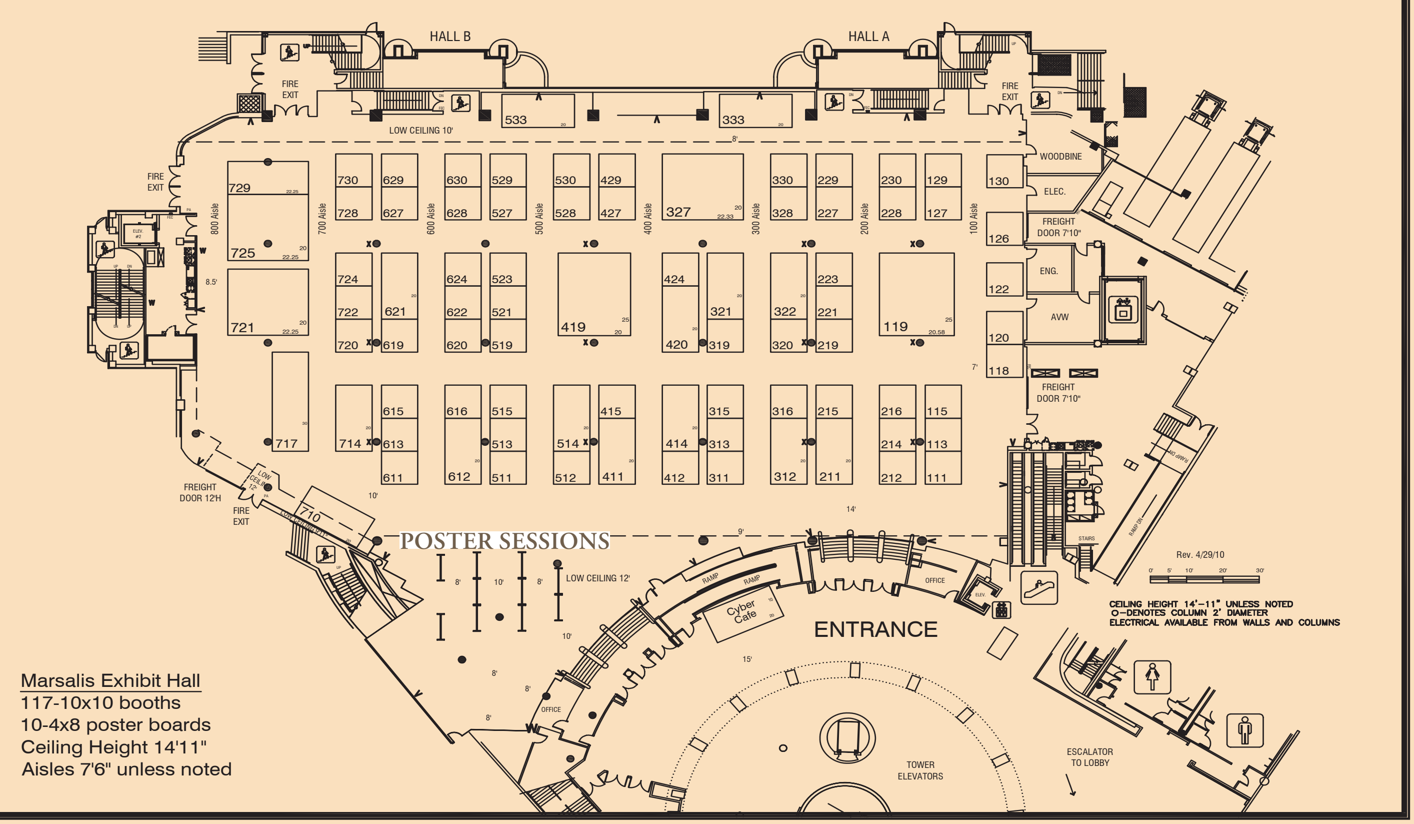
10482 - Small Arms Mounted Radar Sensor for Improving Aiming Accuracy
Dr. Ram Narayanan, The Pennsylvania State University

10578 - Small Caliber Dispersion Modeling
Mr. Jeff Siewert, Arrow Tech Associates, Inc.

EXHIBIT INFORMATION

Booth Number	Company Name
427	AAI Corporation
319	Advanced Armament Corporation
514	Aerojet
228	Aimpoint, Inc.
528	Alcoa Defense
412	American Rheinmetall Munitions, Inc.
513	Anniston Army Depot
725	ARDEC
530	Ares, Inc.
523	Arrow Tech
419	ATK
722	Barrett
612	Bulldog Tactical Equipment
321	Colt Defense, LLC
424	Combined Systems, Inc.
320	Competitive Edge Gunworks
333	Contract Fabrication & Design
529	Cornervision
512	Dayton T. Brown, Inc.
126	DTI Associates
710	ELCAN Optical Technologies
628	EMA Tactical
415	ENSINGER

Joint Armaments Conference, Exhibition & Firing Demonstration
May 17-20, 2010
Hyatt Regency Dallas
Dallas, Texas



119	FNH USA, Inc.
219	GEMTECH
621	General Dynamics Amphibious Systems
327	General Dynamics Armament and Technical Products
322	General Dynamics-OTS
316	GLOCK, Inc.
527	Heckler & Koch
115	Hogue, Inc.
118	Institute for Advanced Technology at the University of Texas
328	ITT Enidine, Inc.
717	Joint Service Small Arms Program
313	Kistler Instrument Corporation
216	Knight's Armament Company
627	L-3 Fuzing & Ordnance Systems
227	Lancer Systems
622	LaRue Tactical
212	Laser Devices, Inc.
122	Lasermax
724	Magpul Industries Corporation
730	Manroy USA
130	Martin Electronics, Inc.
511	MAST Technology, Inc.
629	Metal Storm, Inc.
720	MILKOR USA, Inc.
429	MSC Software Corporation
411	Nammo Talley, Inc.
521	National Technical Systems Corporation
613	NNSA's National Secure Manufacturing Center
414	Nobles Manufacturing, Inc.
315	Olin-Winchester
311	Otis Technology
619	PCB Piezotronics
214	Pelican Products
728	Platt Mounts - USA, Inc.
721	PM Soldier Weapons
211	Remington Arms
519	Ringfeder Corporation
129 & 215	RUAG Ammotec
533	S&T Daewoo
111	Sabre Defence Industries, LLC
113	Samson Manufacturing
611	Schmidt & Bender GmbH
330	Sierra Bullets
127	Sig Sauer
229	Small Arms Defense Journal
515	Smith & Wesson
120	Spa-Defense
630	Streamlight, Inc.
615	Sturm, Ruger
230	SureFire
223	Taser International
420	Trijicon
616	US Army Aberdeen Test Center
729	US Army RDECOM
312	US Ordnance
624	UTRON, Inc.
620	Vectronix, Inc.
714	VingTech Corporation
221	Wilcox Industries

Exhibit Hours:
Monday, May 17:
5:00pm - 6:30pm Opening Reception

Tuesday, May 18:
9:00am - 5:30pm
5:30pm - 7:00pm Reception

Wednesday, May 19:
9:00am - 3:30pm

ATK is a premier aerospace and defense company with approximately $4.8 billion in annual sales, more than 17,000 employees, and operations in 21 states and internationally. We bring non-traditional approaches to the market, with speed and innovation. ATK has signature expertise in delivering timely, advanced and affordable capabilities with reliable performance – in many cases economically upgrading current inventories with force multiplier affect.

ATK continues to expand its business as a leading provider of enhanced lethality and survivability solutions with core competencies in facility and supply chain management; small-and medium-caliber ammunition design and manufacture, medium-caliber gun system design and manufacture, and advanced propellant and energetics production. We are the technology leader in law enforcement, hunting and shooting sports ammunition, accessories and reloading supplies.

Our product line spans the breadth of individual and crew-served applications, from conventional and special-mission pistol and rifle ammunition, to 30mm and large-caliber for air, land and sea platforms. We have extended our supply chains to include not only U.S. and NATO specification ammunition, but non-standard products as well.

We are pioneering the development of enhanced tactical ammunition, including air bursting munitions, next generation energetics, and advanced propellants that will increase performance.

ATK offers an affordable 70mm precision system, Guided Advanced Tactical Rocket (GATR), which uses a semi-active laser guidance package to achieve extreme accuracy against both stationary and moving targets. GATR is a lock-on before or after launch system that supports integration on fixed/rotary wing and Unmanned Aircraft Systems platforms and is compatible with existing 2.75-inch launcher hardware.

ATK continues to enter new international markets supporting U.S., NATO, and allied forces with affordable, interoperable solutions in support of freedom. These offerings include mission-critical tactical systems and personal protection equipment, including load-bearing vests, hydration packs, holsters, bags, and slings.

ATK brings unmatched reliability and lethality in integrated weapon systems. We offer added value with fully integrated electronics and fire control capabilities supporting our innovative chain gun technology and medium-caliber ammunition systems, presenting a complete lethality package for today's ground and air platforms.

Additional ATK news and information can be found at www.atk.com.

GENERAL DYNAMICS
Armament and Technical Products

General Dynamics Armament and Technical Products, located in Charlotte, N.C., provides a broad range of system solutions for military and commercial applications.

The company designs, develops and produces high-performance weapon and armament systems, defensive armor, countermeasure systems and aerospace composite solutions, as well as off-road axle and suspension systems. It is also a leading U.S. producer of biological and chemical detection systems.

Contact Info:

Kevin Sims
Business Development Manager
Four LakePointe Plaza
2118 Water Ridge Parkway
Charlotte, NC 28217
Phone: 704-714-8291
Fax: 702-714-8212

LaRue Tactical

Located in Leander, TX, LaRue Tactical was founded as Austin Precision Products, Inc. (APPI) in 1980 as a precision machine shop servicing the technical markets, including microprocessors and the computer industry. In the early 90's, LaRue Tactical emerged from APPI, servicing the sniper community, and then quickly branched into design and production that supports all branches of the U.S. military world-wide. "LaRue" is now synonymous with Sniper Targets and Quick-Detachable Mounting Systems for every optic, laser and NVD used by our soldiers. Our facilities house a large array of CNC work-centers, assembly, testing, inventory, and shipping areas. We are co-located with an underground shooting / testing range.

LaRue is known for providing the Warfighter the finest hardware available at the best value. Our specific niche is speed and agility in the production and delivery of field-worthy prototypes, integrating our patented Quick-Disconnect Speed Lever design into a variety of MIL-STD-1913 related products and accessories. The "repeatable" attributes of our manufactured hardware, even under the harshest conditions and most rigorous abuse have given LaRue an idustry leadership reputation.

LaRue also designs and manufactures highly-accurate and dependable weapons systems, including the new 7.62 Optimized Battle Rifle (OBR), The OBR is an accurized gas-impingement AR-platform rifle that is available with 16", 18" or 20" barrels. Almost every part of the OBR is manufactured in-house, providing the ultimate in quality control that yeilds a consistent, sub-MOA rifle.

LaRue Sniper Targets are used by the sniper community world-wide. These robust steel targets are available in auto-resetting and remote-resetting models for calibers ranging from 5.56 through 50BMG. LaRue also provides several designs that are free-standing, reactive targets.

MEGGITT
smart engineering for extreme environments

Meggitt Defense Systems Inc. (MDSI), specializes in the design, development and production of state-of-the-art medium caliber Linear Linkless ammunition handling systems and large caliber compact autoloaders in support of the United States military and her allies.

MDSI has a solid track record in meeting design-to-production requirements for increased capacity, reliability, and volumetric storage efficiency for ammunition handling systems.

MDSI provides a wide range of medium caliber Linear Linkless systems, all of which have been battle-proven. These include: AC-130U Gunship - 25mm, 3,000 rounds; Apache helicopter - 30mm, 1,200 rounds and 250 rounds (Combo PAK); Blackhawk helicopter - two 30mm magazines, 1,200 rounds and 660 rounds; Phalanx Reloader – 20mm, 1,500 rounds; and LALS Reloader – 20mm, 2,100 rounds. Additionally, development programs are underway for 30mm Mk44 Linkless feed systems, 35mm systems, and 40mm systems. Further, a new 20mm Linkless system is now in production, replacing the existing linked system on the Cobra helicopter.

Linkless feeding systems allow simultaneous upload and download of rounds and spent cases (where required), providing weapon system efficiency on the battlefield. Linear Linkless systems are more efficient, lighter, and, most importantly, are more reliable than linked systems. Our feed and transfer systems maintain complete control of rounds as they are fed directly into the gun without wasted space. In the end, this means maintaining multi-year high reliability records. More importantly, it means that in the heat of combat war fighters don't have to be concerned with whether or not their ammunition system will jam and fail them.

MDSI has developed large caliber Compact Autoloader and magazine systems for 105mm, 120mm, 140mm and 155mm. They are electrically or hydraulically-driven, fully automatic battlefield robotics systems. Examples range from prototypes for Main Battle Tanks to today's Stryker Mobile Gun System and to next-generation combat platforms

As the technology leader in ammunition handling and storage systems, Meggitt Defense Systems Inc. is proud to be a sponsor for the NDIA Joint Armaments Conference.

NDIA
National Defense Industrial Association

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
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(703) 522-1885 FAX
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"21st Century Weapon Systems - Providing the Right Response"

MAY 17-20, 2010
HYATT REGENCY DALLAS
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THANK YOU TO OUR PROMOTIONAL PARTNERS!

NDIA's Joint Armaments Conference, Exhibition & Firing Demo
"21st Century Weapon Systems – Providing the Right Response"

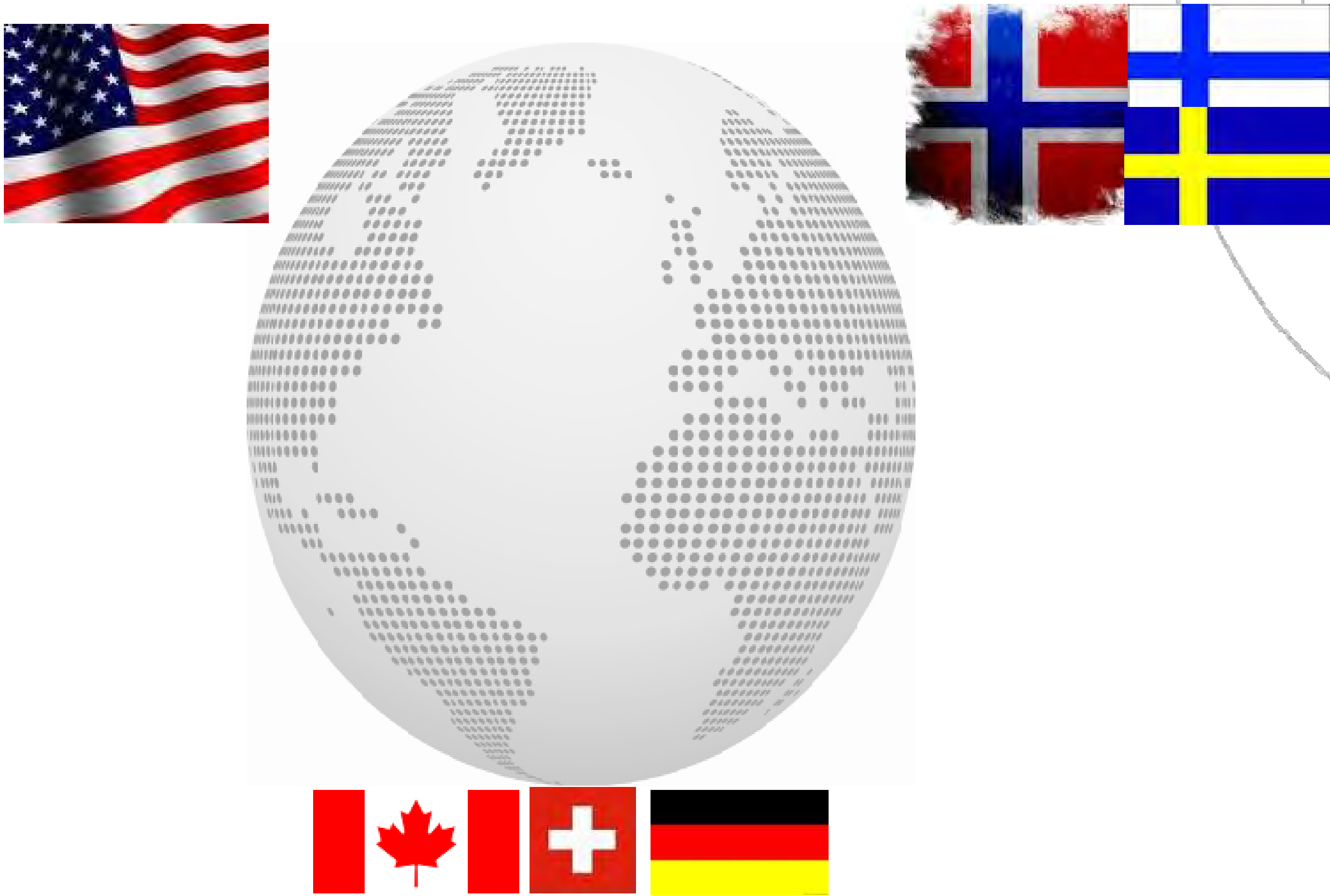
Nammo:
A Solution Provider
– Enabling the Right Response –

By
Edgar Fossheim
President and CEO of Nammo AS

May 20, 2010

Nammo

Local Presence – Global Understanding



PRECISION PEOPLE TECHNOLOGY

Core Business in Support of The Warfighter

PRECISION PEOPLE TECHNOLOGY

Core Technology

- Precision
  - Ammunition for Training and Warfighting
- Lethality
  - Our products shall be precise and minimize collateral damage
- Reliability
  - Shall always work – Thus Day & Night Solutions
- Safety
  - Safe environment for the producer and the user
  - Striving for Insensitive Munition solutions

PRECISION PEOPLE TECHNOLOGY

Nammo

Small Caliber Solutions – Examples:

From 5.56 → 12,7mm

- Armor Piercing
- Reduced Range (RR)

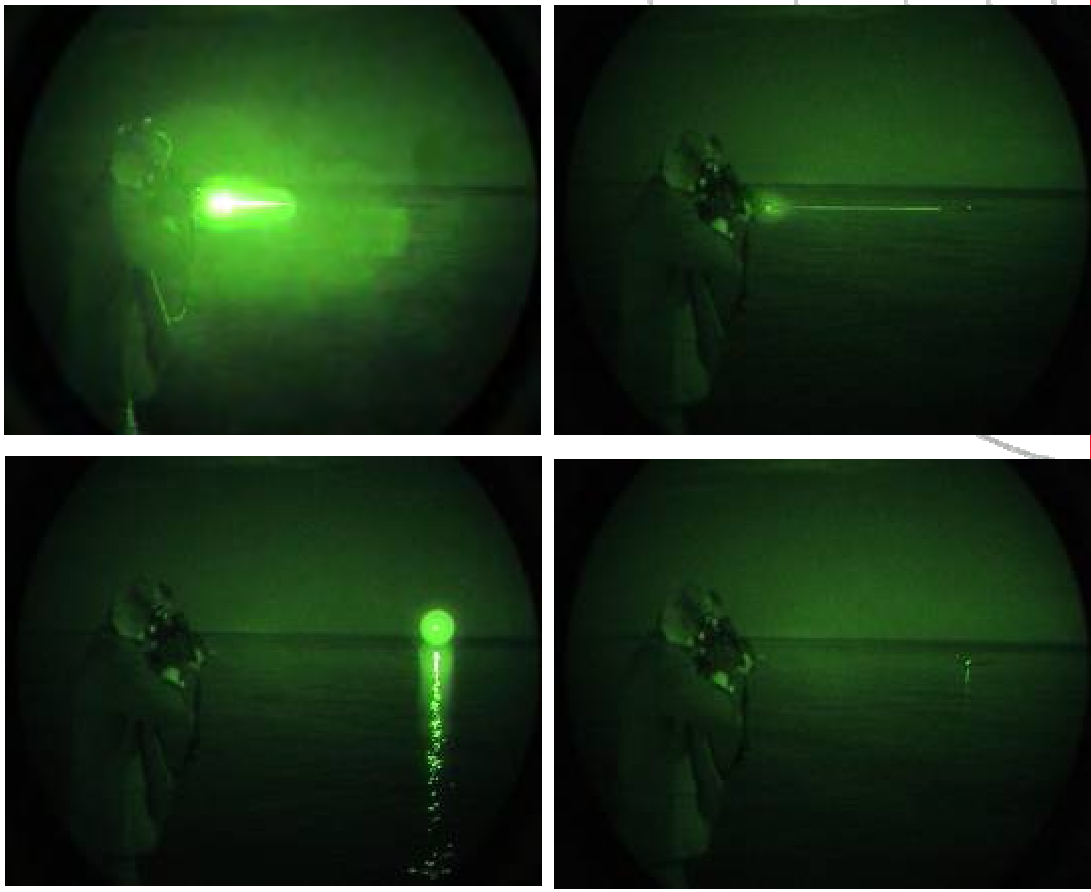
  for Tactical Use
- Dim Trace:

  Standard Trace and IR

  100m at target above water
- Green Ammo
- Lapua .338 High Precision

Standard trace

IR



PRECISION PEOPLE TECHNOLOGY

Getting On Target – Sniper Grade

- Enhancing Performance of the

  AMR for MP, AP-S and SG
- By improving all Components
- Our Goal:

  Better Dispersion than Grade A

PRECISION PEOPLE TECHNOLOGY

Nammo

The 12,7mm Family – Mk 211 MP and others

PRECISION PEOPLE TECHNOLOGY

Nammo

Medium & Large Caliber Solutions

- MK 211
- Apex
- 30mm for Infantry vehicles

  40mmx53HE MK285

  Programmable Airburst

2

- RA79
- Artillery and Mortars:

  From 120mm IMHE to 155mm artillery

3

PRECISION PEOPLE TECHNOLOGY

Shoulder Fired Solutions

- M72 ASM 4
- M72 EC
- M72 FFE
- BDM
- SMAW II 5

PRECISION PEOPLE TECHNOLOGY

Missile Products Solutions

- State of the Art Solid Fuel Rocket Motors
- Tail End Control Technologies to take the Missile outside the Aerodynamic Flight Envelope by using:
  - Thrust Vector Control
  - Jet Flap Technology
  - Nozzle Technology
- Example: Exocet Block II Booster

Important Present and Future Programs

- FCT
- APEX
- AMRAAM
- SL IRIS-T

PRECISION PEOPLE TECHNOLOGY

Nammo

Foreign Comparative Testing

What Makes Foreign Companies Successful in FCT?

- Advocating presence in the United States
- Good relationship with the US Embassy Office of Defense Cooperation
- Strong capabilities that fulfill the needs of the US Warfighters
- If successful a great marketing tool

PRECISION PEOPLE TECHNOLOGY

Important Present and Future Programs

- FCT
- APEX
- AMRAAM
- SL IRIS-T

PRECISION PEOPLE TECHNOLOGY

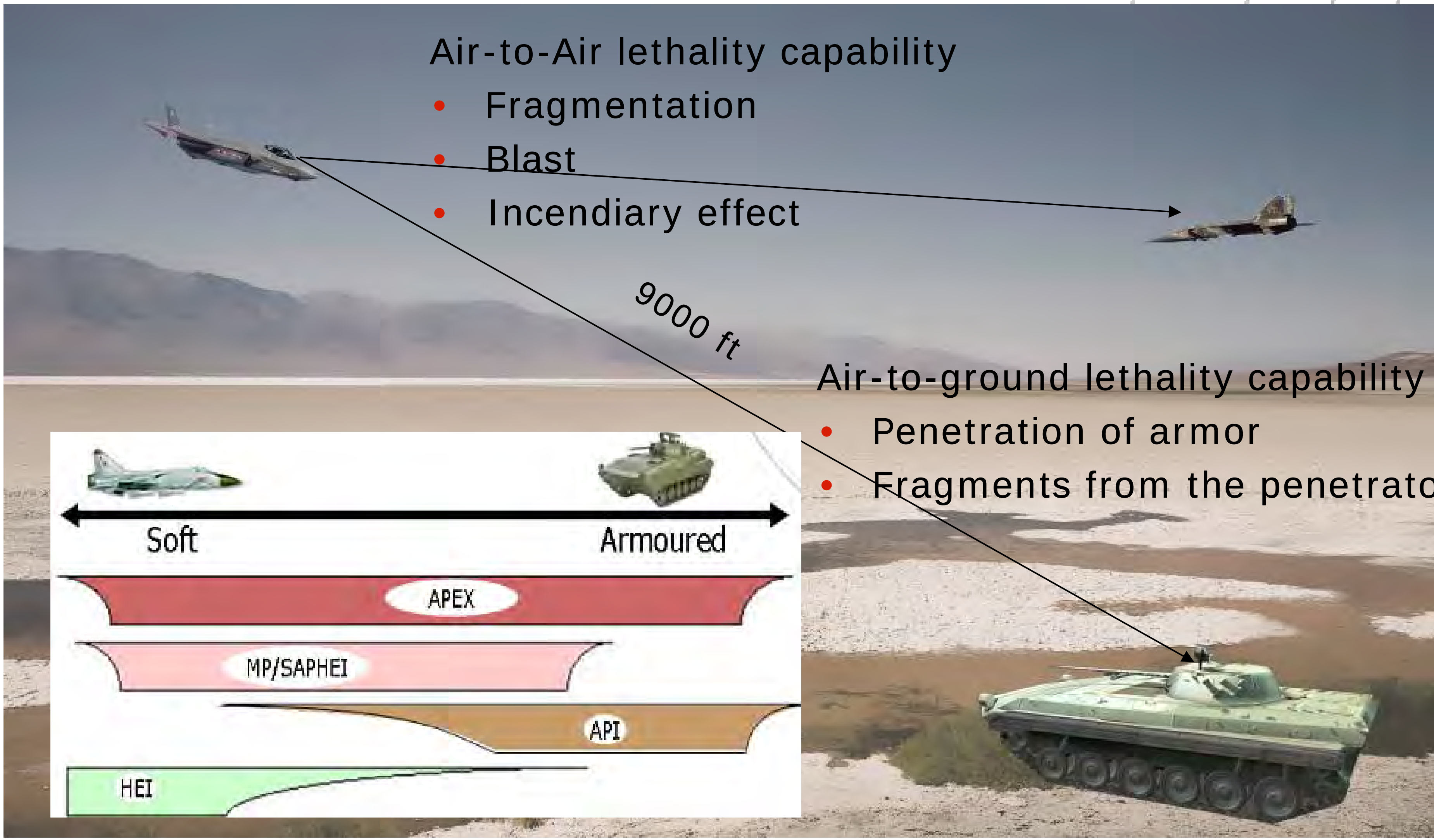
Nammo

APEX – Future Fighter Aircraft Ammunition

- Producer of ammunition in use on Norwegian F-16 Fighters and several other NATO-fighters
- New Fighter Aircraft
  - New Ammunition
- Unique capability
  - New Air-to-Air and Air-to-Ground Capacity
- The Norwegian MoD is funding the development and qualification of the APEX Aircraft Ammunition

PRECISION PEOPLE TECHNOLOGY

APEX – The Multi Role Dual Purpose Round



Important Present and Future Programs

- FCT
- APEX
- AMRAAM
- SL IRIS-T

PRECISION PEOPLE TECHNOLOGY

Second Source on the AMRAAM Program

- Selected by Raytheon to qualify an alternative rocket motor for the AIM-120 Advanced Medium Range Air-to-Air Missile
- Shared financing by USAF, the Norwegian MoD, Innovation Norway, Raytheon and NAMMO
- In use by 36 countries
- Integrated on the F-16, F-15, F/A-18, F-22, Typhoon, Gripen, Tornado, Harrier, F-4, and the F35 JSF aircraft

PRECISION PEOPLE TECHNOLOGY

Nammo

Important Present and Future Programs

- FCT
- APEX
- AMRAAM
- SL IRIS-T

PRECISION PEOPLE TECHNOLOGY

IRIS-T SL

- Optimizing an Air-to-Air Missile for Surface Launched Missions
- Reduced Smoke
- Introducing Composite Motor Case
- Further improved Tail End Control
  – in this case TVC

PRECISION PEOPLE TECHNOLOGY

Nammo

Nammo's # 1 Priority

- The Warfighter
- Because all our Warfighters deserve the World's Best Capabilities

Securing the Future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– ”FREEDOM TRAILS” –
MISSION PERFORMANCE SYMPOSIUM
XIIth MP Symposium, 14-15 June 2011, Raufoss, Norway

Join us at Nammo's Booth # 411
in the Exhibition Hall

Nammo

Thank you so much for your attention!

Edgar Fossheim

President & CEO

Nammo AS

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+47 6115 3600

info@nammo.com

PRECISION PEOPLE TECHNOLOGY

Nammo

APKWS II Update

Joint Armaments Conference

Sponsored by NDIA

LCDR Nick "Waco" Green
Deputy Program Manager, PMA-242
22 May 2010

Distribution Statement A: Approved for Public Release; distribution is unlimited.

Advanced Precision Kill Weapon System II (APKWS II)

- APKWS is a Semi-Active Laser (SAL) guidance kit added to current 2.75-inch rocket motors and warheads

- Low cost, low collateral damage and minimal
  integration

- Accurate: <1 meter CEP in Operational Assessment

- Status: Successful DT/OA
  - 19/21 direct hits
  - 1 miss due to multiple laser spots
  - 1 miss due to degraded laser signal

- Increased Kills/Sortie: 14 - 38 per sortie

- Initial Operational Capability 3rd Qtr FY11

Low Cost, High Precision, Low Collateral Damage for Irregular Warfare

Aviation Operational Need

Unguided Rocket (1-6 km)
- Area Suppression
- Illumination
- Obscuration
- Marking

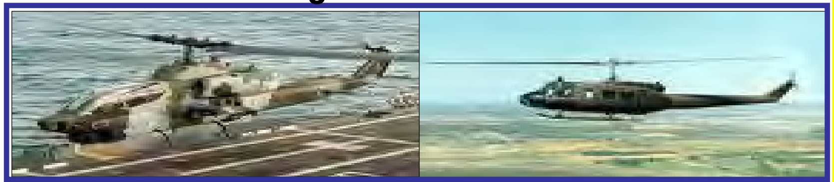
Guided Rocket (1.5-5+ km)
- Precision Engagement
- Soft Targets

Hellfire Missile (1-8 km)
- Anti-Armor

APKWS II Weapons System Overview

LAUNCH PLATFORM

Program of Record



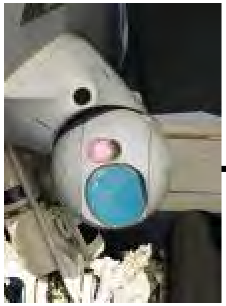
Joint Capabilities Tech Demo

Legacy Launchers
USN / USMC - LAU-61 / LAU-68
USAF - LAU-131
USA - M260 / M261

LASER SOURCE

NTS

GLD



FLIR

APKWS II

APKWS Comparison

WGU-59/B APKWS II

Length	73.8 inches
Weight	32 lbs
Diameter	2.792 inches (max @ bourrelet)
Longitudinal CG	41.39 inches
Lateral CG	0.001 inches

Features	*Unguided 2.75-inch*	*APKWS II*
MK-66 Mod 4 RM	*X*	*X*
M151/MK152 WH	*X*	*X*
Point Detonating Fuze	*X*	*X*
LAU-61/LAU-68 Launcher	*X*	*X*
PA-92 Shipping & Storage Container	*X*	*X*
SAL Guidance Section		*X*

Unguided 2.75-inch rocket

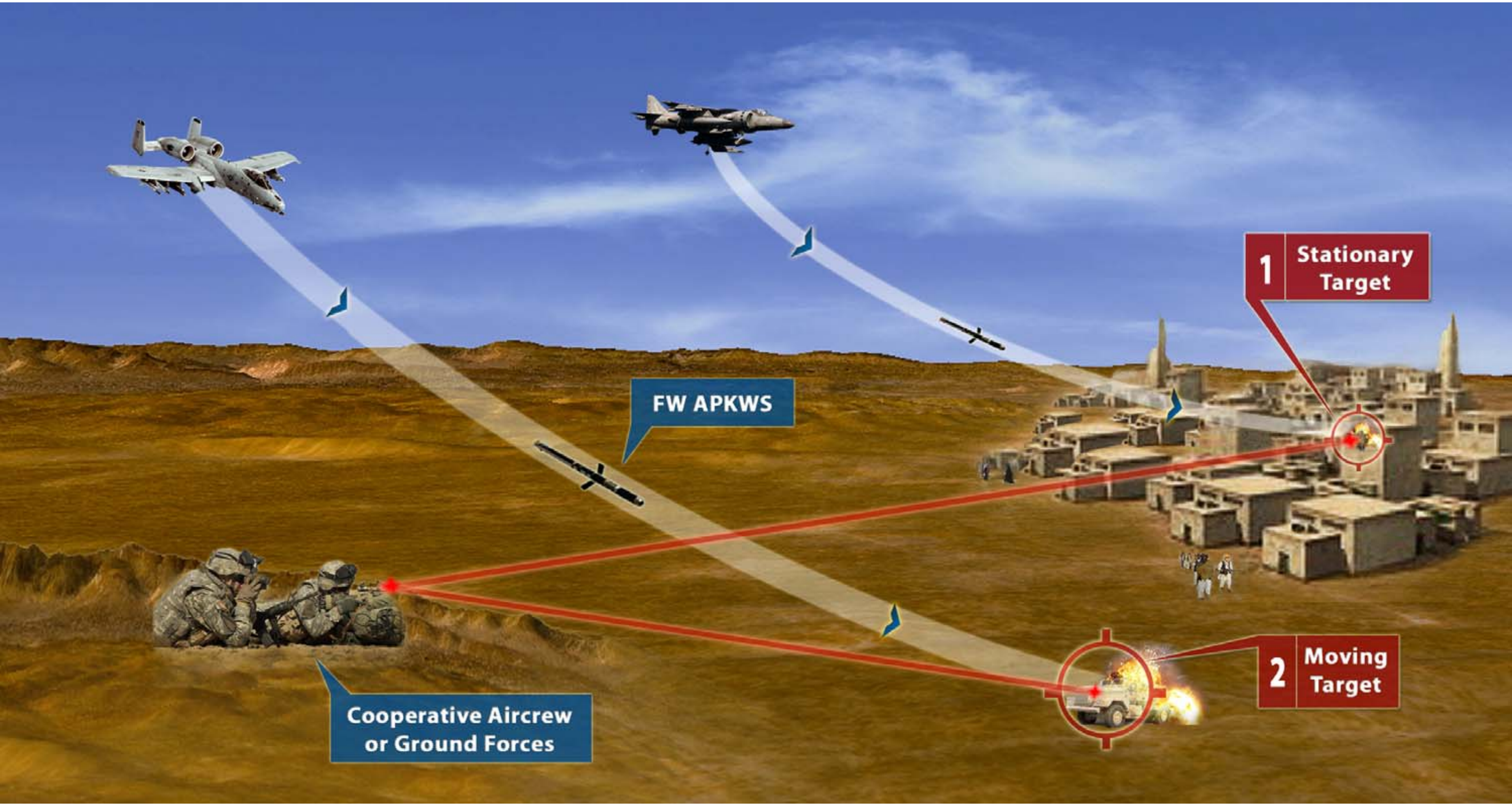
Length	55.3 inches
Weight	23 lbs
Diameter	2.792 inches (max @ bourrelet)
Longitudinal CG	29.92 inches
Lateral CG	0.001 inches

LAU-61C/A Launcher

PA92 SSC

Distribution Statement A: Approved for Public Release; distribution is unlimited. NAVAIRSYSCOM #10-719

Concept of Operations



Distribution Statement A: Approved for Public Release; distribution is unlimited. NAVAIRSYSCOM #10-719

Key Performance Parameters

KPP	Demonstrated	Rotary Wing		Fixed Wing	
		Threshold	Objective	Threshold	Objective
Max Range	5000 meters	5,000 meters	8,000 meters	11,000 meters	16,000 meters
Min Range	1500 meters	1500 meters	500 meters	2,000 meters	<2,000 meters
Prob (H/S) within 2 meters of laser spot	0.95	≥0.80	>0.99	≥0.80	>0.99
System Reliability[1]	0.86	≥0.86	≥0.99	≥0.86	≥0.99

Note 1: System Reliability (0.86) is defined as the guided reliability (0.95) x warhead reliability (0.91) x motor reliability (0.99) given the presence of a firing impulse

Test Results

Safe Separation (August 2009)

Developmental Test (November 2009–January 2010)

- 13 test shots
- 5 for 5 direct hits on 05 JAN 10

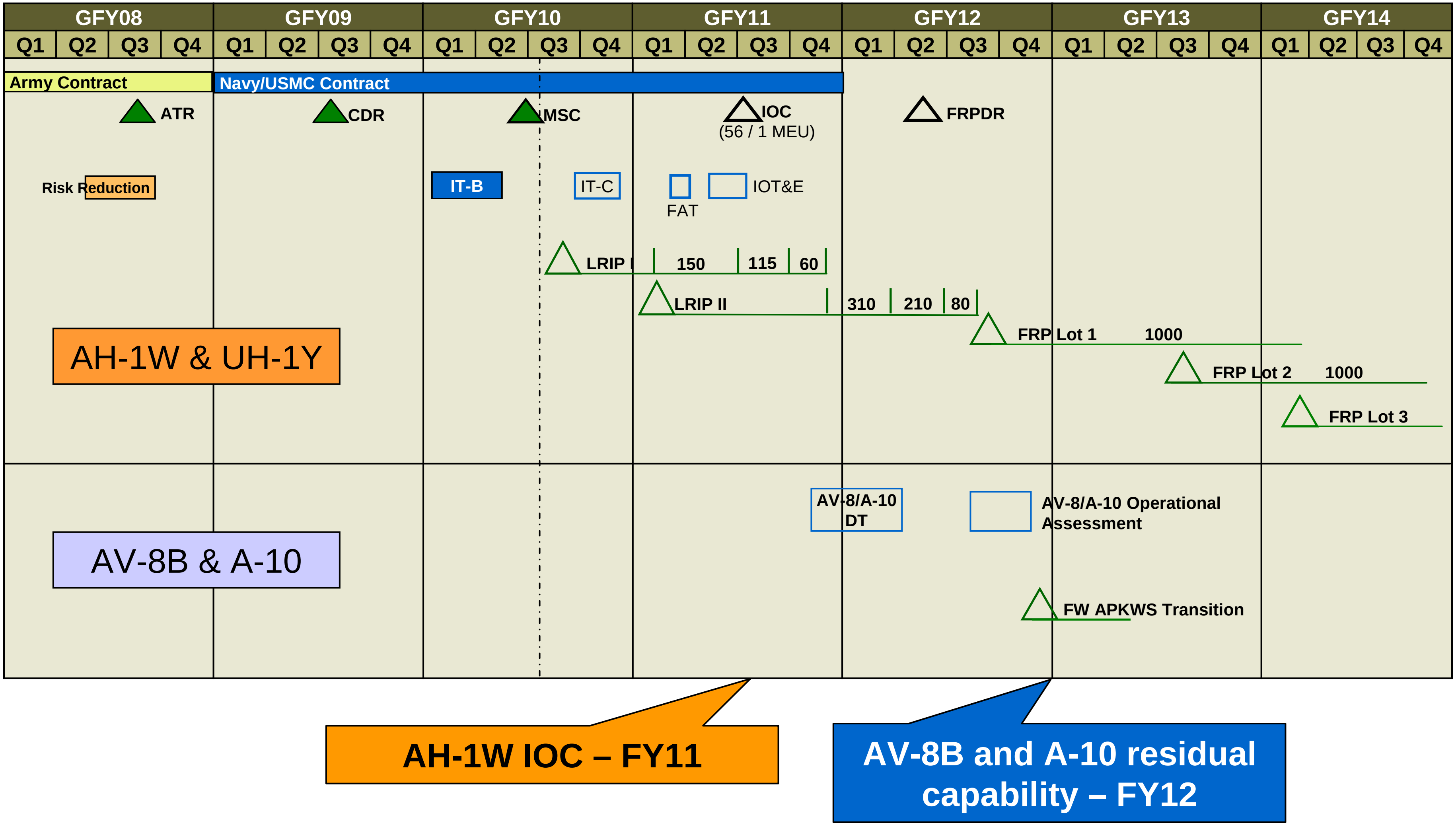
Operational Assessment (January 2010)

- 8 shots against operationally representative targets
- 7 of 8 used M151 HE 10 lb warheads

Average laser spot to impact point distance for all government test shots is

0.47 meters or 1.5 feet

APKWS II Program of Record and FW JCTD Schedule



Innovation ... Delivered.

Demonstration and Validation for Lead Free Ballistic Modifier for Rocket Propellants

Sarah A. Headrick, PhD and Shawn Osborn, PhD, ATK
Larry Warren and Darren Thompson, AMRDEC
Stephen Stiles, NSWC/IH

Lead in Military Applications

- **Double-Base (DB) Rocket Propellants: Cast Cure and Extruded**
  - – Lead citrate is used in TOW, Hellfire and Chapparal launch motors
  - – LC-12-15 in NOSIH-AA-2 propellant for the 2.75 in rocket motor
  - – LC-12-6 in M36 propellant for the Javelin launch motor and other applications
- **Percussion Primers**
  - – Most percussion primers employ lead styphnate
- **Gun Propellants**
  - – Lead carbonate in BS NACO propellant
- **Bullets**
  - – Bullet cores traditionally made of lead

Lead widely used in military applications

2.75 Inch Rocket Background

- 1991 – 1993 Extruded Double Base (EDB) Lead-Free Study (Hercules, Inc)
  - Several candidates (RPD-308 and RPD-309) close to NOSIH-AA-2 requirements for strand burn rates (SBR)
- 1996 – 1998 Lead-Free Double Base Propellant Development (ATK and NSWC/IH)
  - Developed a viable candidate (RPD-422) that did not meet aging requirements
- 1998 – 2000 Accelerated Aging of Lead-Free Propellant (ATK and NSWC/IH)
  - Studied RPD-422 to determine cause of aging issues: identified the monobasic cupric salicylate as problematic
- 2001 – 2002 Coated and/or Pre-Reacted Lead-Free Ballistic Modifiers (ATK and NSWC/IH)
  - Attempted to improve RPD-422 aging through coating and pre-reacting modifiers
    - » No improvement

Introduction/Approach

- 2.75 inch rocket propellant NOSIH-AA2 presently contains LC-12-15, a lead containing ballistic modifier
- Lead is undesirable from an environmental and toxicity standpoint
  - Removal of lead from the rocket is imperative
- Our two-pronged approach is to optimize data obtained from past work
  - First prong: Improve aging on past programs
    - Several ATK studies conducted on 2.75 inch rocket programs
      - » Three formulations with excellent SBR data and unacceptable aging properties
  - Second prong: transfer cast-cure technology to extruded double-based
    - AMRDEC has developed lead-free cast cure formulations based on bismuth compounds
      - » Plan to transfer that technology to an extruded double base propellant

Performance Criteria for Lead Free DB Propellants

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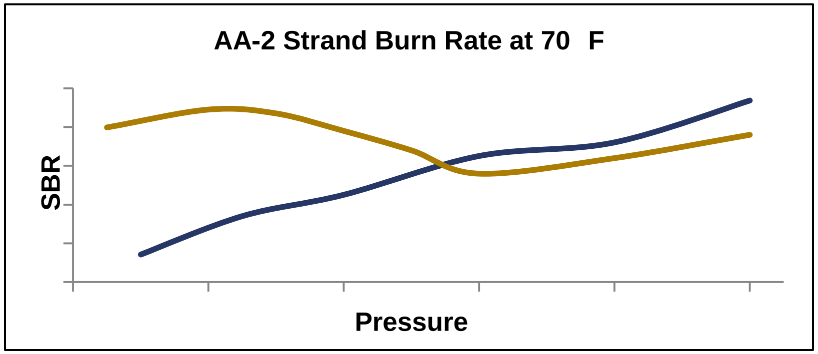
- **Ballistic Performance (Burn Rate)**
  - ✓ Plateau behavior over operating temperature range
  - ✓ Low temperature sensitivity
- **Propellant Aging Properties**
  - ✓ Must perform as well as or better than leaded ballistic modifiers
    - – Needs to retain as much as or more stabilizer upon aging than traditional
    - – Must retain plateau burn rate behavior after accelerated aging
    - – Must retain temperature sensitivity after accelerated aging



Several metrics for success

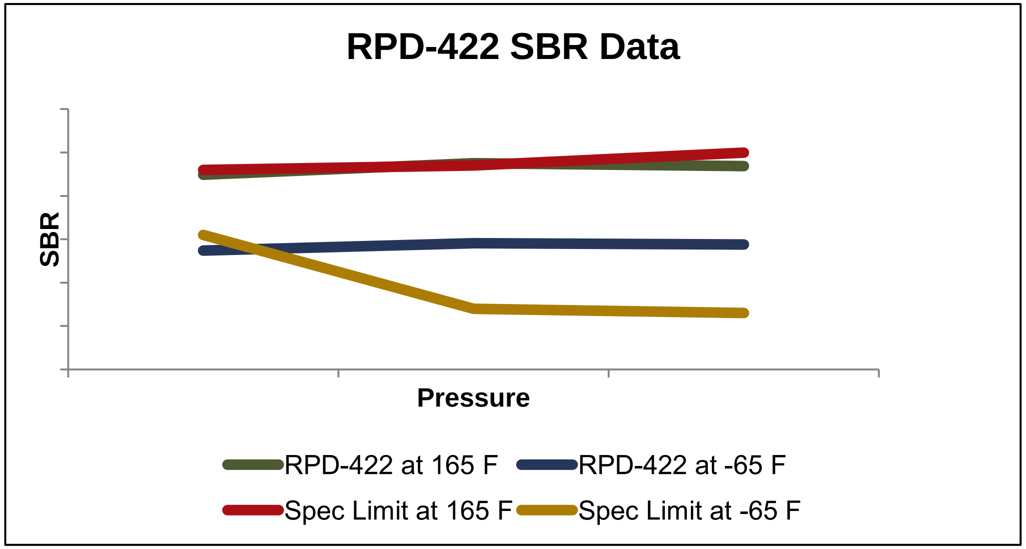
Status of Present ESTCP-Funded Program

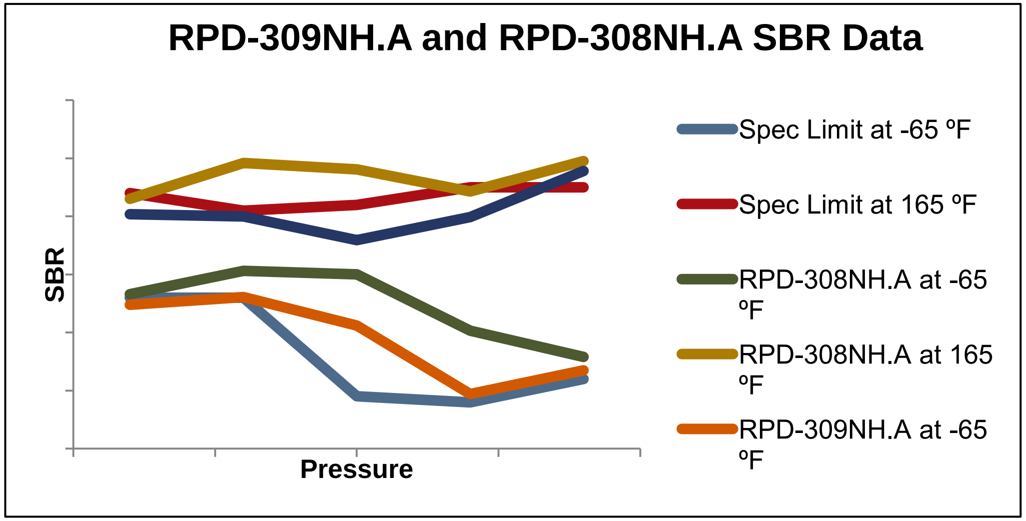
- **Evaluations Completed to Date**
  - ➢ Formulations developed to improve on earlier studies
    - – AMRDEC's cast-cure results
      - – Based on bismuth compounds
    - – ATK's Copper based formulations that performed well but aged poorly
      - − Attempted to improve aging properties

- **Results**
  - ➢ Attempts to improve aging properties proved unsuccessful
  - ➢ Formulation based on cast cure work showing promise
    - – Exhibits plateau behavior with respect to strand burn rate
    - – Excellent accelerated aging properties

Promising new lead free candidate

First Prong: Optimizing to Improve Aging

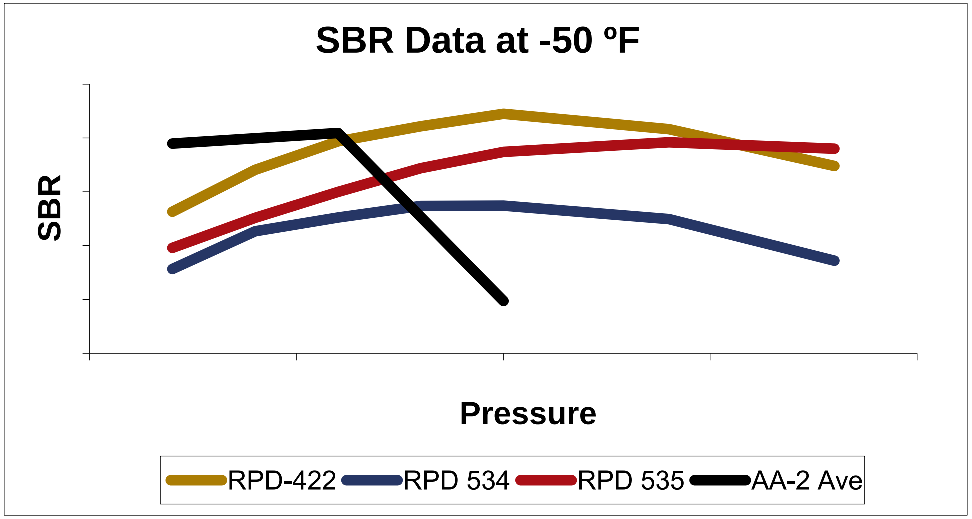


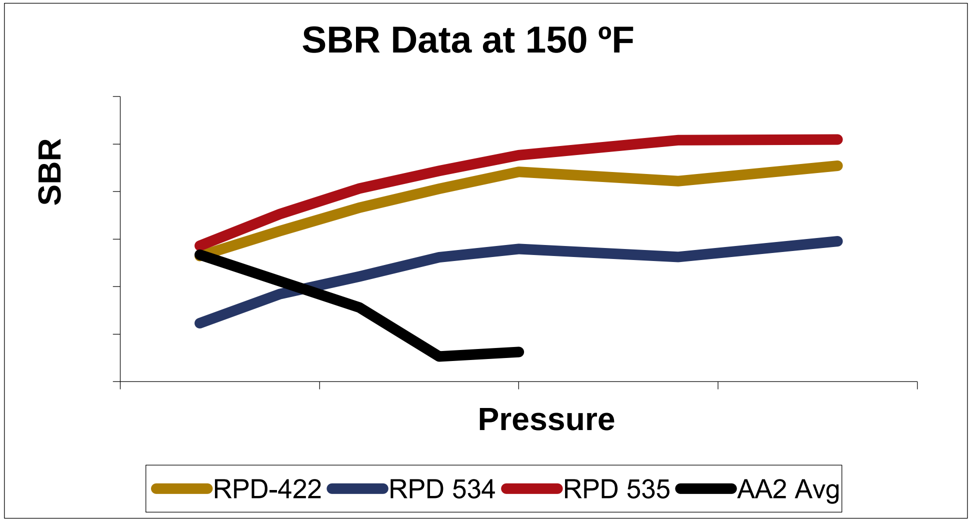


- Past studies yielded formulations with excellent SBRs and poor aging properties
- Formulations RPD-309NH.A, RPD-308NH.A and RPD-422 were modified in order to improve their aging properties
- All formulations were based on copper and bismuth compounds
- Previous data had indicated that monobasic copper (II) salicylate was causing aging problems for RPD-422

Excellent SBRs and unacceptable shelf-life

First Prong: Optimizing Aging of RPD-422





- RPD-534 identical in formulation to RPD-422 except a monobasic cupric salicylate was coated
    - Identical slopes to RPD-422 with lower SBRs
    - Lower SBRs expected due to addition of inert coating
- RPD-535 identical to RPD-422 except monobasic copper (II) salicylate was swapped out for copper (II) salicylate
    - SBRs for 535 were very similar to 422 as expected

Successful mimicking of RPD-422 ballistic modification

First Prong: Optimizing Aging of RPD-422

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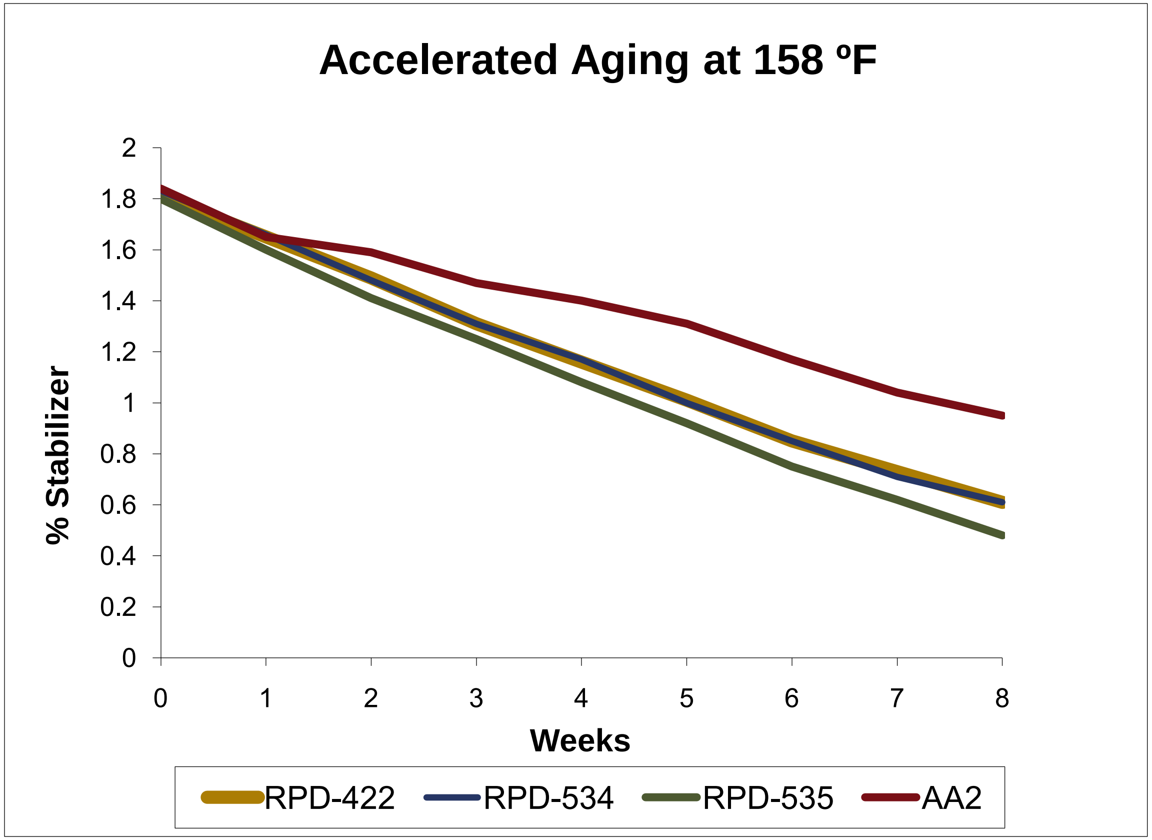
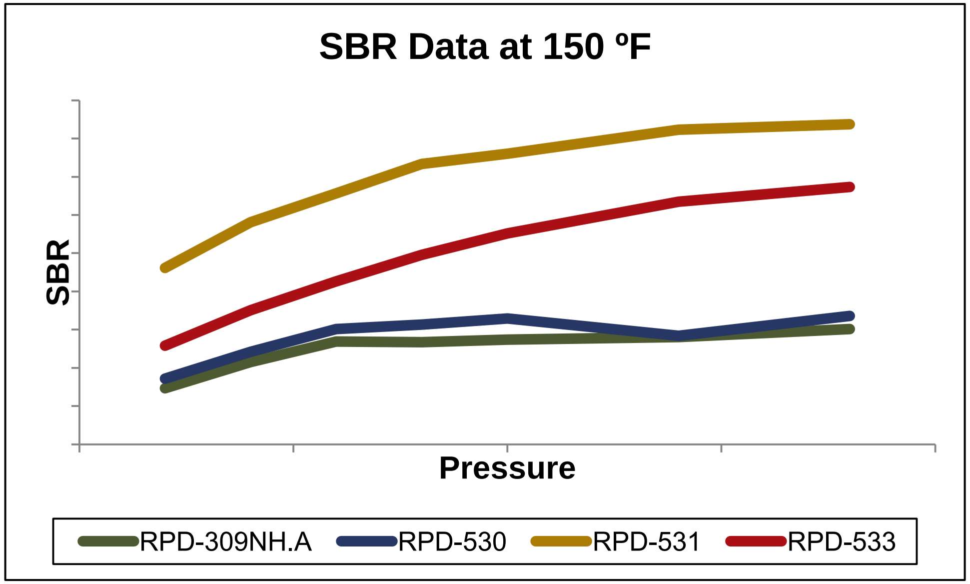
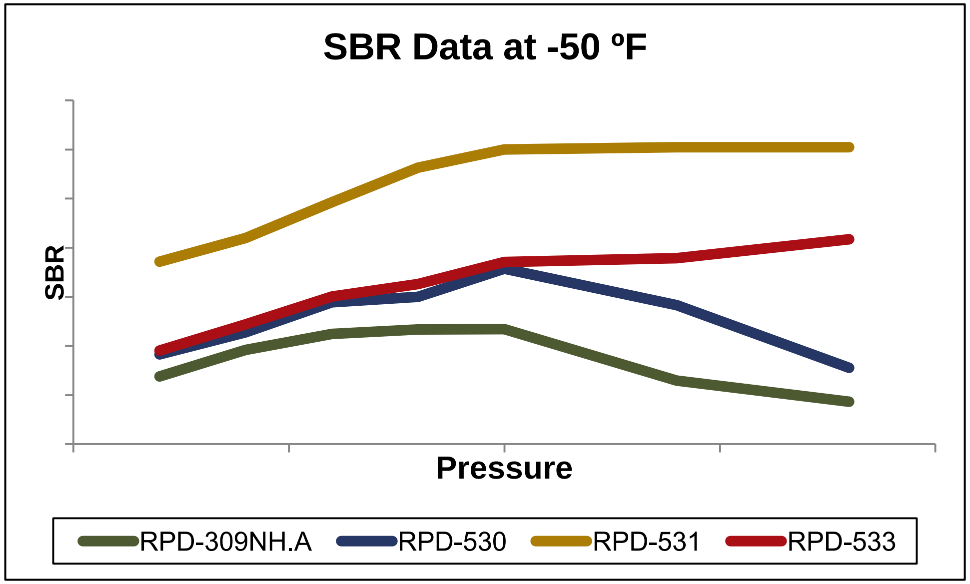


- RPD-422 and it's derivatives were subjected to an 8-week accelerated aging study
- Modifications to RPD-422 did not improve aging
- RPD-534 (coated modifier formulation) aged identically to RPD-422
- RPD-535 aged slightly worse than RPD-422

Efforts to Improve RPD-422 aging unsuccessful

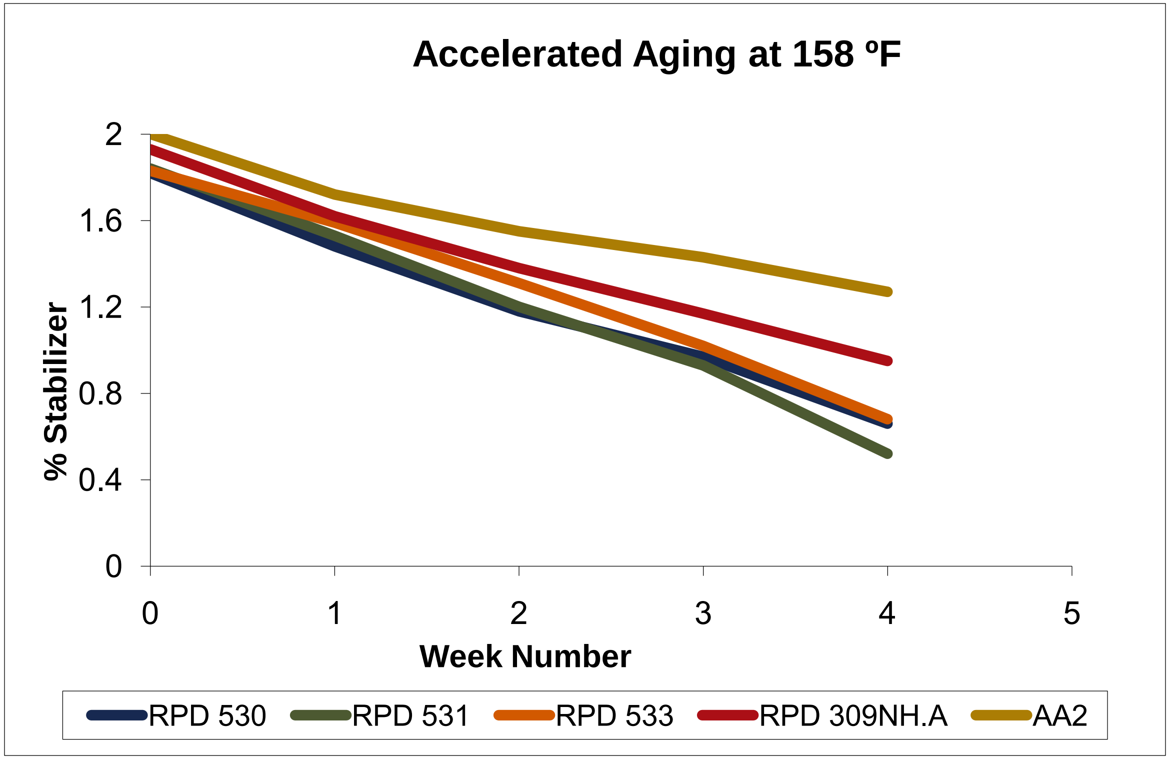
First Prong: Optimizing RPD-308NH.A and 309NH.A





- RPD-530 identical to RPD-309NH.A except copper and bismuth hydroxides were replaced with acetates
  - Performed very similarly to RPD-309NH.A
- RPD-531 identical to RPD-309NH.A except copper and bismuth hydroxides were replaced with oxides
  - Performed well in terms of slope but had increased burn rate over RPD-309NH.A
- RPD-533 identical to RPD-309NH.A except sodium bicarbonate (present in small amount) was removed
  - Acceptable performance in terms of slope, higher burn rate at hot temperature

First Prong: Optimizing RPD-308NH.A and 309NH.A



- Data showed that no formulations aged similarly or better than AA-2
- Aging study was discontinued at 4 weeks due the unacceptable aging results

Efforts to Improve RPD-309NH.A and 308NH.A aging unsuccessful

Second Prong: Strand Burn Rates of RPD-517

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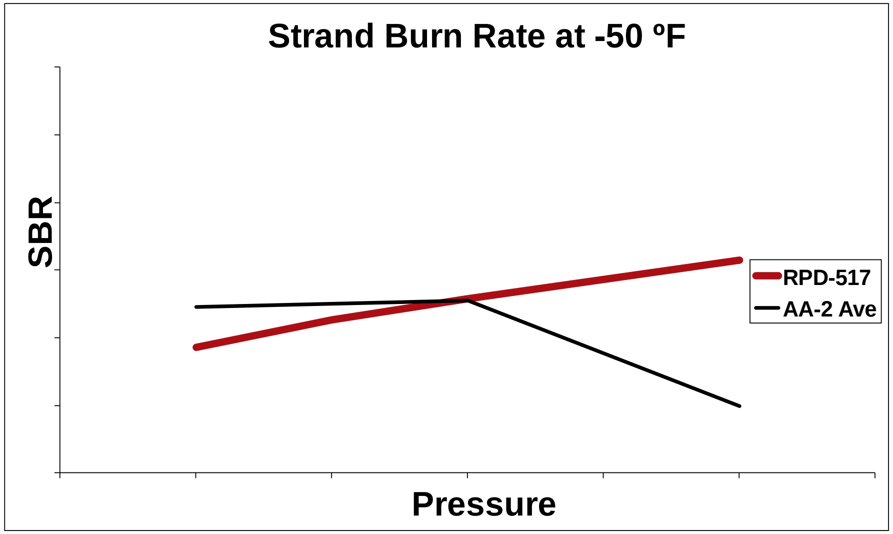

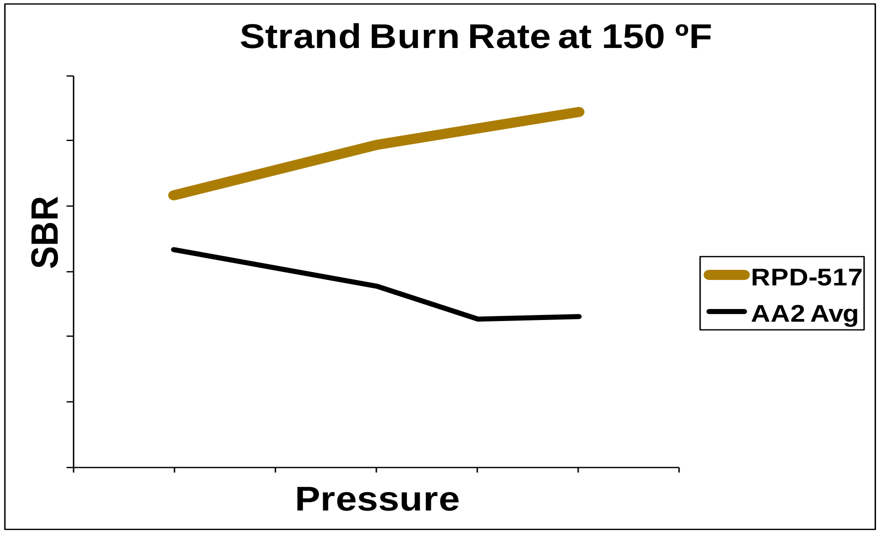

- Modifier matrix based on work conducted at ABL on cast cure propellants
  - Bismuth based modifier system
- Fairly flat slopes at both high and low temperature
- Burn rate at low pressure is low
- Chosen for further optimization

RPD-517 shows promise

Second Prong: RPD-517 Aging Study Results

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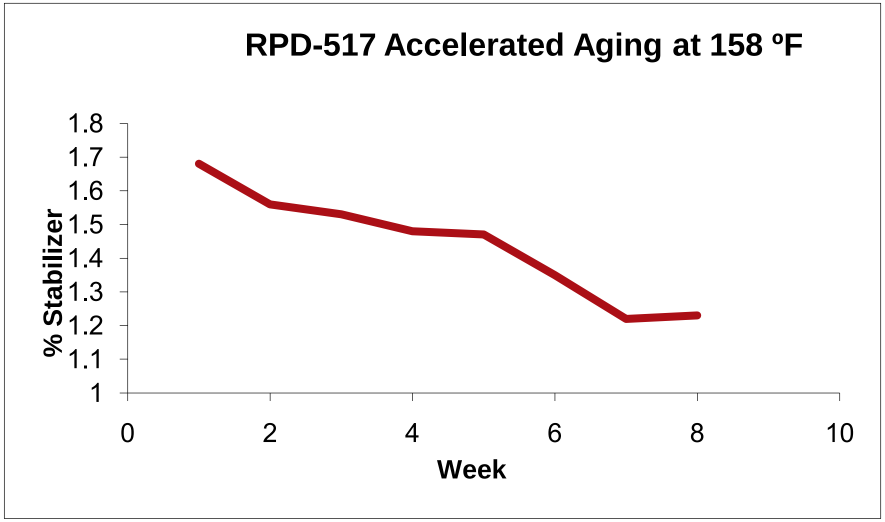
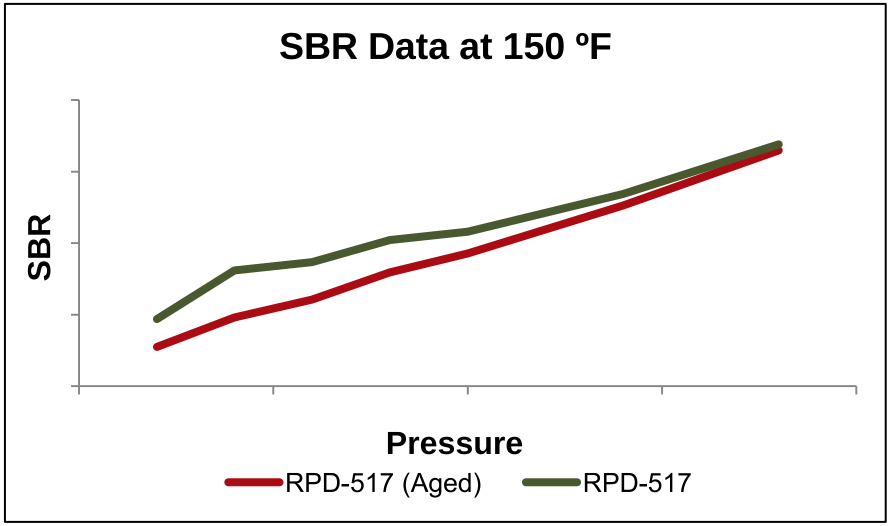
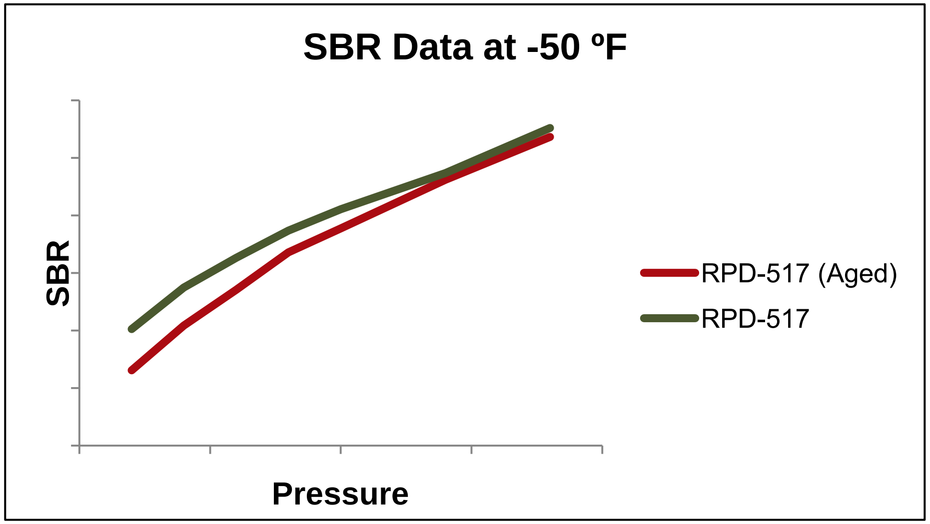


- RPD-517 lost 27% of its stabilizer after 8 weeks of aging
  - The presently used NOSIH-AA-2 propellant loses 50%
- RPD-517's SBR data before and after aging virtually the same

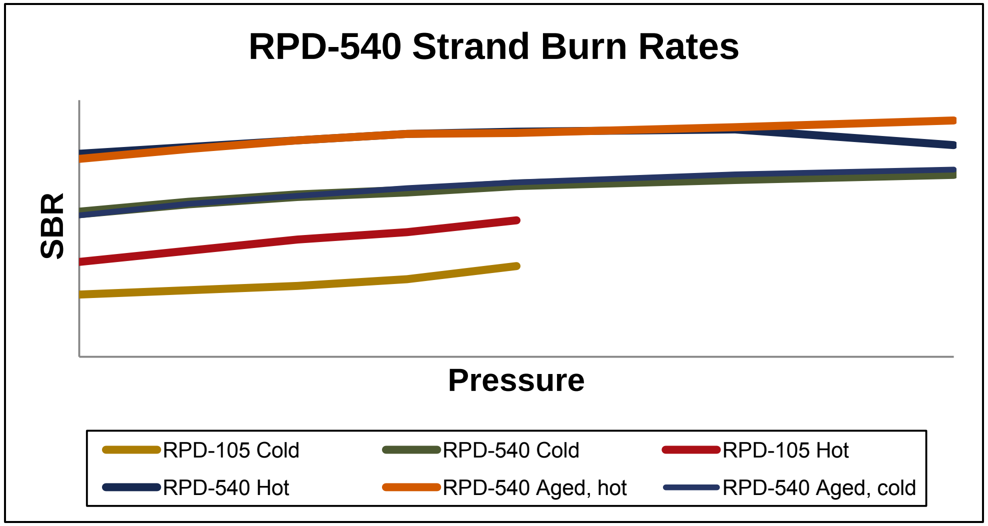


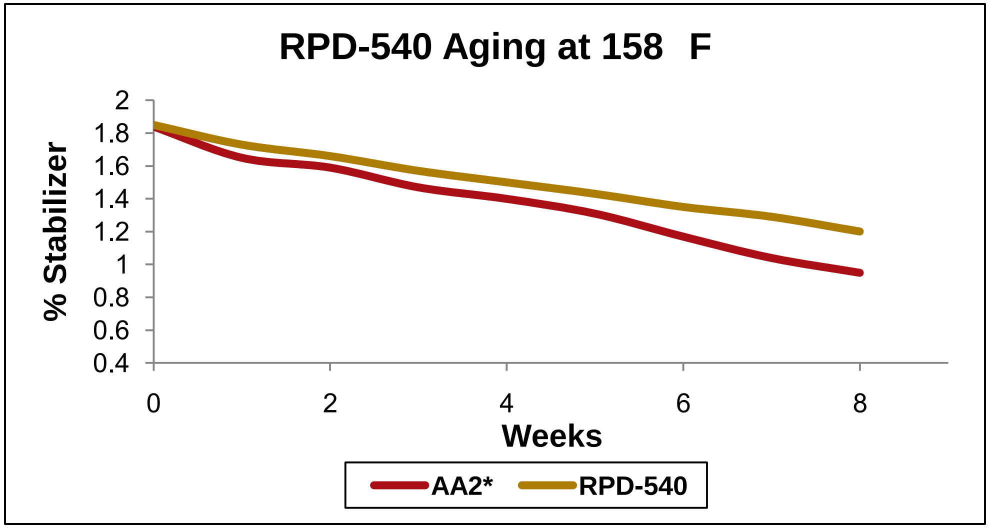


RPD-517 retains 46% more stabilizer than AA-2 in aging studies

Second Prong: Optimization of RPD-517

- RPD-540 exhibits the required strand burn rate (SBR) plateau behavior
- Retains SBR behavior after accelerated aging
- RPD-540 retains MORE stabilizer after accelerated aging than NOSIH-AA-2





Novel formulation improves aging over legacy

Summary

- A two-pronged approach was implemented to develop novel lead-free formulations
- First prong involved developing novel formulations aimed at improving aging characteristics of lead-free formulations that performed well in the past
  - Novel formulations did not achieve the desired goal
- Second prong involved applying successes from previous cast-cure work to EDB propellants
  - RPD-540, the most promising formulation, was developed using this approach
- Future plans are to static test RPD-540 heavy weight test configuration

Acknowledgements

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- **Kind thanks extended to:**
  - Larry Warren and Darren Thompson of AMRDEC
  - Stephen Stiles of NSWC/IH
  - Bruce Sartwell of ESTCP for funding
  - Dave Myers, Dr. Sandra Case, Jeremy Smith, Matt Rinehardt and Dr. Steve Ritchie of ATK for assistance in propellant manufacture

RDECOM

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT, & ENGINEERING CENTER (ARDEC)

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Dr. Barton Halpern

Joint Service Small Arms Program Futures (2012-2020)

Alternatives Strategy

19 May 2010

Bottom Line up Front

Our #1 initiative is the successful transition of technology for small arms related technology to PM Programs of Record

- Achieve this through a balanced portfolio strategy
- Focused on Capability Gaps as identified in the Joint Small Arms Capability Assessment and Army Small Arms Capability Based Analysis
- Focused on identified requirements from through the Joint Service Small Arms Master Plan
- Focused on leveraging :
  - Technology
  - Academia
  - Industry
  - Weapon concepts feasible for further research and development

Malcolm Baldrige National Quality Award 2007 Award Recipient

Why Do We Innovate?

Great Inventions & Technical Achievements over the last 20 years

DVDs (1995)

Video Telephone (1992)

Http and Html (1990)

Digital Answering Machine (1991)

Hulu.com (2008)

You Tube (2005)

DIRECT TV (1994)

Pentium Processor (1993)

Blue tooth Headset (2007)

The iPhone (2007)

RDECOM

Great Inventions & Technical Achievements over the last 20 years for Small Arms from JSSAP

- Picatinny Rail
- Modular Accessory Shotgun (MASS)
- M118 Long Range Sniper Cartridge)
- OICW – XM25
- XM307 (25mm Air Bursting)
- M430 A1 40mm Grenade Cartridge
- OCSW – XM806
- 7.62mm Steel Cased Ammunition)
- Micro Electro Mechanical System (MEMS)
- Small Green Ammo – M9

Malcolm Baldrige National Quality Award 2007 Award Recipient

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Joint Service Small Arms 2009 Futures Conference

Third Futures Conference held by JSSAP (1986, 2008, 2009)

Twenty scientists met at BATELLE from November 17 -19, 2009 to:

"provide a forum conductive to 'free thinking' in order to capture the thoughts and ideas of imaginative and creative people not necessarily prejudiced with current or past weapons development"

Objective of the conference was to identify alternative candidate futuristic weapons systems that would offer high-performance payoff related to:

1) Energy Usage
2) Target Effectiveness
3) Target Engagement.

….as related to small arms…

Focus Area: Energy

Energy: This concerns supplying power for the warfighter's individual weapon system that reduces the weight and resupply issues. Discussions were encouraged on better energy management methods including generation and conservation.

*** A successful implementation of an off-weapon power supply would:

Reduce cost	Increase efficiency
Eliminate of variance	Save soldier's lives
Increase OPTEMPO	Reduce risk on multiple levels
Reduce soldier load	Reduce environmental impacts

Barriers to solving this problem are?

- Power and energy density
- Transduction efficiency for transmission and harvesting
- Ability to mask transmission signature to enemy forces

Focus Area: Target Engagement

Target Engagement: Improving the warfighter's ability to engage the target. This includes better sighting, the ability for mass fires, and engaging Beyond Line of Sight (BLOS) and Non Line of Sight (NLOS) targets.

*** Successful target engagement solutions might include technology improvements in:

Wireless Sighting	Massed Fires
Fire and forget	Automatic target identification
Weapon networking	Highest possible accuracy

Barriers to solving this problem are?

- Lack of sensors for a small guidance system and seeker.
- Will need sensor fusion (combining the information from multiple sensors) to accurately locate the target's vulnerability
- Networking information to and from other sensors/soldiers in real-time.

Focus Area: Target Effectiveness

Target Effectiveness: Improving the effectiveness of any ordinance delivered on the target.

*** Successful target effectiveness solutions might include technology improvements in:

Scalable effects	Infinite ammunition
EMP pulses	Able to hit a target regardless of the weapon aim
Weapon networking	Diagnostic and prognostic indicators on the weapon

Barriers to solving this problem are?

- Weight
- Recoil
- Size / warhead
- Delivery system?
- Initiation is critical
- Difficult to define the target (e.g., type of door, density, wall)

Potential Identified Solutions

Focus Area	Possible Solution	Time Period
Energy Concepts	Offset power use by power harvesting/transmit / collect 2-4 watts from the soldier to the weapon to benchmark the technology to quantify the benefits, needs, requirements, impacts and trade-offs in order to reduce the weapon carry weight (load) carried by the soldier.	2012-2014: Demonstration / Benchmark Power Transmission and Consolidation 2015-2017 : Further refinement depends on the demonstration / baseline effort
Target Effectiveness	Door Breaching… Concept: Remotely (15-75 M away from the target) breech man-sized holes in walls (i.e., reinforced concrete) and doors from a small arms platform.	2012-2014: Each can occur during this timeframe or earlier
Target Effectiveness/ Engagement	Defeat the soldier of the future who is similarly armed, equipped and supported through Sensor fusion .	2012-2014: The basic components are available. What is lacking is the integration and over time the miniaturization that enables more sensors and more capable sensors.

Potential Identified Solutions

Focus Area	Possible Solution	Time Period
Target Engagement	SPIDER integrated sensor system for situational awareness sent to a scope with markers for friend, foe or unknown in the view as the weapon is panned (day/night, all weather) with targets in defilade or BLOS.	2012-2014: The basic components are available. What is lacking is the integration and over time the miniaturization that enables more sensors and more capable sensors.
Target Engagement	Ability to locate and identify hidden targets using a distributed sensor network delivered by a 40mm grenade and fed to a scope on the infantry weapon.	2012-2014: Each can occur during this timeframe or earlier

Potential Identified Solutions

Focus Area	Possible Solution	Time Period
Target Engagement	Take sensor information and display it on an individual soldier's rifle using a thermal or CCD image technology. The sensor information (e.g., range, azimuth to target) is being shared may also come from other sources such that there is greater situational awareness of where potential enemy threats are located.	2012-2014: Capability to collect and integrate information into the display , Digital "overlay" into the soldier's sight picture, Potential targets (friend and foe) 2015-2017 : Add tag and mark, CCD or thermal, Prioritization / engagement of targets – given current tactics / observers / military, etc. 2018-2020 : Add Virtual weapon & heads up display, Behavioral characteristic identification / target threat assessment

Next Steps

We want you as Industry members to push the envelope of technology as related to:

Become active in The National Small Arms Center (NSAC)

- FY11 Request for Project Proposal (Summer)
  - "DARPA-Style" Excellence Challenge
  - Next Generation Small Arms Systems – Looking for industry to develop concepts for the future "Small Arms Systems" for 2016 and beyond

Project Manager Maneuver Ammunition Systems

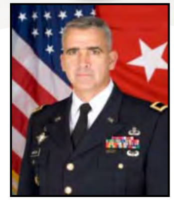
Direct Fire Outlook

PM MAS
Project Manager Maneuver Ammunition Systems
Reliable, Precise, Lethal

Chris Grassano
Project Manager

19 May 2010

PEO Ammunition Organization



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Be the best provider of conventional and leap-ahead munitions and counter improvised explosive device products by fostering innovation and diversity to increase the combat power of our Warfighters.

Project Managers

PM CAS Combat Ammunition Systems

Indirect Fire Munitions and Mortar Weapon Systems
- PM Mortars
- PM Excalibur

973-724-2003
john.scott.turner@us.army.mil

PM CCS Close Combat Systems

Close Battle Systems, Networked Munitions, and Force Protection
- PM Countermine & EOD
- PM Intelligent Munitions Sys
- PM IED Defeat/Protect Force

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raymond.nulk@us.army.mil

PM MAS Maneuver Ammunition Systems

Direct Fire Munitions
- PM Large Caliber
- PM Small & Medium Caliber
- PM Medium Cannon Caliber
- PD Non-Standard Ammo

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PD JS Joint Services

- Ammunition Industrial Base
- Ammunition Logistics
- Technology and Prototyping
- Demilitarization

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O/EDCA Executive Director Conventional Ammunition

- SMCA Assessment

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PD JP Joint Products

- Navy and Air Force Bombs & Energetics

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DISTRIBUTION STATEMENT A:
Distribution unlimited-Approved for Public Release

Single Manager for Conventional Ammunition

Project Manager
Maneuver Ammunition Systems

66 Products Managed

74 Products Managed

PM MAS Has 222 Products Under Mgmt.

11 Products Managed

44 Products Managed

Equipping US and Allied Warfighters with World Class Direct Fire Combat and Training Ammunition Through Strategic Life Cycle Management

PM-MAS Goals

Support Warfighters

- Maintain ammunition stocks
- Expedite ammunition delivery to theater as necessary
- Supply Allies with Standard and Non-Standard Ammo

Enhance Organic/Commercial Strategic Capabilities

- Transition of product items from other customers
- Modernization of facilities
- Avoid peaks and valleys in demand
- Expand sources of supply

Develop & Field Capability Improvements

- Lead Free Ammo
- Safety Improvements
- Target Effects
- Ground Combat Vehicle Support
- Next Generation 120mm KE
- 105mm Training Ammo

Roadmaps Keep Us Focused on Where We Want to Go

FY10 Accomplishments

Support Warfighters (OCO)

- Maintained Theater Assets at Needed Levels
- Continued Filling Stockpile to QWARRM Levels
- Meeting All FMS requirements for Coalition and Friendly Forces
- Executed UMR for 40mm IR Illumination (M992)

Enhance Organic/Commercial Strategic Capabilities

- Continue Modernization of LCAAP to Improve Product and Capacity
- Expanded Small Business Participation in Ammunition NTIB Production
- 30mm M789 Second Source Contract Awarded to GDOTS

Develop & Field Capability Improvements

Safety

- Small Cal Safer 5.56/7.62/.50/9mm Dummy, Drilled & Inert (DDI) in Depot
- 40mm M549A1 fuze replacement w/USMC
- 120mm Advanced Case System Design Concepts &Testing
- Awarded M14 Propellant Replacement Contracts to GDOTS and ATK

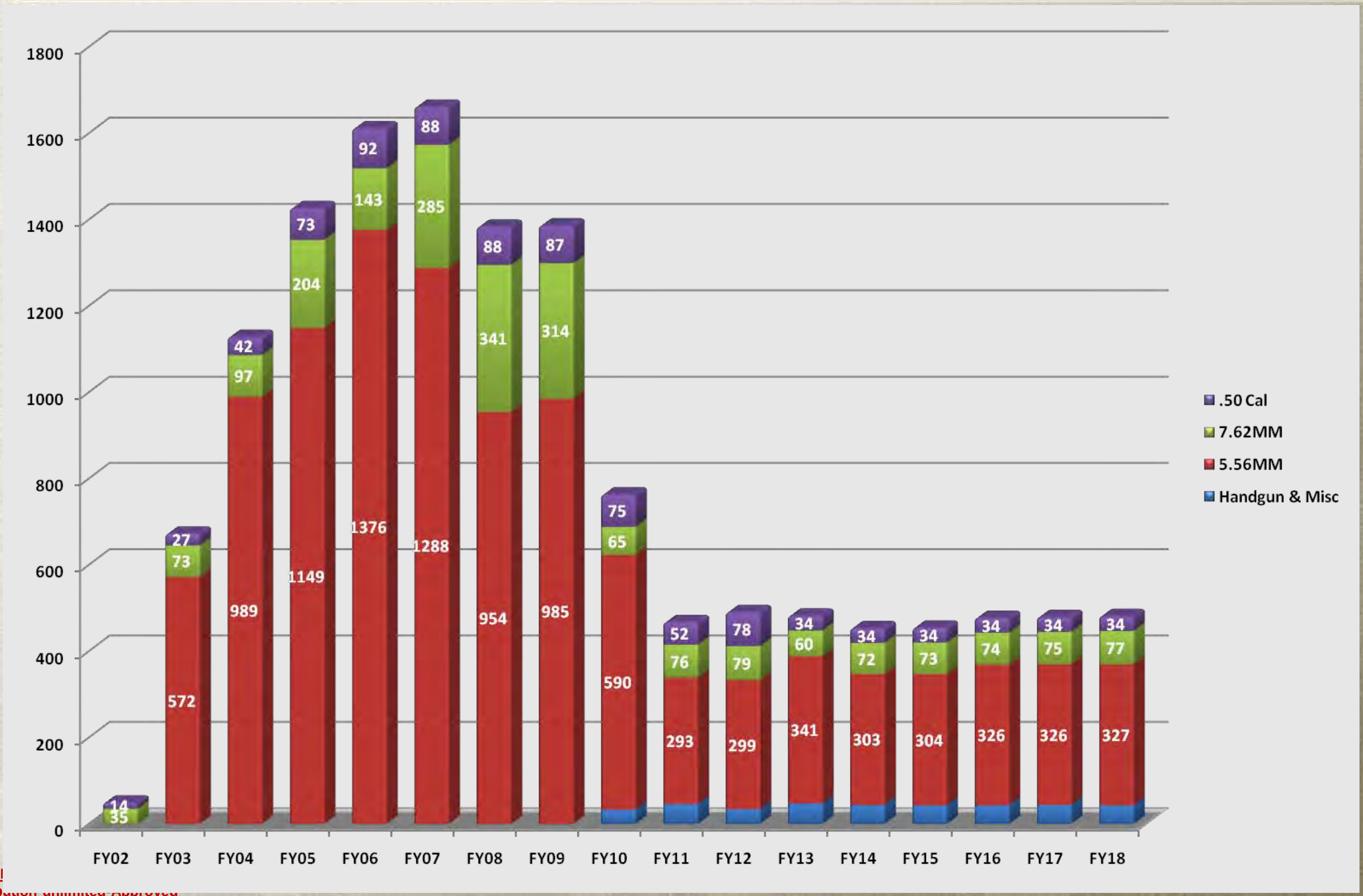
Perf QA

- M855A1 – Enhanced Performance & Environmental Stewardship
- M829E4 EMD Contract Awards to GDOTS & ATK
- Improved Packaging; Easier Warfighter Use and Cost Savings
- 30mm LW Flashtube and Propellant
- 40mm Pivot Coupling In Production

Working to Incorporate Evolutionary Advancements that improve Reliability, Lower Cost, Improve Safety and Grow Performance

Small Caliber Ammunition

Pres Bud



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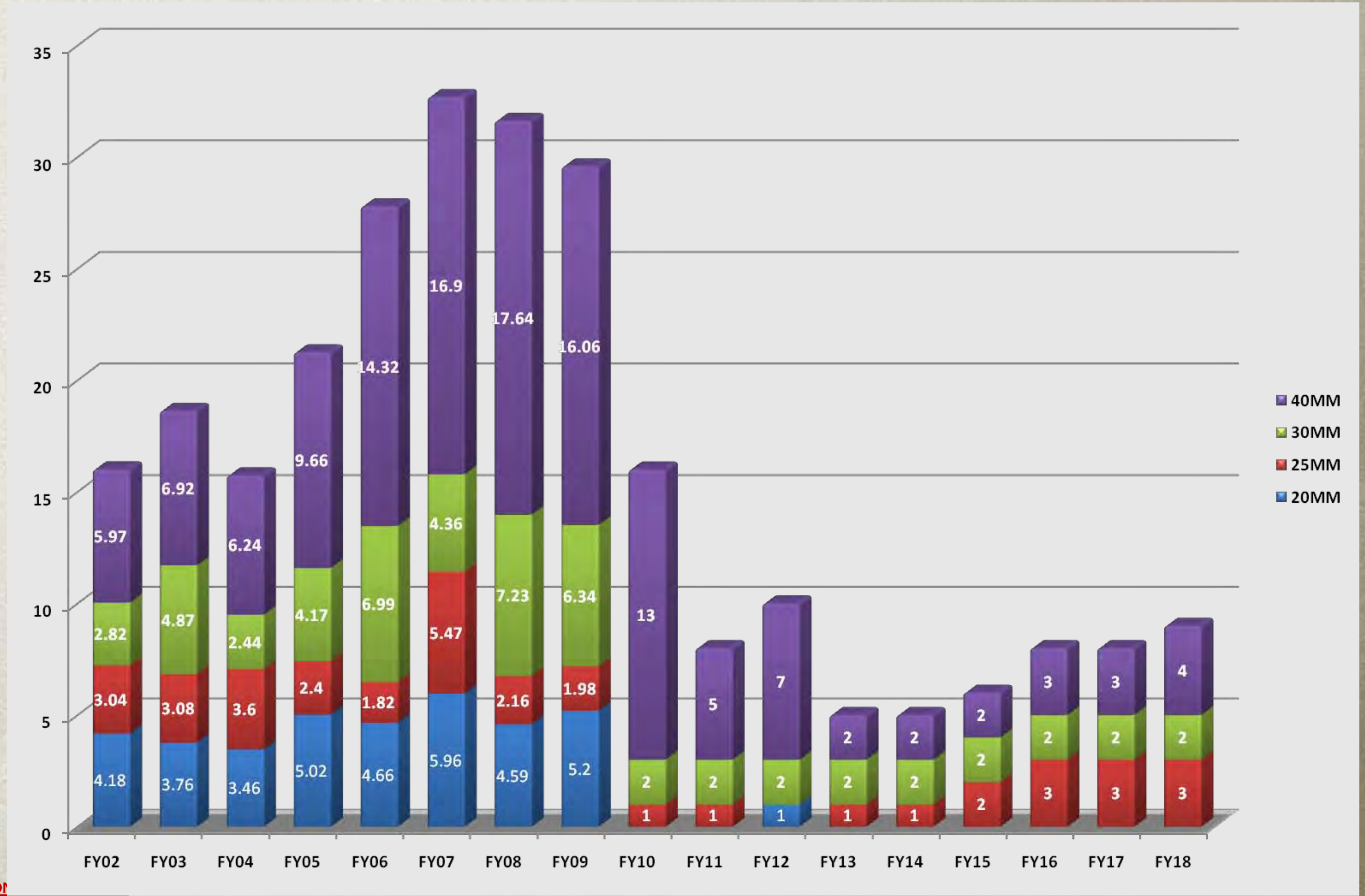
Medium Caliber Ammunition
Pres Bud



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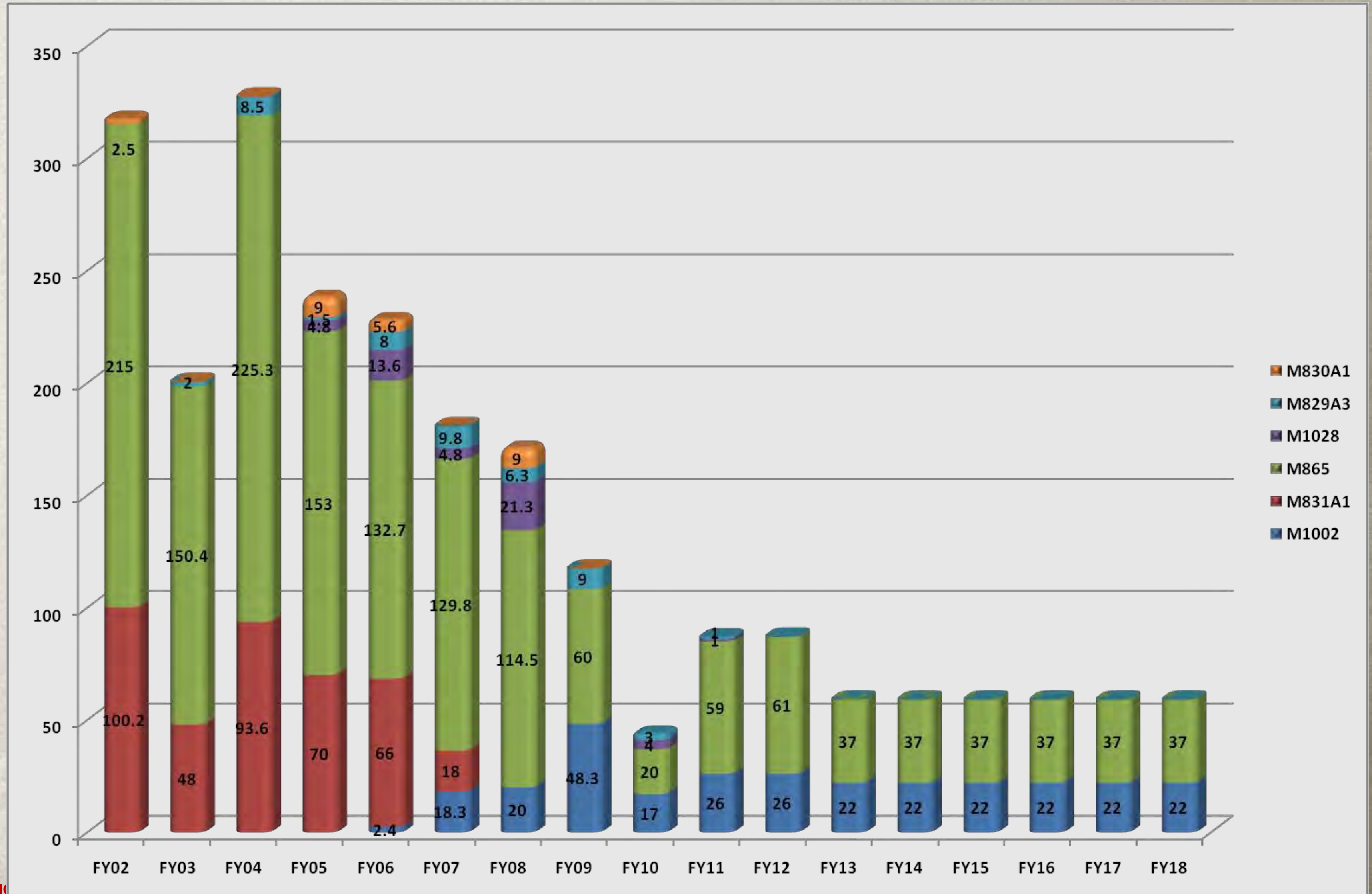
Large Caliber Ammunition

Pres Bud



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Warfigher Focused Team

Gov't – Industry – Academia Team has Performed Well!

Continued Team Effort is Required

- **Maintain Production:**
  - ✓ **Quality**
  - ✓ **Affordability**
  - ✓ **Competancies**
  - ✓ **Surge Capabilities**
- **Development:**
  - ✓ **Limited Resources**
  - ✓ **Mature Technologies**
  - ✓ **Cost/Benefit Analysis**
  - ✓ **What is Displaced**

NEXT: Briefs by Product Teams

- Small Caliber is continuing to modernize and enhance production and ammunition capabilities
- Medium Caliber continues to support other services, fill stockpile and support the Ground Combat Vehicle
- Large Caliber is developing the M829E4 and making safety improvements to current designs
- PM MAS has added Non-Standard Ammunition to its portfolio, which is expanding its customer base and its commodities

Steady Improvement in Products and Services

NSAC

INDUSTRY
ACADEME
GOVERNMENT

National Small Arms Center Update – A Look Back and A Look Forward

Frank P. Puzycki
Research Program Director
National Small Arms Center

Agenda

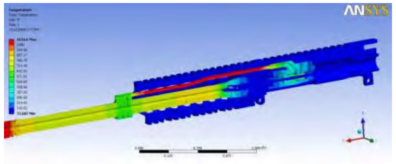
- A Look Back – 5 Years of Lessons-Learned
- A Look Forward
  - Growth/Change
  - Solicitations
  - Governance
  - Future Activities
- Conclusions

A Look Back

- Over $20 million dollars and 40 plus awards in fiscal years FY05 through FY09
- Four major "so-whats"
  - Lightweight Case Alternatives to Cartridge Brass
    - Polymer not yet ready
    - Stainless Steel as promising candidate
  - Tracker Projectile
    - University conceived/funded
    - War-fighter interest

A Look Back

- Thermal Modeling
  - Spawned from USMC IAR program
  - Multiple generations



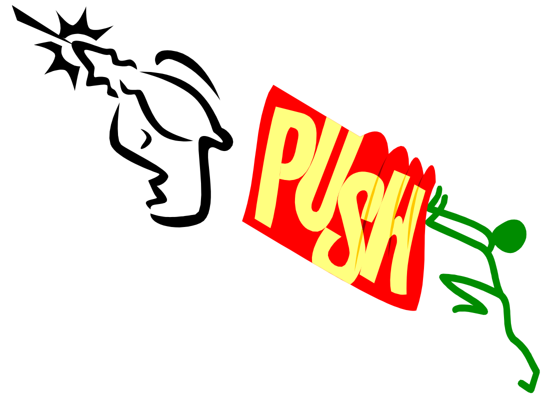
- Advanced Technology Objectives
  - Advanced Fire Control
  - Enhanced Lethality
  - *We now have a more informed sense of the state-of-the-art*

A Look Back

- Information Exchange
  - Member Meetings
    - Muddy Boots
    - Muddy Brains
    - Expert Subject Matter Speakers
    - National Labs
    - Congressional forums

" I belong to a few of these type associations but I get more "take-aways" from one of these meetings than I get from all of the other forums combined. You do a great job in executing these meetings!"

A Look Back



- Member Influences
  - Request for Business Development Proposals
  - PM Face-to-Face White Paper Briefs
  - Synchronization of Budget/Proposal Activity Scheduling.
  - White Paper Impacts on JSACA/CBA Structure
- Partnering
  - USAIC Sponsorship
  - NSATC-ARDEC CRADAs
  - Significant non-traditional member activity

A Look Forward - Growth

- Annual membership increases.
- Acquisition Function moved to the National Business Center, Department of Interior @ Fort Huachuca AZ
- Meeting venues and agendas expanded to encourage attendance and participation
  - Muddy Boots
  - National Labs
  - Muddy Brains

A Look Forward - Solicitations

- FY 10 White Paper Call
  - 29 Submissions
  - Top-Ten Presentation to PM community including multi-service audience
- FY10 Request for Project Proposals
  - 5 Submissions
  - Entire FY10 program obligated
- FY10 Request for Business Development Proposals
  - 19 Submissions
  - Connectivity to White Paper Process

A Look Forward - Solicitations

- FY10 Request for Project Proposals
  - 5 Submissions – all received awards
  - Award Status
    - Dindl Consulting: Non-lethal Breaching Munition ($148K)
    - AAI Corp: Advanced Fire Control Power and Information Management System ($309K)
    - AAI Corp: Combined Lethal and Non-lethal Munitions ($276K)
    - Dynamic Flow Form: Flowform of super alloys into Machine Gun Barrels ($682K)
    - AAI Corp: Enhanced Fragmentation for Small Arms Warheads ($360K)
    - Options for all of the above would total additional $10 M

Results suggest we have benchmarked Advanced Fire Control and Enhanced Lethality Technology Thrusts via three year survey

A Look Forward - Governance

- New Executive Committee Member Elections
- Disposition of Single Point Entity Decision

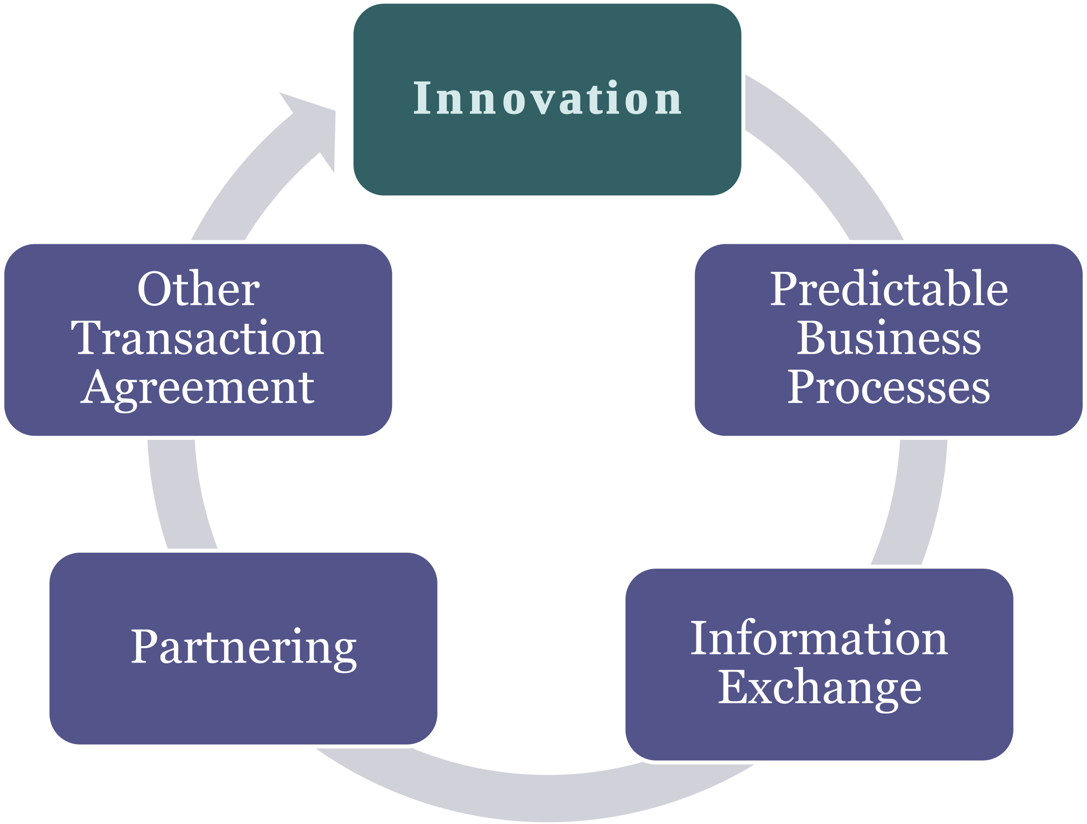
A Look Forward - Future Activities

- Semi Annual Meetings
  - Columbus Ohio: 22/23 June 2010
  - Columbus Georgia: December 2010 (tentative)
- FY11 Request for Project Proposal (Summer)
  - "DARPA-Style" Excellence Challenge – Next Generation Small Arms Systems
- FY 11 Call for White Papers (Summer)

Conclusions

- Second OTA underway
- Interim Acquisition Strategy places us back on track
- Member activity on the upswing
- Meeting content continues to mature
- First Five Year program provided USG with a realistic technology benchmark on Advanced Fire Control and Enhanced Lethality capability alternatives

The Bottom Line



Membership Information: www.nationalsmallarmscenter.org or call Ms. Barbara Byrnes at 703-212-8030, ext 223

Product Manager Small Caliber Ammunition

Small Caliber Ammunition

Enhancing Capabilities

(2010 NDIA Joint Armaments Conference)

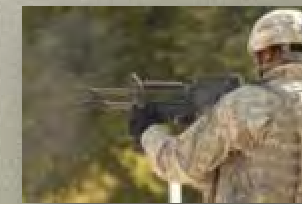
LTC Jeffrey Woods
Product Manager, Small and Medium Caliber Ammunition

20 May 2010

Small Caliber Portfolio

5.56MM, 7.62MM, 9MM, .50 CAL, SHOTSHELL

5.56mm



7.62mm

.50 Cal.

Agenda

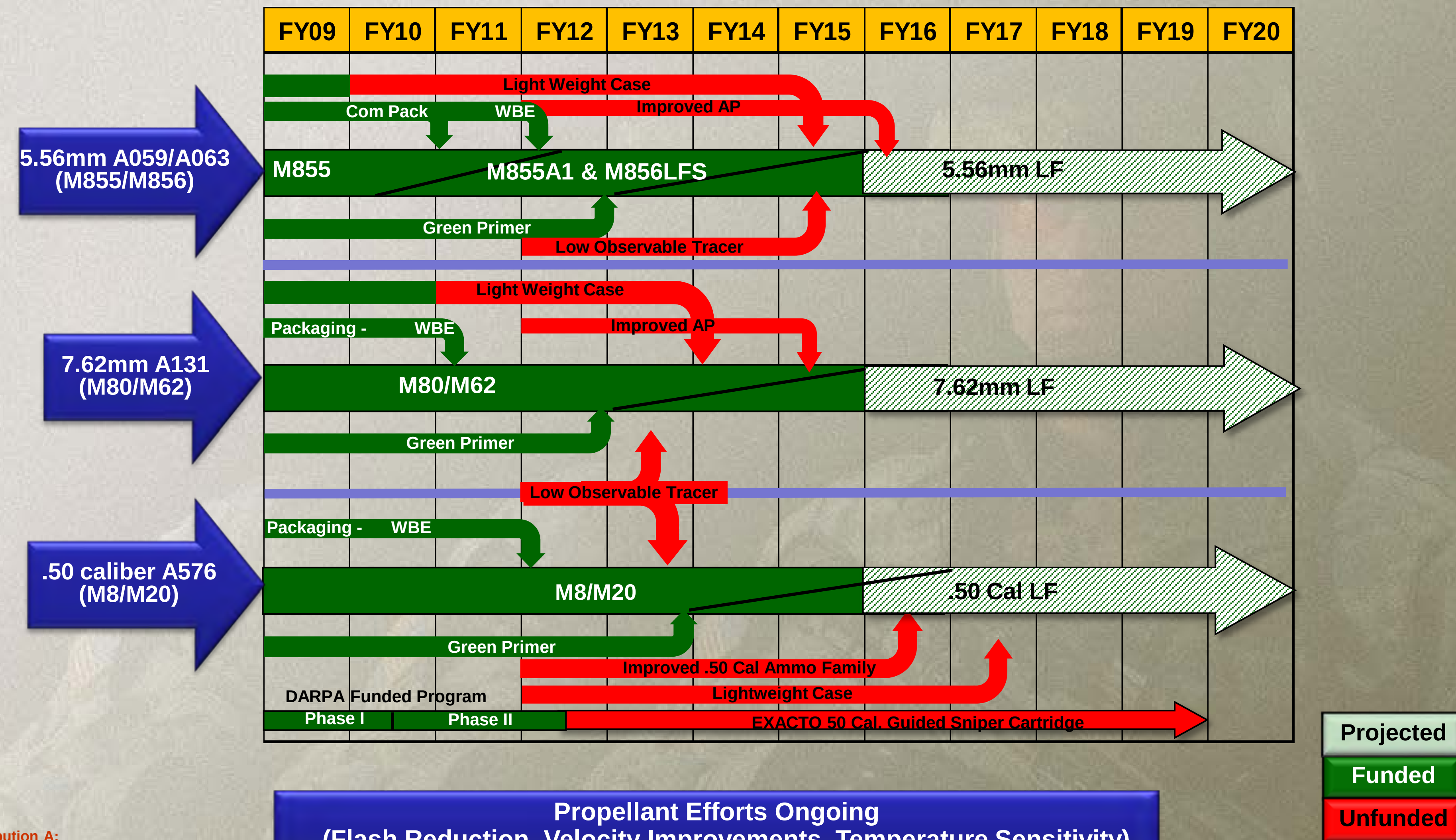
- Small Caliber Roadmap

- 5.56mm
  - M855A1 Enhanced Performance Round (EPR)
    - History
    - Performance
    - Status

  - M856 Lead Free Slug (Tracer)

- 7.62mm
  - M80 Lead Free

Small Caliber Ammunition Roadmap



Propellant Efforts Ongoing
(Flash Reduction, Velocity Improvements, Temperature Sensitivity)

History of the Lead Free Program

- **Why Green?**
  - Montreal Protocols, Executive Order (1993), EPA 17 List, AEC Study
  - Some training ranges becoming lead restricted
  - Army's policy on environmental stewardship
  - Expected tightening of future environmental restrictions
  - Public awareness of environmental concerns
  - Cost of removing hazardous materials from installations
- **Greening Efforts**
  - 5.56mm ball and tracer
  - 7.62mm ball and tracer
  - Green Primer across calibers

Resulted in the M855A1 Enhanced Performance Round

M855A1 EPR Benefits

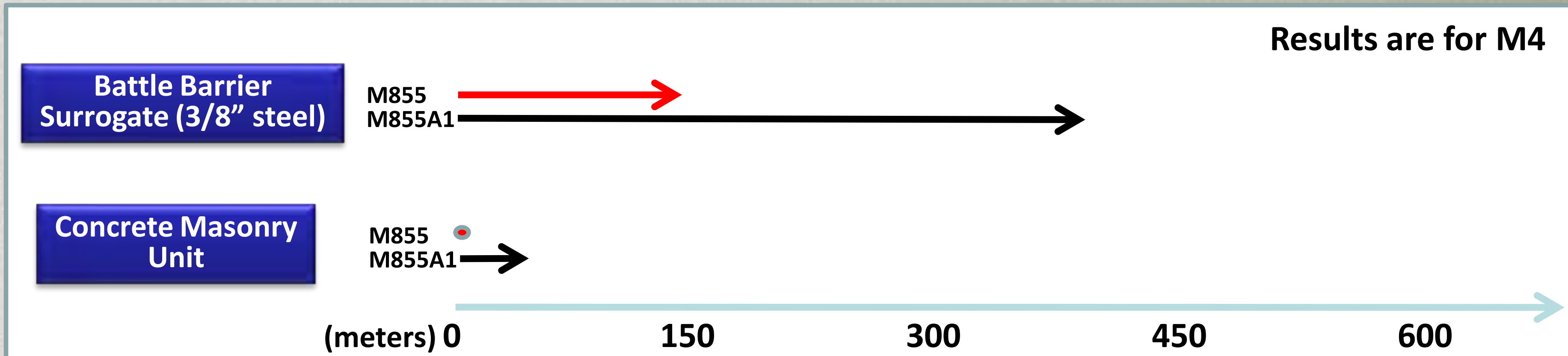
- **Environmental Impact**
  - **Lead free projectile**
  - **Eliminates ~ 2,000 tons of lead from production**
  - **Allows use of training ranges with restrictions**
  - **Removes lead hazard from mfg environment**

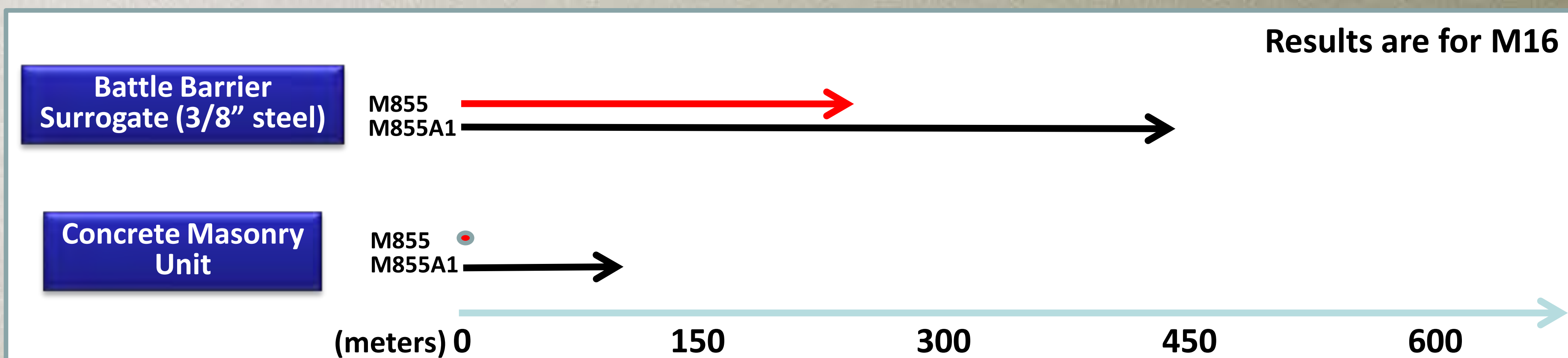
- **Performance Benefits**
  - **Improves hard target performance**
  - **Provides consistent effects against soft targets**
  - **No weight increase, improved propellant, reduced flash**
  - **Trajectory Match—no Soldier training transfer difference**
  - **Extremely effective against a wide variety of target sets (a true, general purpose round)**

M855A1

Distribution A:
Approved for Public Release;
distribution is unlimited

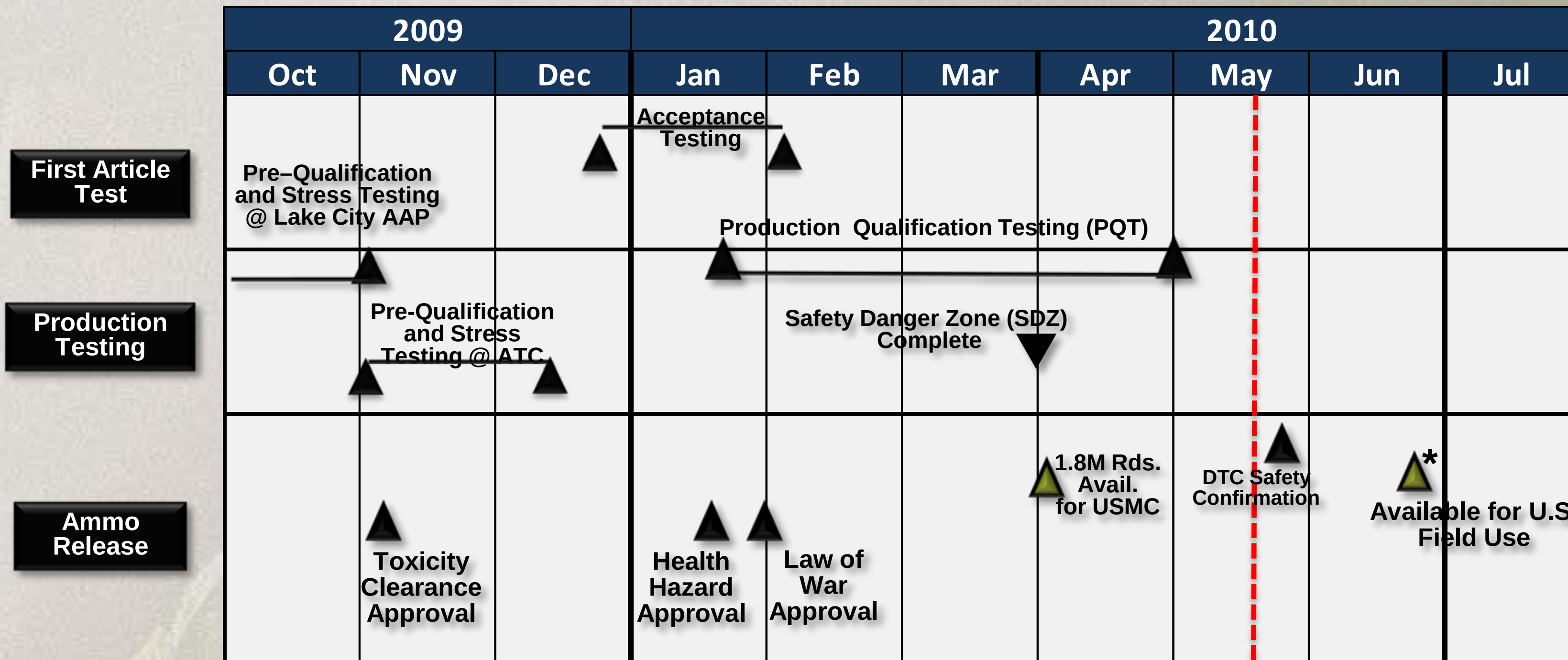
M855A1 Hard Target Performance





M855A1 has Improved Hard Target Performance

M855A1 Path to Fielding



* Airlift dependent

Available for Use in Theater in June 2010

Distribution A:
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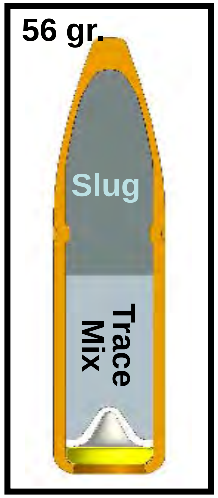
M856A1 Lead Free Slug
(M856 LFS, Tracer)

- **Goal**
  - Implement green technology in M856 Tracer
  - Ballistic match to M855A1
  - Improve trace to range consistency compared to current M856
- **Environmental impact**
  - Allows integration of M855A1 for M249 and rifle systems to create complete "lead free bullets"
  - Eliminates an additional 500 metric tons of lead from production/environment yearly
- **Status**
  - Down-selected M856LFS configuration utilizing M855A1 common components
  - Successfully demonstrated ability to meet:
    - Trajectory match with M855A1, M855, & M995
    - Trace requirements
  - Design Verification Testing is in process
  - Production qualification testing 1QFY11
  - Full rate production 4QFY11

Volume Match



Final Concept

M80A1 Lead Free (M80 LF)

- Goal - Environmentally friendly cartridge with same or better performance than current M80 cartridge
- Environmental impact
  - Green M80 – 2nd highest consumer of lead at LCAAP
  - Eliminates an additional 1,500 metric tons of lead from production / environment yearly
- Status
  - Completed facility upgrades at LCAAP for performance testing
  - Tested 18 concept bullets
  - All concepts can be produced with existing LCAAP equipment
  - Working closely with PM Soldier Weapons to ensure weapon system performance/functionality
  - Production Qualification Testing 2QFY12
  - Full Rate Production 4QFY12
  - Green Primer
    - Cost drivers identified
    - Process mapping, human factors study, automation analysis underway
    - Primer mix eval 1QFY11, Down-select 2QFY11, ECP 3QFY12

Take Aways

- **M855A1 Enhanced Performance Round (EPR)**
  - Environmentally friendly cartridge with improved performance
  - A true general purpose round optimized to a wide array of targets
  - Significantly improved hard target performance
  - Provides consistent performance against soft targets
  - Uses a lead free projectile (unlike M855)
    - Eliminates ~ 2,000 Tons of Lead from Production/Environment Yearly
    - Allows Use of Training Ranges with Lead Restrictions
  - Planned to replace M855 for the Army
  - Fielding Planned for June 2010

Continuing to Provide Improved Capabilities for our Warfighters!

US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award

2007 Award Recipient

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Lightweight Small Arms Technologies

May 2010

Contact : Mrs. Kori Phillips
US Army ARDEC
(973) 724-7912, DSN 880-7944
korene.phillips@us.army.mil

Program Goals

Program Goals:

- Fill critical operational needs
- Revolutionize weapons and ammunition
- Mature technologies for transition
- Maintain affordability of current systems
- Alleviate logistics burdens

Approach:

- "Clean Slate" design
- Trade studies - reduced weight is priority
- Extensive modeling & simulation
- Incorporate User feedback

Operational Problem

- Inability to sustain operations at high tempo without significant fatigue, affecting warfighter effectiveness
- Inability to execute missions in difficult terrain or at high elevations without reducing combat load
- Inability to maneuver effectively around obstacles, in buildings or vehicles
- Weapons and ammunition are 2 out of the 5 heaviest items warfighters carry

LSAT Advantages

- Significant weight and size reductions for small arms systems, with improvements to key system capabilities
  - Lighter weight weapons
  - Lighter weight ammunition
  - Reduced ammunition size/volume
  - Compatible with full range of ancillary devices
  - Improved system accuracy
  - Improved system reliability
  - Reduced system maintenance and training requirements

Ammunition Weight/Size Reduction

	M855 Brass Cased Ammo	Cased Telescoped Ammo	Caseless Ammo
Weight (600 rounds)	20.8 lbs	12.7 lbs	10.1 lbs
Cartridge			
Propellant	Ball Powder	Ball Powder – Flash Reduced	HMX Based
Case	Brass	Polymer	None
Weight	12.2 grams	8.3 grams	6.3 grams
Volume	0.247 in^3	0.215 in^3	0.152 in^3
Links			
Weight	2.0 grams each	0.5 grams each	0.5 grams each
Material	Steel	Polymer	Polymer
Configuration	Open link	Full circumferential	Full circumferential
Ammunition Pouch			
Weight	0.25 lbs	0.28 lbs	0.28 lbs
Capacity	100 rounds	150 rounds	150 rounds
Quantity Carried	6	4	4

Malcolm Baldrige National Quality Award 2007 Award Recipient

LMG System Weight Reduction

Ammunition:

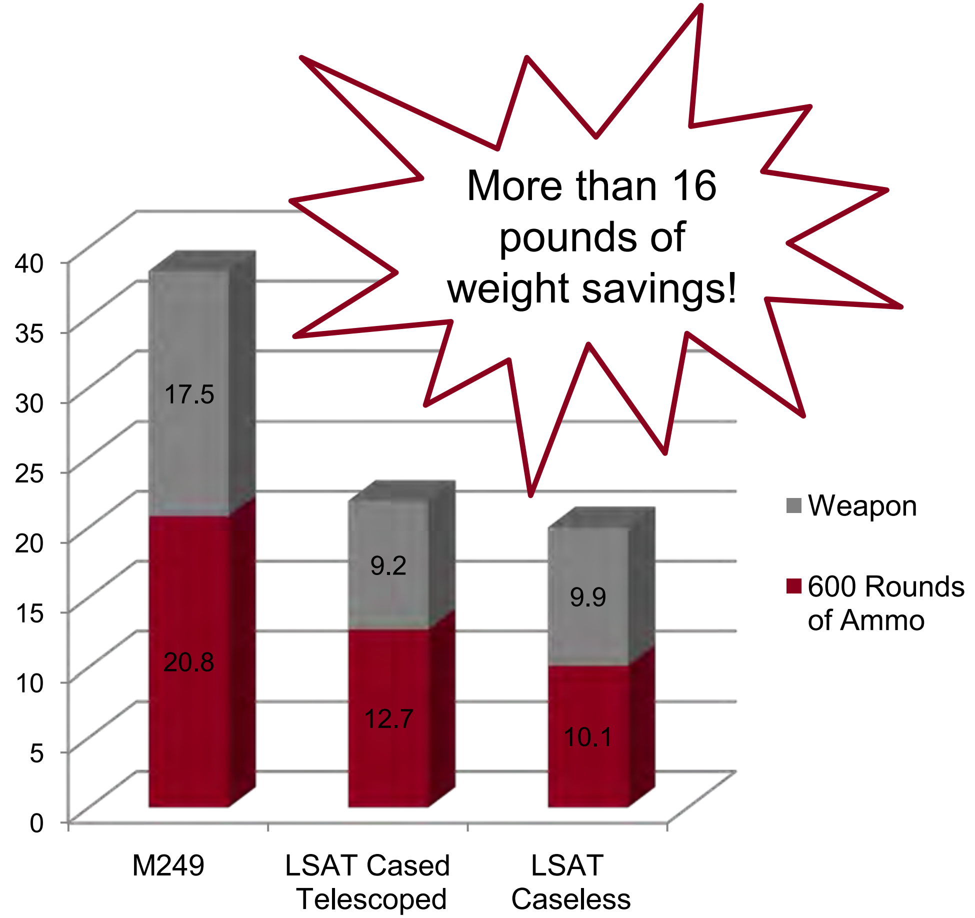
Cased

Caseless

- Develop technologies that can be applied across various platforms
- Demonstrate in 5.56mm

Weapon:

- Light Machine Gun (SAW) designs for both Cased Telescoped and Caseless Ammunition

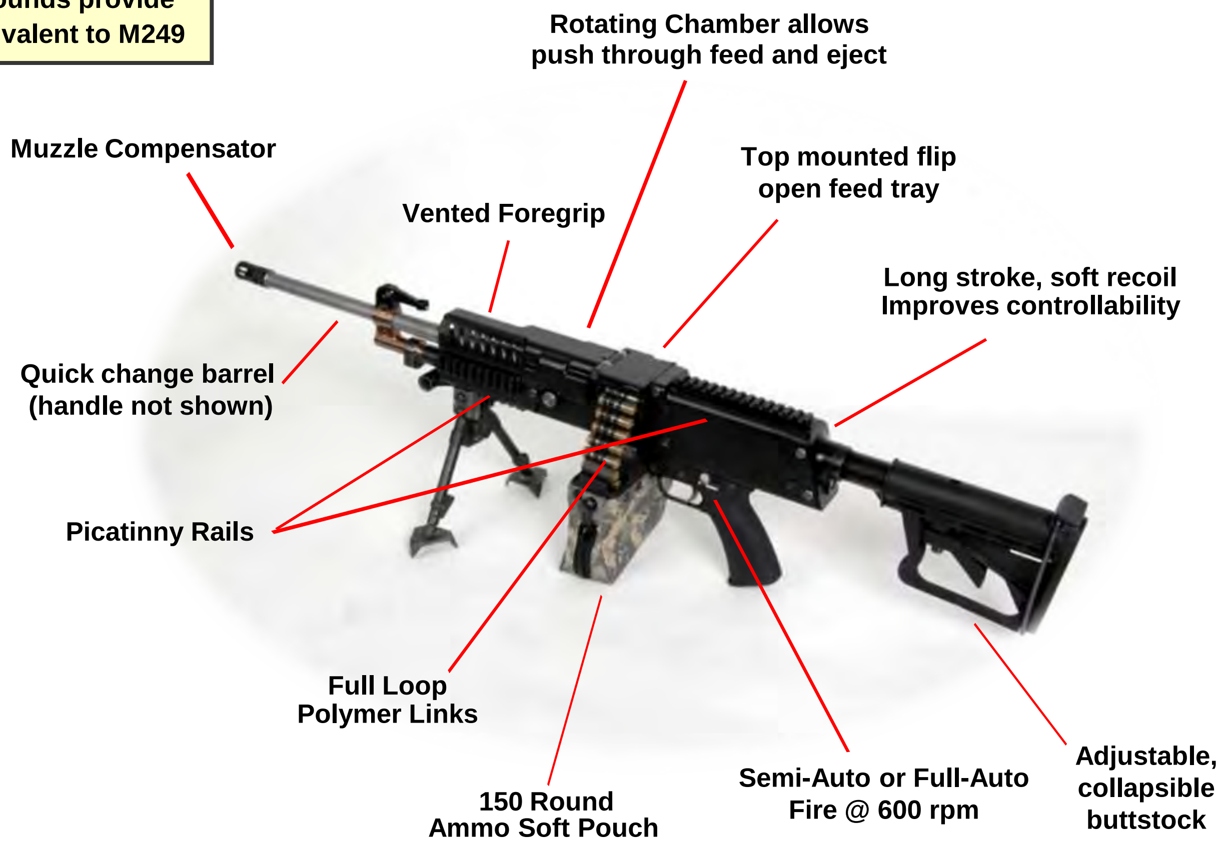


Light Machine Gun Technologies

M855 ball rounds provide lethality equivalent to M249

Key Technologies

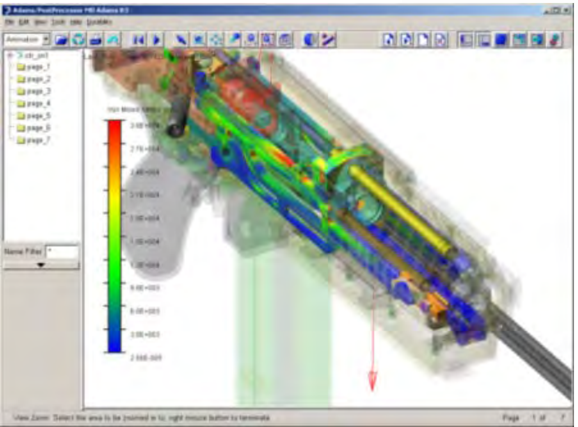
- Use of telescoped ammo: Cased or Caseless
- Structural configuration & lightweight materials
- Thermal management
- Caseless chamber sealing
- Human factors
- Integration of electronics



Both cased telescoped and caseless configurations

Rifle Technologies

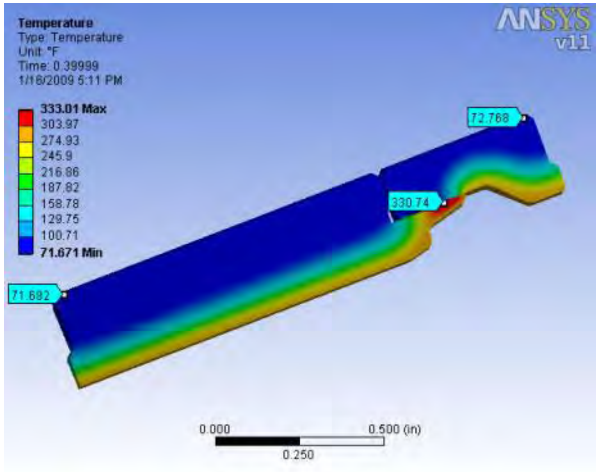
- Cased Telescoped Rifle:
  - Aft feed, rising chamber design
  - Same overall weight and length as M4, with *4" longer barrel*
  - 24.75" with buttstock folded
  - 42 round magazine
  - Weapon action testing started March 2010



Weapon Action Test Fixture

Caseless LMG Technologies

- Unique features:
  - Two piece sealing chamber
  - Sealed firing pin
  - Gas expansion volume
- Test Status:
  - Firings in semi and full auto modes
  - Muzzle velocity, dispersion, etc.
  - Fired almost 500 rounds of caseless ammo
  - Two VIP demos conducted
- Future testing activities
  - Safety testing
  - Shoulder firing and demos
  - Wear, erosion, and reliability
  - TRL 5 demo



Caseless Ammunition Technologies

- Spiral 2 development completed:
  - Same basic formulation as HITP
  - Small pilot plant set up for fabrication
  - Over 1,000 rounds made, 500 tested
  - 50% weight reduction, 38% size reduction

- Spiral 3 development underway:
  - Replacement of legacy energetic binder (PNP)
  - One "quick-look" formulation using polyethylene glycol (PEG)
    - Mixing/molding studies completed
    - Testing showing promising results
  - Alternate binder formulation
    - Matrix of materials vs. key characteristics established
    - Includes non-energetic and energetic binders
    - Energetic binder selected (9-DT-NIDA)
  - Manufacturing process/facility study ongoing

Maturity of CT Light Machine Guns

CT LMG SN1 and SN2

- CT LMG SN1:
  - Fired over 8,600 rounds (300 last week!)
  - Conducted numerous live fire demos
  - Analyzed system characteristics
  - Weight: 9.97 lbs

- CT LMG SN2:
  - Fired over 2,200 rounds
  - Converted to fire Spiral 3 CT Ammo
  - Weight: 9.81 lbs

Live Fire Demo at Ft. Benning

- CT LMG SN3:
  - *Weight reduced to **9.21** lbs*
  - Designed to incorporate lessons learned
  - Includes barrel handle, new bipod, new buttstock, updated housing, etc.
  - Over 250 rounds fired on weapon action
  - Integrated weapon testing to start in May

CT LMG SN3

Maturity of CT Ammunition

- Spiral 2: Over 10,000 rounds fired
  - Mann Barrels and machine guns
  - Temperatures from -65F to +160F
  - 35% weight reduction
- Spiral 3: Over 1,600 rounds fired
  - 400+ fired from Mann barrel
  - Also fired from LMG's SN2 and SN3
  - Compacted propellant
  - 13% volume reduction
  - 41% weight reduction
  - Pilot production being established

Belt of CT Spiral 2 Ammo

CT Spiral 1 | **CT Spiral 2** | **CT Spiral 3**

Demonstration and Assessment

- Conducted multiple high-level demonstrations
  - Sergeant Majors, General Officers, Senior Executive Service
  - Reps from all US Armed Forces, Canada, and the UK have fired CT LMG
  - Available for User demo by request

- Planning for Military Assessment:
  - Demonstrate military utility of lighter weight weapons and ammunition
  - Hardware available in May 2011
    - 8 Light Machine Guns and 100,000 rounds of CT Ammunition
  - Demo ties in to ICD and roadmap for future small arms

Requirements & Transition

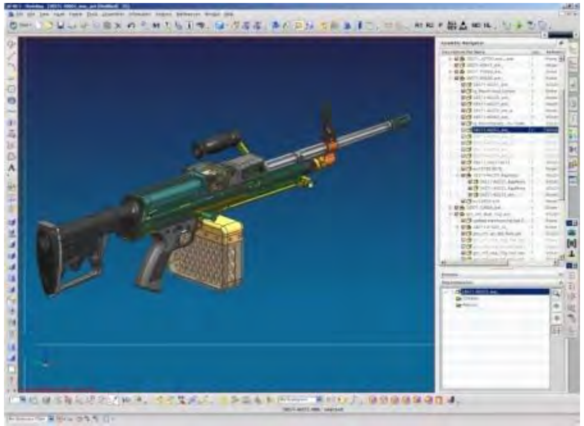
- Initial Capabilities Document: (aka Battle AXE)
  - Draft version 0.6 dated 16 April 2010, final draft planned for May
  - Joint document, with input from all services
  - Based on capability gaps identified in Capabilities Based Analysis (CBA)
  - Timeframe is 2015-2025

- Timeline:
  - Transition/Milestone B dependent on approval of requirements and funding
  - Once transitioned, 2-3 years for EMD, 1-3 years for Production & Deployment
  - Potential first unit equipped as early as 2016 (depends on final configuration)

Technology Maturity

- Ammunition:
  - 5.56mm Cased Telescoped (TRL 5 now, TRL 7 in Apr 2011)
  - 5.56mm Spiral 3 Caseless (TRL 5 scheduled for Dec 2010)
  - Alternative projectiles possible in either CT or Caseless
- Weapons:
  - 5.56mm CT Light Machine Gun (TRL 6 now, TRL 7 in Apr 2011)
  - 5.56mm Caseless Light Machine Gun (TRL 5 scheduled for Sep 2011)
  - 5.56mm CT Rifle (TRL 5 planned for Jul 2011)
  - 5.56mm Caseless Rifle (basic design exists)
- Scalable design provides significant modularity and commonality

Cost Comparable to Current Systems



- Weapon:
  - Current weapon costs used as baseline
  - Optimized for manufacturing and maintenance
  - Uses readily available materials

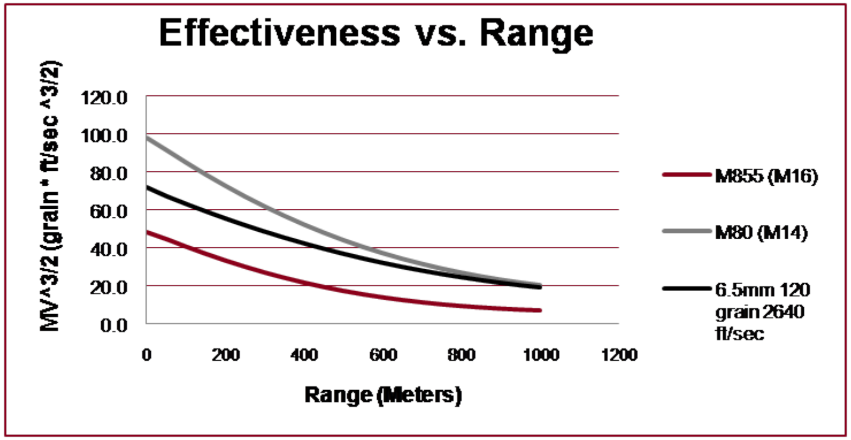
- Cased Telescoped Ammunition:
  - Uses conventional molding process
  - Can be outsourced to multiple suppliers
  - Adaptable to current assembly line

- Caseless Ammunition:
  - Previous efforts proved feasibility
  - Current efforts focused on reducing cost
  - No reliance on price of brass

Investment for Future Warfighter

Flexible/modular technologies can be applied to:

- Ammunition calibers/configurations
  - "Intermediate" calibers
  - Integration of LFS/SOST
- Weapon configurations
  - Rifle (in work)
  - Medium Machine Gun
  - Sniper Rifle
- Platforms:



Reduced Logistics Burden

- Reduced weight and volume improves storage and handling

- Decreased need for resupply reduces fuel costs and associated hazards

Improved Operational Availability

- Improves Reliability
  - Fewer stoppages as a result of simplified feed & extraction
  - Reduces cook-off as chamber is thermally isolated
  - Reduces weapon powering requirement with lighter belt pull loads
- Improves Maintainability
  - Reduces maintenance intervals with low friction coatings
  - Simplifies field stripping with modular assemblies
  - Spares support levels consistent with current systems
- Durable Construction
  - No sacrifice of durability for weight reduction
  - Optimal mix of conventional metals/composite materials
  - Will undergo full spectrum of qualification tests

Program Summary

- Program Goals:
  - Fill critical operational needs
  - Revolutionize weapons and ammunition
  - Mature technologies for transition
  - Maintain affordability of current systems
  - Alleviate logistics burden

"Weight is the currency with which we buy capability"
LTC Glenn Dean, US Army

Product Manager Large Caliber Ammunition

Training Ammunition Safety Initiatives

LTC Kenneth Robertson
Project Manager

20 May 2010

Agenda

- Problem
- Cause & Effect
- Technical Solutions
  - Advanced Case System
  - Skive Joint Modification
  - M14 Propellant Replacement
  - Loader Tray Upgrade (discussion)
- Path Forward

Problem

Three Incidents of Training Cartridge Ignition Resulting in Fatalities or Injury

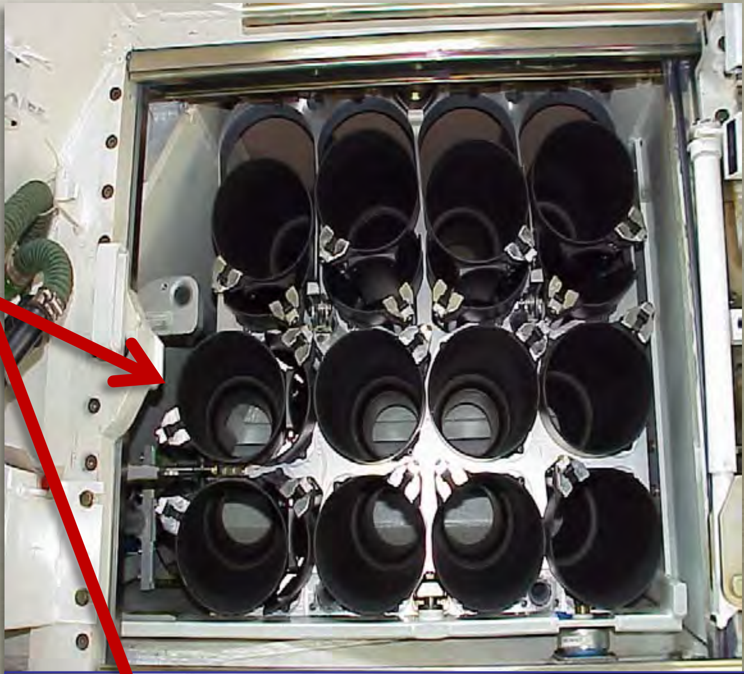
Cause & Effect

- Ignition Caused by a "Perfect Storm" of Events
  - Cartridge Case Damage Caused by Extraction of Non-Fired Round from 2nd Gen Loaders Tray
  - Damage is not Facing Loader–Damage Goes Unnoticed

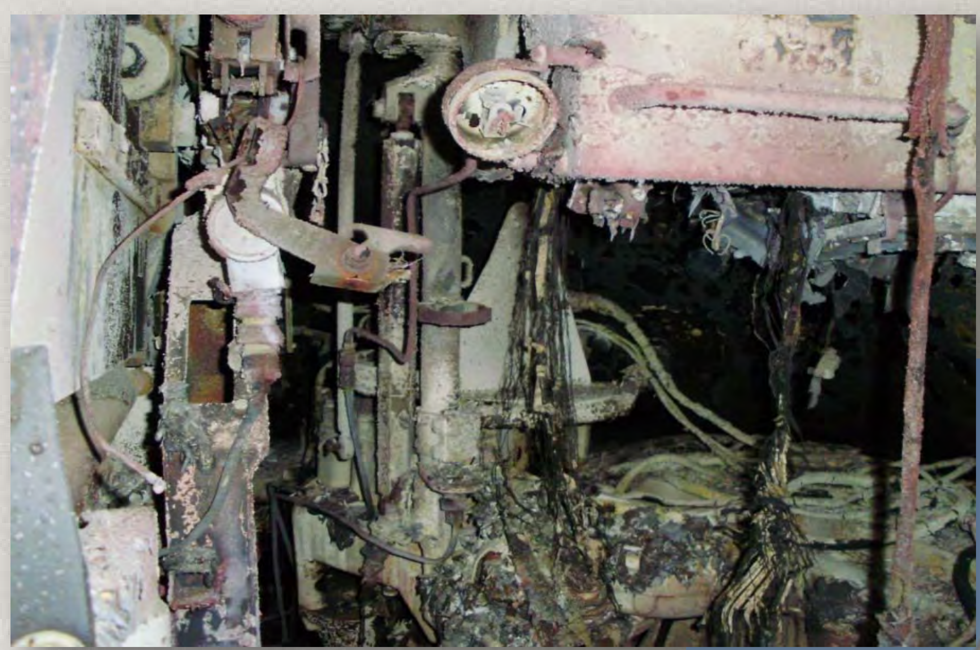
DISTRIBUTION STATEMENT A:
Approved for Public Release;
Distr. Unlimited

Cause & Effect

- Chip in the Ready Rack Coating Previously <u>Exists</u>
- Diethyl Ether Fumes Escape from Just Right Sized Hole
- Round Placed in Ready Rack Causing Static Charge-Then Removed for Firing
- Venting Ether is Ignited Due to Electro Static Discharge



Cause & Effect



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Advanced Case System

- **ACS Program Eliminates the Bond Joint at Projectile Forward End of Cartridge**

Skive Joint

Current Case

Skive Joint Modification

- **Large Stockpiles of M865, M831A1 and M1002 Training Cartridges with Forward Skive Joint**

Polyurethane Tape

- **ACS Cannot be Applied to M831A1/M1002 in Inventory**

Polypropylene Band Edges Sealed with epoxy

DISTRIBUTION STATEMENT A:
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M14 Propellant Solution

- Potentially Replace M14 Propellant with Less Vulnerable Solution
- Competitive Contracts with Promising Results
- Reduction in R&D Overall Risk-Leverage Previous Efforts
- Affordability is an Exit Criterion

Path Forward

- FY11: Skive Joint Modification to Existing Stockpile
- FY11: ACS Solution to Future Production of M1002/M865
- FY14: M14 Replacement Based Decision by USMC / Army

Photo of M1A2 SEP taken by SSG Steven Johnson C3-67 Armor, Fort Hood, Texas on 11 Nov 00

Product Manager Medium Caliber

NDIA Small Arms Systems Symposium

MAJ Marc Meeker
Assistant Product Manager
Medium Caliber Ammunition

Agenda

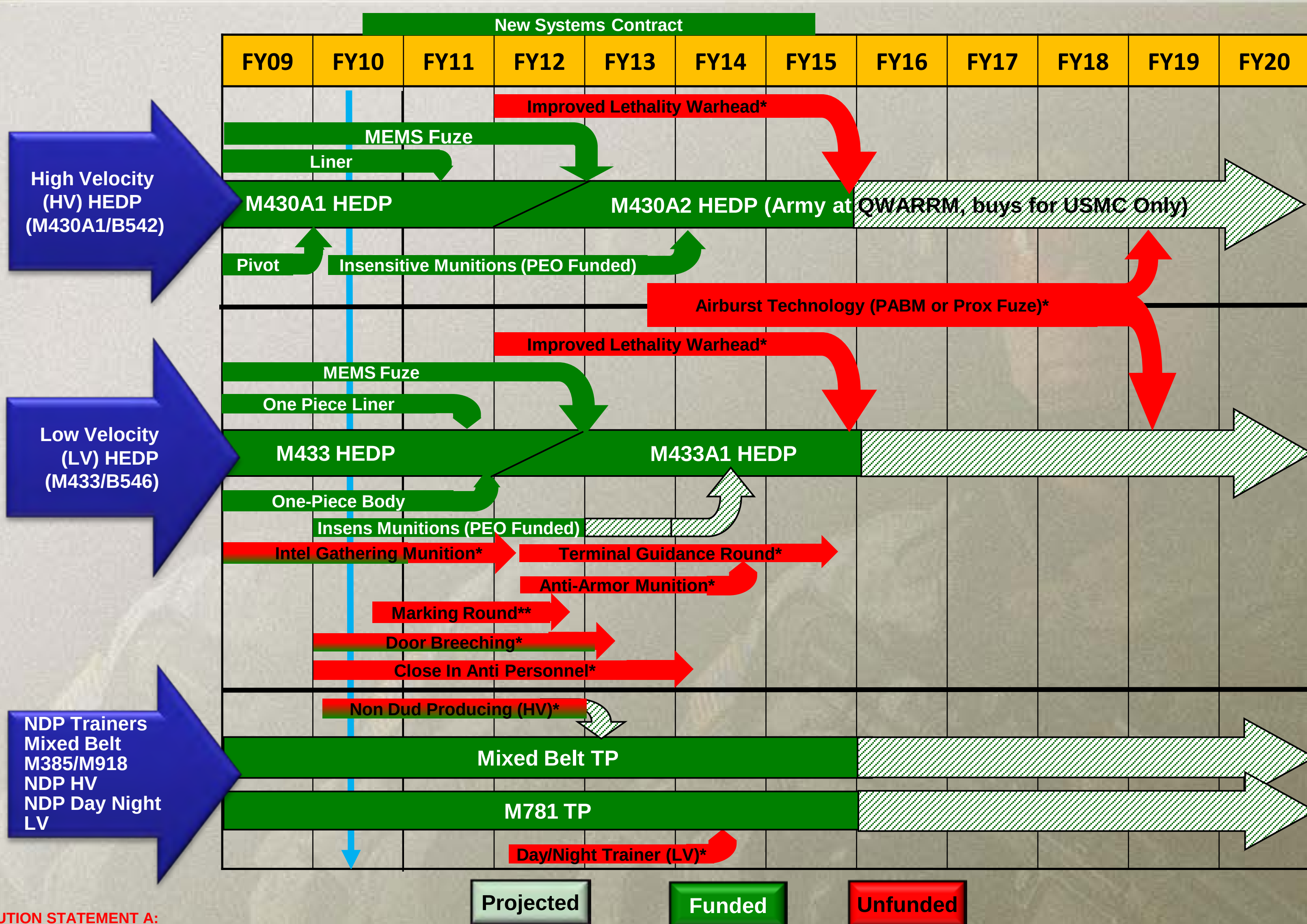
- 40mm Family
- Funded Efforts
- Emerging Requirements
- Wants/ Ideas

40mm Family

High Velocity

Low Velocity

2010: 40mm Grenades Roadmap



DISTRIBUTION STATEMENT A:
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* Requirement Pending from USAIC, source: SAB 1~N List, Published 08 March 2010

40mm Grenades: Funded Production/ NRE

M430
- One Piece Liner
- Pivot Coupling

Mixed Belt (M385/M918)

M433
- One Piece Liner

Illumination Family
- M992 IR Illum Round

M781

40mm Grenades: RDT&E

- MEMS Fuze
- Door Breeching
- Intel Gathering
- Non-Dud Producing
  - NDP, of course
  - Day/ Night/ NVD/ Thermal Signature
  - Platform compatibility
  - Ballistic Similitude
  - Fire Safety

40mm Grenades: Anticipated Requirements

- **High Velocity**
  - Non-Dud Producing Training Munition
- **Low Velocity**
  - Non Dud-Producing Training Munition

40mm Grenades: Wants/ Ideas

High Velocity

- Programmable Airburst
- Prox Fuze
- 1 **Improved Lethality**
- Terminal Guidance Round
- Marking Round
- Anti Armor

Low Velocity

- Programmable Airburst
- Prox Fuze
- 2 **Improved Lethality**
- 3 **Terminal Guidance Round**
- Marking Round
- 5 **Anti Armor**
- 4 **Intel Gathering**
- Close-In Anti-Personnel

NDP Round Road Ahead

- **Staff CDD (HV) and CPD (LV)**
- **Complete Market Survey (Check FEDBIZOPS)**
- **Draft Acquisition Strategy**
  - Looking at NDI solution, with a shoot-off to down select
- **Develop Detailed Schedule**

Product Director Non-Standard Ammunition

Overview

LTC. Robert Dionisio
Product Director
Non-Standard Ammunition
(PD-NSA)
Email: robert.dionisio1@us.army.mil
973-724-1685

Non-Standard Ammunition (NSA) Mission

The Non-standard Ammunition Office Executes Non-standard Ammunition Requirements for the Department of Army, While Coordinating With all Services, in Order to Enhance the Security and Training Capabilities of Allied Nations

DISTRIBUTION STATEMENT A:
Approved for Public Release;
Distribution is unlimited

Non-Standard Ammunition

PEO-Ammunition
BG Jonathan Maddux

Project Manager
Maneuver Ammunition Systems
Chris Grassano

Product Director
LTC Robert Dionisio

Assistant Product Manager
MAJ Todd Masternak

- Chief Engineer – John Resch
  - Quality – Robert McDuffie
  - Weapons – Kevin Caflin
  - Packaging – Greg Farbanish
  - Test – Chad Sensenig
  - Ammunition – As Needed
- Quality Assurance Specialist – Doug Williams
- Business Analyst – Rosemarie Rapka
  - Acquisition Specialist – Stephanie Resch
- Project Engineer – MAJ Paul Alessio

Combined Security Transition Command - Afghanistan

CSTC-A

Defense Contract Management Agency (Italy)

DCMA

Security Assistance (Rock Island, ILL)

S.A.

Joint Munitions Command (Rock Island, ILL)

JMC Contracting

Enterprise

Core

Matrix

Non-Standard Ammunition
Products (67 Items)

Small Caliber Pistol, Rifle & Machinegun
- 5.45mm to 12.7mm (Ball, Tracer, Armor Piercing (AP))

Medium Caliber Aircraft & Anti-Aircraft
- 14.5mm to 30mm (AP, High Explosive (HE), Tracer)

Tank & Artillery
- 100mm, 115mm, 122mm (High Explosive Anti Tank (HEAT), Kinetic Energy (APFDS-T), HE, Smoke, Illum)

Mortars
- 82mm, 120mm (HE, Smoke, Illum)

Rocket Propelled & Recoilless Rifle
- 40mm PG/OG-7, 73mm PG/OG-9 (HE, HEAT)

Launched and Hand Grenades
- 40mm, Hand Grenades (HE/Frag, Bounding, Flash)

Aircraft Munitions
- 57mm Rockets, PPI-26 Flares, PP3/PP9/PPL

DISTRIBUTION STATEMENT A:
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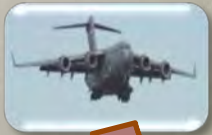
Distribution is unlimited

Non-Standard Ammunition Support to Afghanistan

Afghanistan Three-Year Plan	
Small Caliber	330M
RP / Launched Grenades	1.2M
Med & Large Caliber Direct	1.5M
Mortars & Artillery	625K
Aviation Rockets	29K
ATGM	2K
Misc Links, Belts, Flares	340K

CSTC-A Forecast for ANA & ANP
*** Force Structure increase not factored into forecast**



ANP – Afghan National Police
ANA – Afghan National Army

DISTRIBUTION STATEMENT A:
Approved for Public Release;
Distribution is unlimited

Non-Standard Supplier Base

Prime contractors are US ammunition companies subcontracting to foreign suppliers/producers…new ammunition off the production line.

Manufacturers in Russia SSI

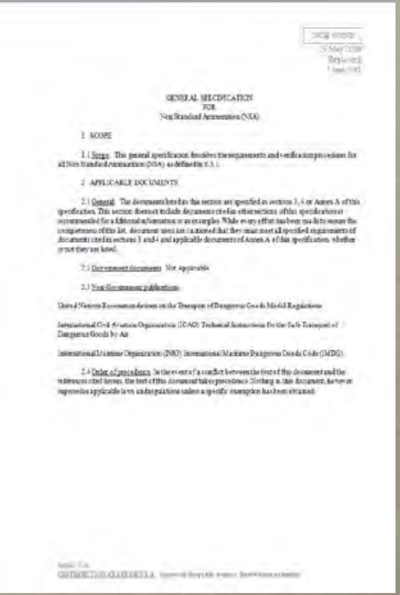
Program Management

- **Established Acquisition Strategy and Implemented Acquisition Processes**
  - **Improve Timeliness**
  - **Longer Term "Best Value" Contracts; Base + Options; Multiple Prime Contractors**
- **Implement IPTs With all Prime Contractors to Improve Communication**
  - **Technical and Overarching**
- **Work Requirements With Customers**
- **Coordinate Efforts With State Department**
  - **Coordinate State Department Participation in Industry Day**
  - **Work With State Department and Defense Technology Security Administration (DTSA) on Brokering Authorizations for Solicitations**

Establish program management similar to standard US ammunition

Technical Management

- **Established and Continually Improving Knowledge Base of Items and Producers/Suppliers**
  - **Facility/Capability Assessments**
  - **Discussions W/ Design and Production Engineers**
- **Apply General Technical Specifications to Ammunition to Establish QA Levels**
- **Review And Approve Producer / Supplier Specific Top-level Assembly Drawings**
  - **63 Technical Data Packages Approved for 3 Prime Contractors and 14 Suppliers**
- **Established and Manage Technical Data Base for Performance Documentation and Trend Analysis**
- **Implemented Configuration Management**
- **Validate Test Technologies and Methodologies Performed by Suppliers**


GENERAL SPECIFICATION
FOR
Non Standard Ammunition (NSA)

1. SCOPE

1.1 Scope. This general specification describes the requirements and verification procedures for all Non Standard Ammunition (NSA) as defined in 6.3.1.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 or Annex A of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 and applicable documents of Annex A of this specification, whether or not they are listed.

2.2 Government documents. Not Applicable.

2.3 Non-Government publications.

United Nations Recommendations on the Transport of Dangerous Goods Model Regulations

International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air

International Maritime Organization (IMO) International Maritime Dangerous Goods Code (IMDG)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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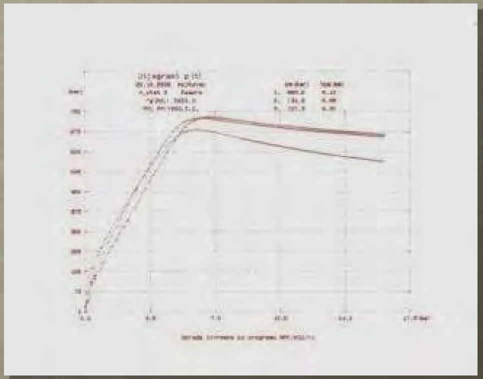


Quality Assurance

- **Require Prime Contractor to be ISO Certified or Equivalent and Flow Down Quality Processes to Producers**
- **Review and Approve Lot Acceptance Test (LAT) Criteria and Results for Each Ammunition Item**
- **Validate Approved Criteria Through LAT Observation Whenever Possible**
- **Update Technical Data to Incorporate Enhancements Observed During LAT**
- **Execute Source Inspection of all Shipments Using Critical Quality Assurance Representative (QAR) Support From DCMA**

Verifying Compliance to Quality Standards Prior to Delivering to Theater

Non-Standard Ammunition Quality Assurance

Kind - Count - Condition

DISTRIBUTION STATEMENT A:
Approved for Public Release;
Distribution is unlimited

Future Activities

- Continue to provide quality ammunition as long as required to:
  - Coalition Allies
  - Test agencies
  - Research and development requirements
  - Training/Other
- Establishing a robust acquisition strategy and program plan to meet developing needs
  - To be Posted in the Federal Business Opportunities (https://www.fbo.gov)
  - Expect an Industry Day 3QFY10

Summary

Successfully

Delivering Ammunition to US and Allied Forces…

Supporting

Large & Changing Requirements…

Managing

A Complex Worldwide Supply Chain

Enterprise approach in "implementing requirements that are reasonable, understandable, & executable."

US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award 2007 Award Recipient

Advanced Lethality Armament Technology for Small Arms

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

NDIA
Joint Armaments Conference
May 20, 2010

Sabbian Registe
Small Caliber Munition Division
RDAR-MEM-I
sabbian.registe@us.army.mil

Outline

- Introduction
- ATO Overview
- Technical Approach
- Project Portfolio
- Project Updates
- Results
- Summary

Introduction

What is the Advanced Lethal Armament Technology for Small Arms ATO?

An Army Technology Objective (ATO) effort funded thru the JSSAP office which was started in 2008. The aim of this effort is to identify, find, mature, and demonstrate those small arms technologies which, when developed, integrated, tested, and fielded will provide leap ahead benefits to significantly augment the effectiveness of the next generation War-Fighter.

Advanced Lethal Armament Technology for Small Arms

Objective:

– To improve the ability to incapacitate targets in defilade.

Challenges:

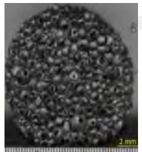
– Small payload
– Payload efficiency
– Delivery accuracy
– Effectiveness on defilade targets
– Recoil

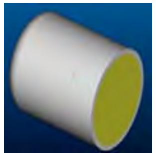
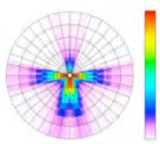
Overcoming Challenges:

– Improve the distribution of warhead fragments.
– Alter flight trajectory.
– Altering the warhead orientation near the target.
– Provide advance fuzing to set-off warhead at the optimum distance from the target.
– Improve accuracy.

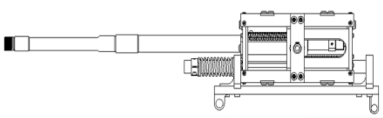
Expected Outcome

TRL 4 (Brass board) component technologies which, when matured, integrated, and fielded will lead to multiple capability gaps mitigation.





Technical Approach (Metrics & Objectives)

Measure	Current	Threshold	Objective	TRL
Small Fragmenting Munitions -- P(I)	Pi/Lethal Area	25% over current systems	>25% over current systems	Start 2 End 4
Control of Directionality of Fragments	None	Angle of Fall to Gravity	Optimize on Target	Start 2 End 4
Reduced Recoil / Weight	Extrapolate from current capability	Reduced by 20%	Greater than 20%	Start 2 End 4
Recoil Survival	4.2 lb sec	Reduced by 30%	Reduced by 50%	Start 2 End 4
Combined Lethal & Non-Lethal Warhead	None	Less Lethal to Lethal	Optimize on Target	Start 2 End 4

Small Fragmenting Munitions Technologies related to small arms munition which has been designed to generate ballistic fragments in a specified way (specified size, weight, spread, velocities) against a specified array of threats (anti materiel, anti personnel, etc) in specified scenarios (range, defilade, etc).

Control of Directionality of Fragments
This research area include technologies related to focusing on the augmentation of the munition system's ability to direct, channel, or otherwise enhance the performance of the fragmenting munition's warhead in its given role.

Combined Lethal & Non-Lethal Warhead.
The purpose of this research area is to advance variable effect component technology. Variable effect technology is defined as technology that limits or directs the effectiveness of the warhead in a controlled and precise way. Ideally, we are seeking to advance technology components that will eventually enable the war-fighter to deliver a selectable level of effect (ranging from less-than-lethal to lethal) to one or more targets across the full operational range envelope. Variable effects will give commanders more options in complex settings while potentially reducing the logistical footprint and/or weight of carried munitions.

Project Portfolio

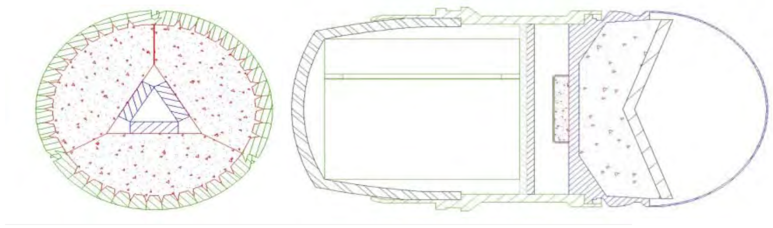
Project Name	Technology Provider	Metrics Area
40mm Directed Fragmentation Munition	Battelle	1,2
Optically-Fuzed Airburst Munition	Metal Storm	1,2
Advanced Warhead Effort	ARDEC	1,2
Dynamically Reshaped Fragmenting Warhead	Dindl Firearms	1,2
"Programmable" Fragmentation Warhead	ARDEC	1,2
Localized Annealing Fragmentation	Los Alamos National Lab (DOE) / ARDEC	1,2
40mm Precision Grenade	Georgia Tech RI	1,2
Adv. Lightweight Recoil Attenuation	Knight's Armament Co.	3,4
Kinematic Recoil Chain Attenuation	ARDEC	3,4
Thermal Management for Smalls (Carbon Foam)	Oak Ridge National Labs (DOE)	1,3
Lethal /Non Lethal Door Breaching 40mm round	Dindl Firearms	5
Lethal/Non Lethal Munition	(Award Pending)	5
Enhanced Fragmentation Munition	(Award Pending)	1,2

Metrics **(Advanced Lethal Armament ATO)**			
1	Enhanced Effects on Target	4	Reduced Recoil Impulse
2	Dispersion and Control of Effects on Target	5	Combined Lethal/ Non Lethal
3	Reduced Recoil / Weight		

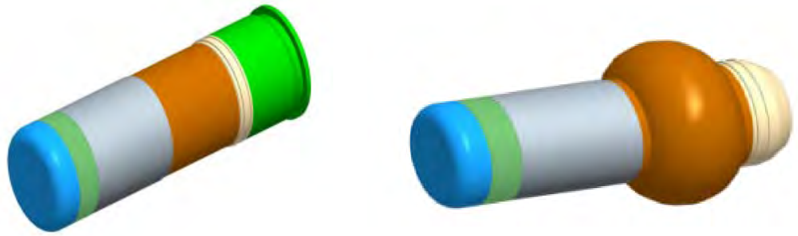
Project Updates

Small Fragmenting Munition

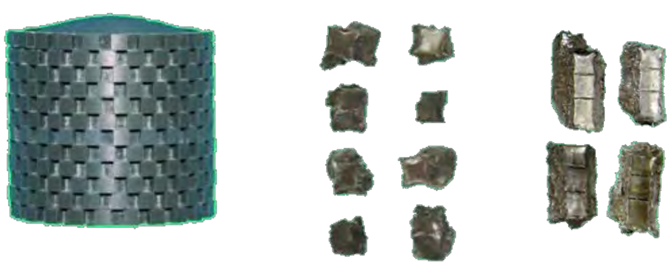
40mm Directed Fragmentation Munition



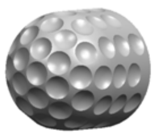
Dynamically Reshaped Fragmenting 40mm Warhead



40mm "Selectable" Fragment Warhead



Enhanced Fragmentation Munition

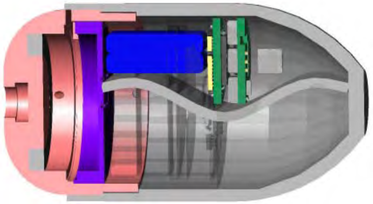


Project Updates

Control Directionality of Fragments

Optically Fuzed Air-Burst Munition (OFAB)

40mm Precision Grenade



Enabling Technology

High-Temperature/ High Strength Carbon Foam

Project Updates

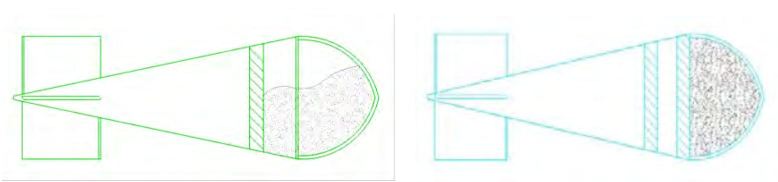
Recoil Reduction

Kinematic Recoil

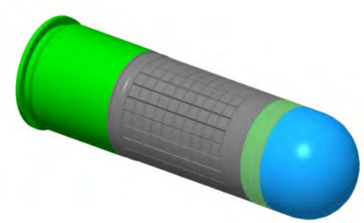
Advanced Recoil Attenuation

Combined Lethal / Non-Lethal

Lethal /Non-Lethal Munition



Lethal/Non-Lethal Door Breaching Round



Results

Progress on ATO

- **Improvements in Probability of incapacitation.**
- **Improvements in Lethal Area compared to legacy round.**
- **Improvements in Fragmentation patterns.**
- **Demonstrated 90% decrease in recoil impulse compared to M240 MG.**
- **Transition Carbon Foam material for barrel wrap application.**

Thank You!!!

Contact Information

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US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award

2007 Award Recipient

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Advanced Fire Control Technology for Small Arms

Terence F. Rice
US ARMY ARDEC
Joint Services Small Arms Program Office(JSSAP)
RDAR-EIJ
terence.f.rice@us.army.mil

Joint Armaments Conference, Exhibition and Firing Demonstration

20 May 2010

Agenda

- *Introduction*
- *Advanced Fire Control Technology for Small Arms ATO*
- *Technical Approach (Metrics & Objectives)*
- *Project Portfolio*
- *Industry Status*
- *Enabling Technology Status*
- *Summary & Path Forward*

Introduction

- *What is Fire Control?*
  - Science of offsetting the direction of weapon fire from the line of sight to the target in order to hit the target

- *Fundamentally, fire control are variations of the same basic situation.*
  - Launching a projectile from a weapon station to hit a selected target.
  - Target or the weapon station or both may be moving.
- *Categorized as either tactical or technical.*
- *Small Arms Fire Control*
  - Advanced Fire Control for Small Arms ATO focus is technical fire control.
  - Provides the computational and mechanical operations required for the weapon system to hit a specific target with a specific munition.
  - Augment the soldier's capability, enabling the soldier to fire on more targets both more quickly and more accurately

US ARMY RDECOM

Advanced Fire Control Technology for Small Arms (ATO)

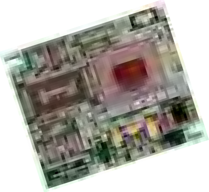
Purpose

To demonstrate advanced fire control component technology determining correct range to moving targets and further power sharing within weapon for current and future warfighters.

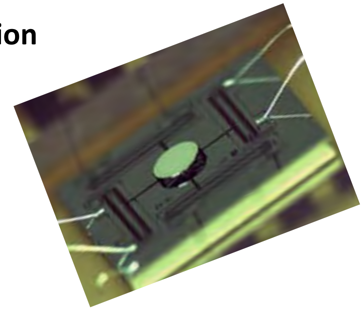
Challenges

- Moving targets prior to their seeking cover
- Unsupported firing position.
- Inaccurate ranging limits precision
- Weight near muzzle leads to poor aiming
- Multiple batteries reduces accessory availability

How do we solve this problem



- Technologies for automatic target detection
- Laser steering to increase the soldier's ability to accurately determine range to non cooperative moving targets.
- Improved lethality in unsupported firing positions
- Develop range determination to overcoming wobble associated in an unsupported firing position



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Payoff

- TRL 4 (Breadboard) component technologies integrated to establish that they will work together
- This is relatively "low fidelity" but shows we are getting there!!

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Technical Approach
(Metrics and Objectives)

Measure	Current	Program Objective	Army Objective	Technology Maturity Level
Unsupported Range Determination	4+% to 15% of range	3 meters to targets in cover	2 meters to targets in cover	Start: TRL 2 End: TRL 4
Missed moving targets	60%	20%	<20%	Start: TRL 2 End: TRL 4
Shared Power Weight reduction	Batteries (multi) & cables	Reduce weight & one battery	Reduce weight & one battery	Start: TRL 2 End: TRL 5

Subset

Measure	Current	Threshold (T)	Objective (O)	Technology Maturity Level
Volume Reduction	Extrapolate from current capability	Reduce by 20%	Greater than 20%	Start: TRL 2 End: TRL 5
Power Distribution/Sourcing	Multiple batteries and cables	Remove Cables/Reduce Battery Load	Advanced Power Management/Distribution	Start: TRL 2 End: TRL 5
Energy Recovery/Harvesting	None	Reduce Power Cost by 5%	Reduce Power Cost >20%	Start: TRL 2 End: TRL 5

TRL 2: Technology concept and/or application formulated
TRL 4: Component and/or breadboard validation in laboratory environment
TRL 5: Component and/or breadboard validation in relevant environment

US ARMY RDECOM

Project Portfolio

Project Name	Technology Partner	Metrics		
		1	2	3
Laser Steering and Automated Target Tracking	L3/Brashear	X	X	X
Multi-Spectrum Sensor System	Stevens Institute of Tech	X	X	X
Target Tracking Laser Range Finder for Small Arms TA/FC	IAI	X	X	
Covert RF sensor for location and tracking of defiladed human targets	Penn-State University	X	X	X
Advanced Fire Control	Award Pending **			
Small Arms Electrical Energy Harvesting by Linear Induction	ARDEC			X
Optical Fiber Based Barrel Reference Sensor	ORNL	X	X	
Adaptive Optical Zoom for Combat Rifles	SANDIA	X	X	
Concept & Numerically Modeling for Energy Harvesting	LOS ALAMOS			X
Microsight Technology	IDAHO NATIONAL LAB		X	

New for FY09

New for FY10

Metrics (Advanced Fire Control ATO)	
1	Unsupported Range Determination
2	Missed moving targets
3	Shared Power Weight reduction

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Industry Status

✓ **Stevens Institute of Technology**

- **Project Title:** "A Standalone/Networked, Compact, Low Power, Image-fused Multi-Spectrum Sensor System for Target Acquisition, Tracking and Fire Control"
- **Status:** Phase I completed, TRL 2 achieved, Phase II in-process (working to TRL 3)

✓ **L-3 Brashear Corp.**

- **Project Title:** "Steering and Automated Target Tracking
- **Status:** Phase 1A, 1B completed, TRL 2 achieved, Phase II in-process (working to TRL 3)

✓ **Penn-State University**

- **Project Title:** "Covert RF Sensor"
- **Status:** FY09 award, characterization of components, materials, for initial concept underway

✓ **Intelligent Automation Associates (IAI)**

- **Project Title:** "Automated Target Tracking Laser Range Finder for Small Arms TA/FC
- **Status:** FY09 award, Target tracking concepts /component integration initiated, TRL 2 achieved

Fire Control Technology Areas Addressed

- Multi-wavelength imaging target acquisition system comprised of a dual laser radar system (LIDAR)
- Acoustic SONAR and forward looking infrared (FLIR) image acquisition technologies.
- Transmit/receive optics for DVO, night vision, and range-finding, RF Sensor technology
- Integrated technologies for Laser Rangefinder, Micro-Display, Thermal Imager, and control electronics
- Low light level TV/IR camera, Software target recognition, Software trackers
- Laser transmitter, Laser beam steering, Laser receiver, Laser signal processing, Advanced Optics
- Minimization of weight, volume, and power consumption parameters

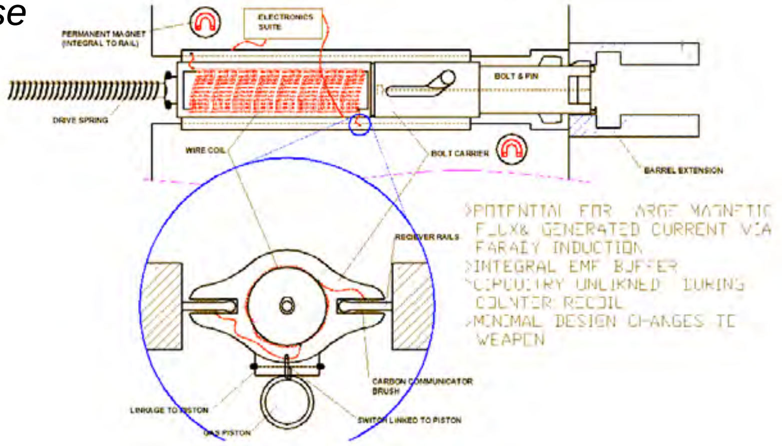
Enabling Technology Status (ARDEC)

Armament Research Development & Engineering Center (ARDEC)

- ***Title:*** *Weapons Electrical Energy Harvesting (WEEH)*

- ***Objective:*** *Investigate novel ways by using the cyclic motion in small caliber machine guns to generate electricity*

- ***Status***
  - ✓*Magnetic circuit design and bolt wiring scheme optimization (wire loop dimensions, orientation, magnet selection, mounting)*
  - ✓*First iteration layout formulated for incorporation into small cal.*
  - ✓*First order power output estimation analysis conducted*
  - ✓*Los Alamos Labs providing numerical modeling expertise*



Enabling Technology Updates (Department of Energy)

Oak Ridge National Lab (Optical Fiber-based Barrel reference sensor)

- **Objective:** Implement a barrel deflection reference sensor on weapon.
- **Status:**
  - Measurement & characterizing barrel oscillations completed
  - Bore sight laser calibration system established and tested
  - Breadboard fiber optic interference system built

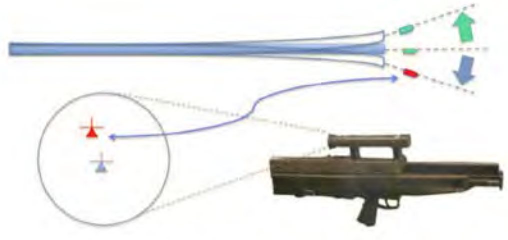


Figure 0. Barrel position sensor and reticle compensation system.

Sandia National Lab (Adaptive Optical Zoom for Combat Rifles)

- **Objective:** Provide a variable power magnifying optic over a much wider range with a button
- **Status:**
  - Polymer lens fabrication & characterization established
  - Lens core actuation modification in progress
  - Temperature compensator sensor initiated

Idaho National Lab (Microsight Lens technology)

- **Objective:** Dual focus lens capability for simultaneous focus on both the front sight and target.
- **Status:**
  - Three (3) designs with under development to address sight radius for M4/LSAT.SAT.

Summary & Path Forward

- **Awaiting confirmation to extend Advanced Fire Control ATO one (1) additional year.**
  - Full maturation of technology will be achieved (TRL 4)
  - Enhances transition to follow-on effort (PM, ATO's)

- **One (1) new effort to be awarded in FY10**

- **Enabling Technology Efforts on-going**
  - Idaho National Labs
  - Los Alamos National Labs

Path Forward?

- *We are getting answers from industry academia, and government.*
- *ATO components technology is maturing*
- *Take best component technology and start integrating onto weapons platform to support multiple missions!!*

LORD Corporation

Magnelok™ – Rotary Brake Technology

NDIA Joint Armaments
May 19, 2010

Paper by Fernando Goncalves and Vince Sadd
Presentation by Scott Miller

VALUABLE
RESPONSIVE
INNOVATIVE

LORD
Ask Us How™

A Technology-Oriented Global Corporation

Core Competencies:
•Surface science
•Polymer science and engineering
•Material science
•Mechanical design
•Dynamic system design and analysis
•Electromechanical systems

- $610 million annual sales
- 2,400+ employees
- 17 manufacturing facilities
and 8 R&D centers in 9 countries
- Over 90 sales and service centers worldwide
- Corporate headquarters in Cary, NC
- Privately held

Aerospace Customers

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Honeywell

eurocopter
an EADS Company

DASSAULT AVIATION

BAE SYSTEMS

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GE

NORTHROP GRUMMAN

ATK

MD HELICOPTERS

U.S.ARMY

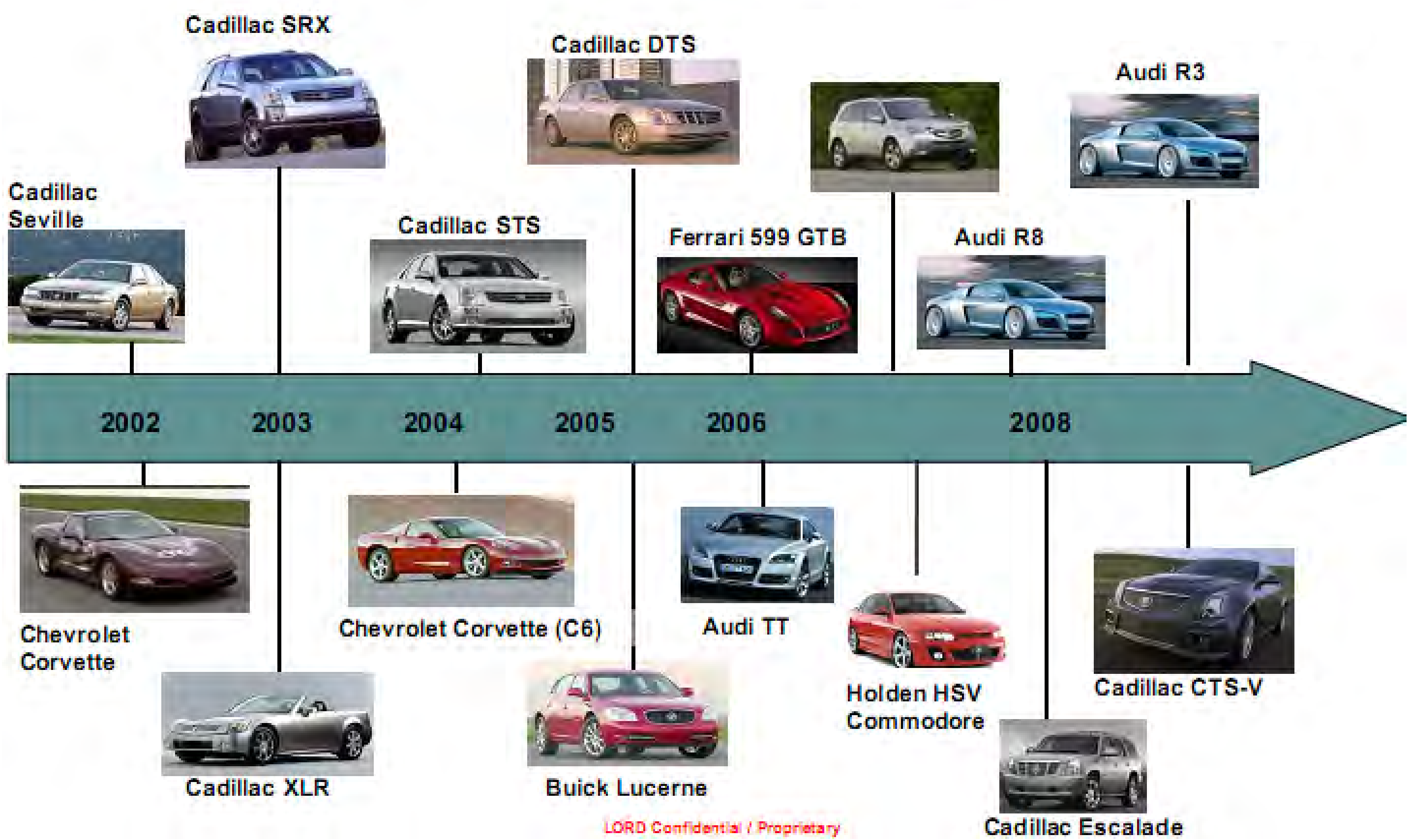
DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA

DARPA

Rockwell Collins

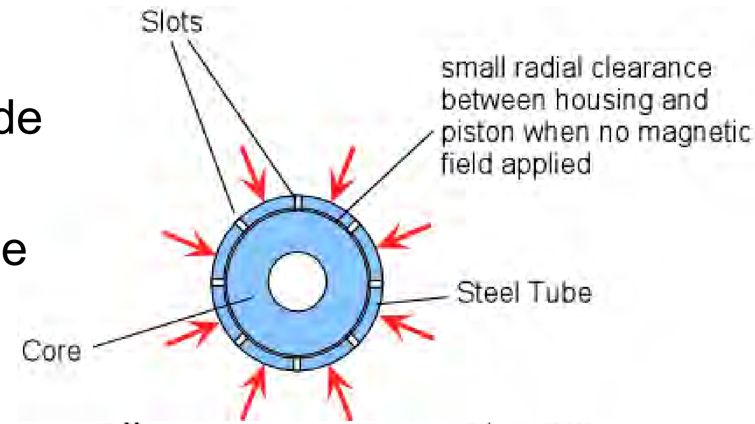
Magneto-Rheological (MR) Fluid-Based Controllable Dampers

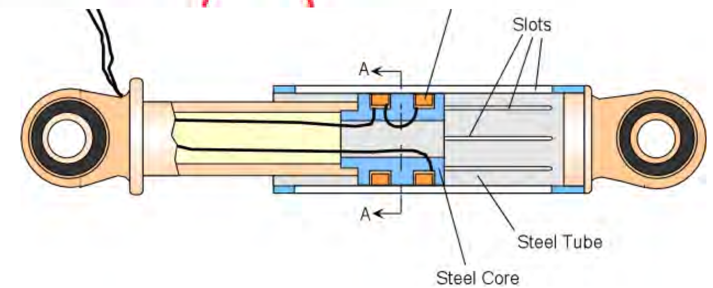
- LORD Corporation's MR technology has been proven through the licensing and broad intellectual property portfolio used in developing BWI Group's MagneRide™ suspension system. The system now appears with more than 500,000 MR devices in more than a dozen models from multiple automotive OEMs of LORD MR technology.

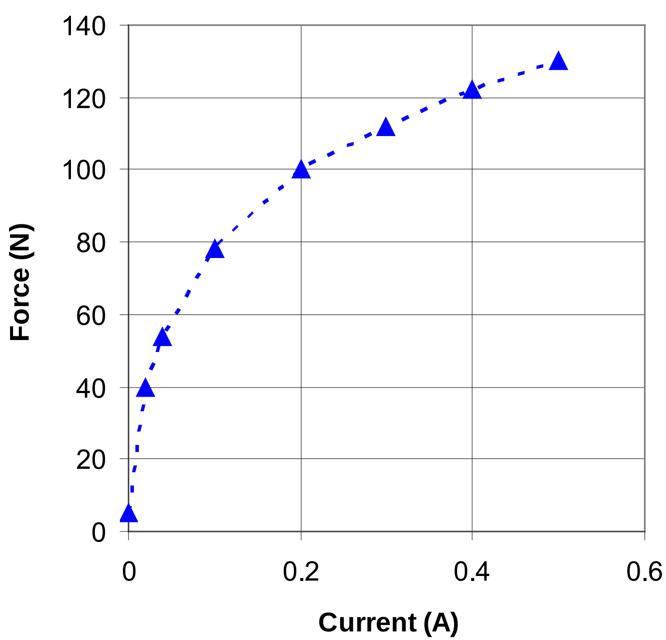


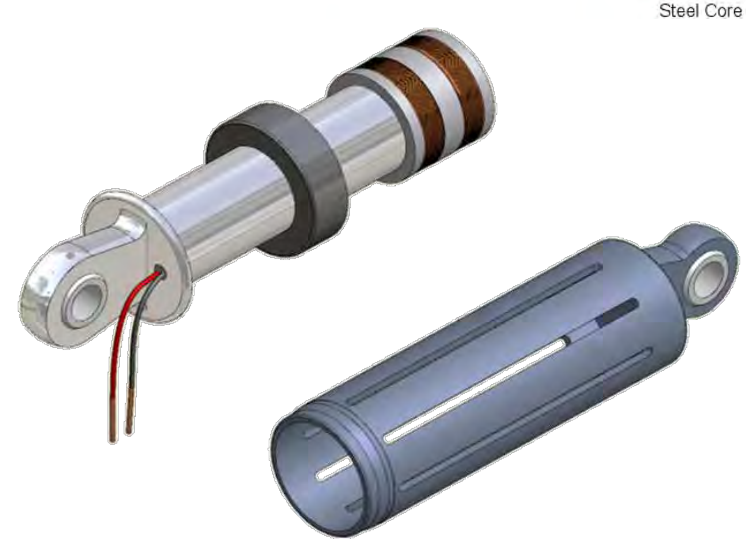
Magnelok ™ – A Technology Platform

- Complimentary to MR fluid technology
- Magnelok™ devices contain no MR fluid and provide better locking capability and complete decoupling
- In linear versions, normal force is proportional to the magnitude of the magnetic field
- Application of magnetic field causes the housing to constrict radially and squeeze the piston
- Force is a function of the magnetically-controlled normal force and the coefficient of friction



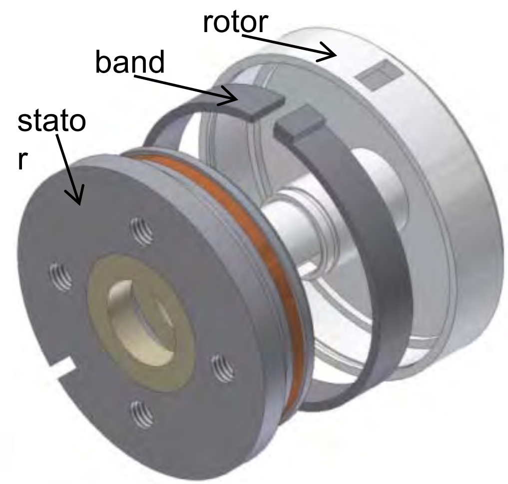


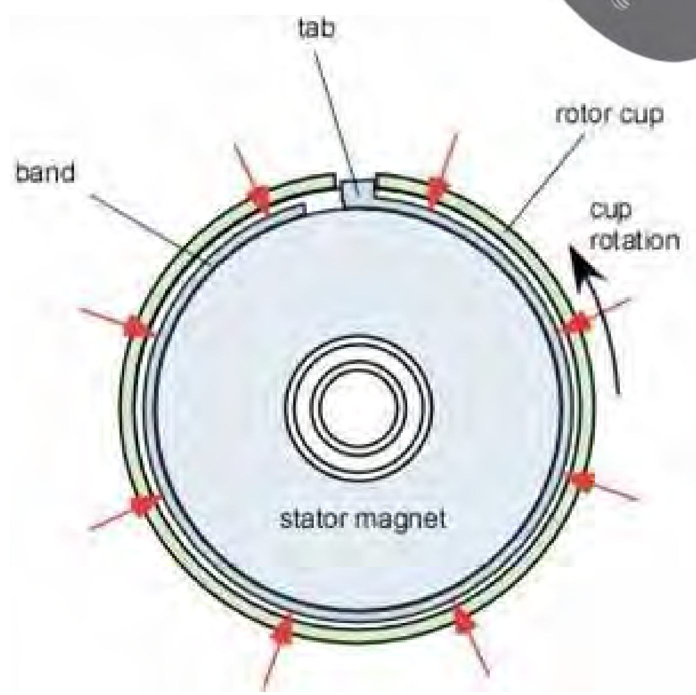




Rotary Magnelok™ Brakes Became Particularly Intriguing as They Evolved into Band Brakes

- The rotary Magnelok™ brake utilizes a flexible band
- The band is pulled azimuthally around the core by the rotor cup
- The rotary Magnelok™ brake leverages the property that the friction coefficient affects the torque output exponentially—leading to the potential of very high torques in small packages



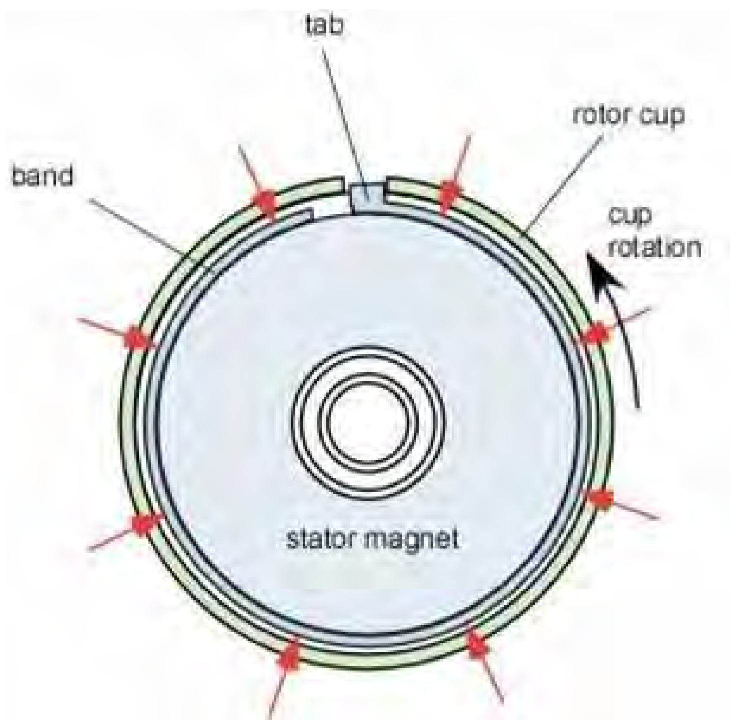


$$Torque = P_{mag} r^2 w\left(e^{\mu\phi} - 1\right)$$

Failsafe (Power-to-Unlock) Magnelok™ Brakes are a complementary development

Traditional Magnelok™ Band-Brake (power-to-engage)

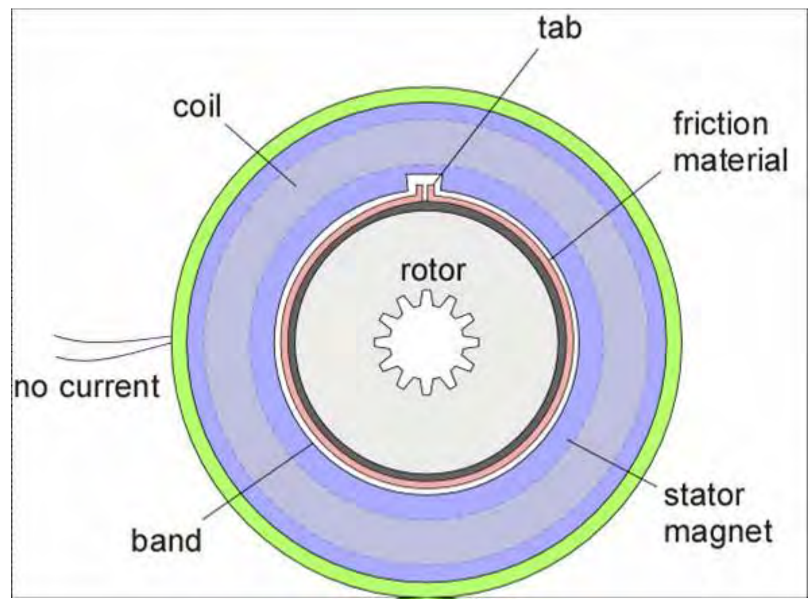
Magnetic field controls the normal force and hence the frictional force



T.R.L. ≈ 7

Failsafe Magnelok™ Band-Brake (power-to-unlock)

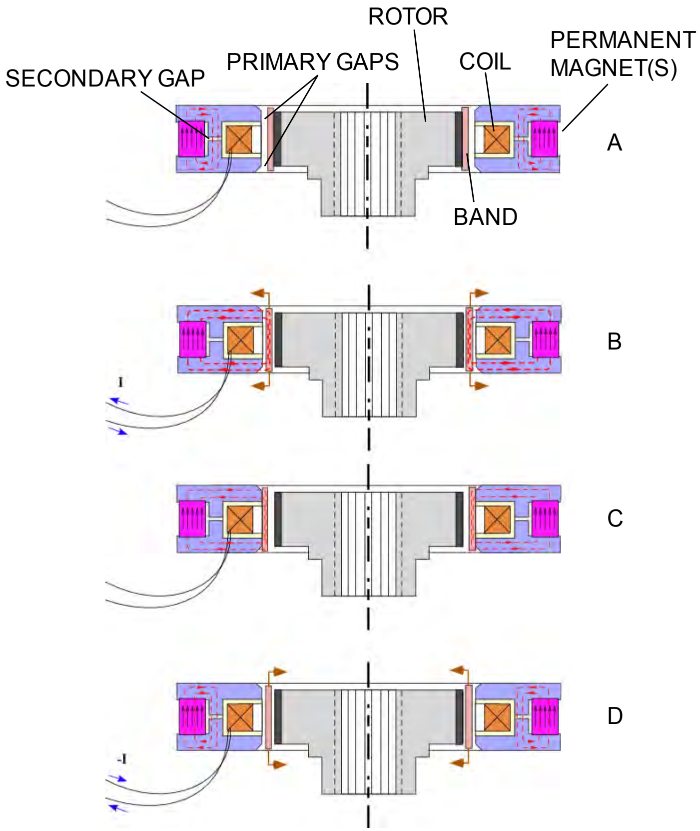
Band stiffness controls normal force and hence frictional force



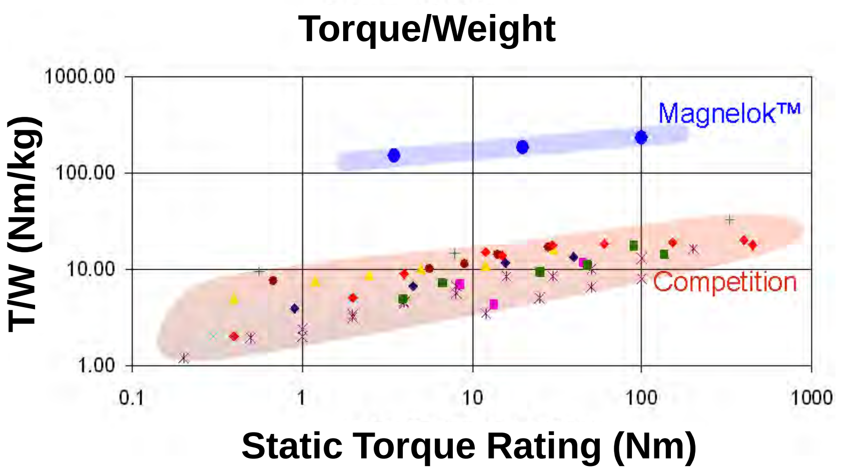
T.R.L. ≈ 3

Pulse-On/Pulse-Off Embodiment

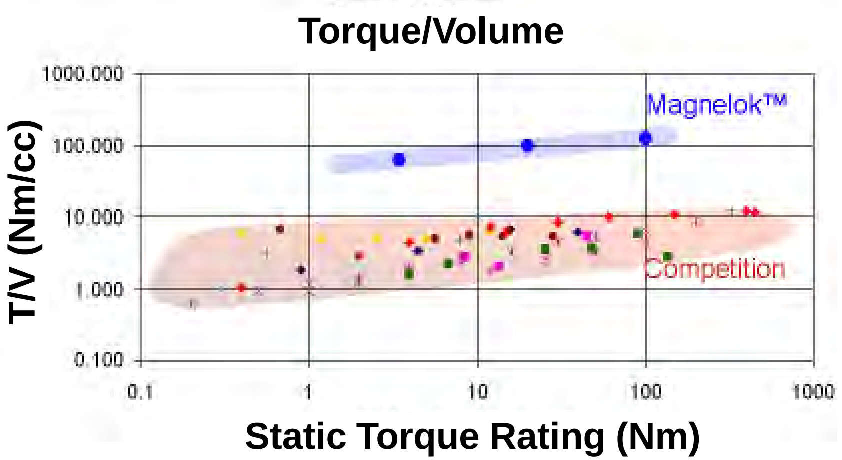
- A version of the technology that changes state in response to an electrical pulse has been demonstrated, and is near T.R.L. 2



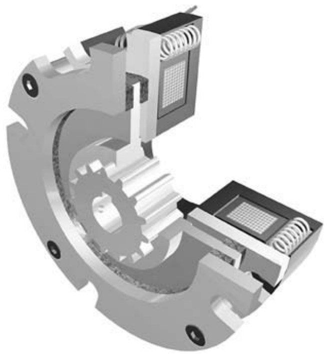
… is lower weight



… takes less space

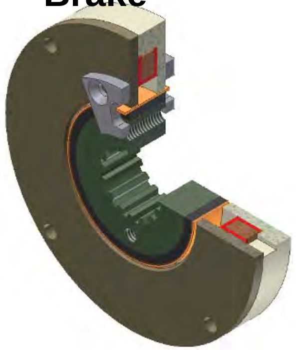


Incumbent



$$T = \frac{2}{3} P \pi \mu \left(r_o^3 - r_i^3 \right)$$

Magnelok™ Brake



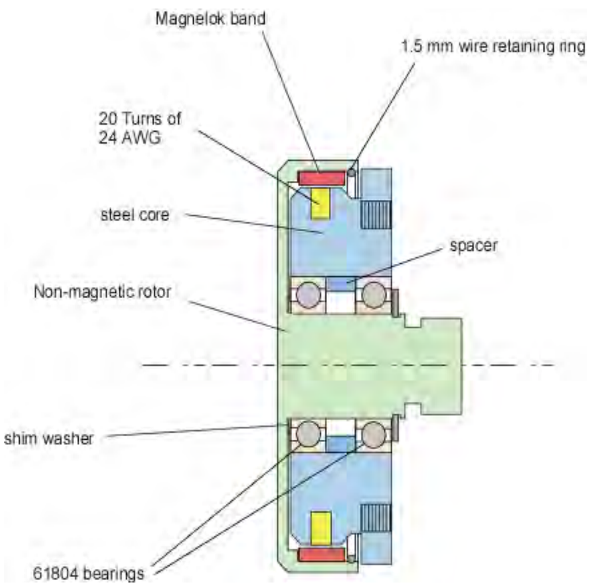
$$T = Pwr^2 \left(e^{\mu \phi} - 1 \right)$$

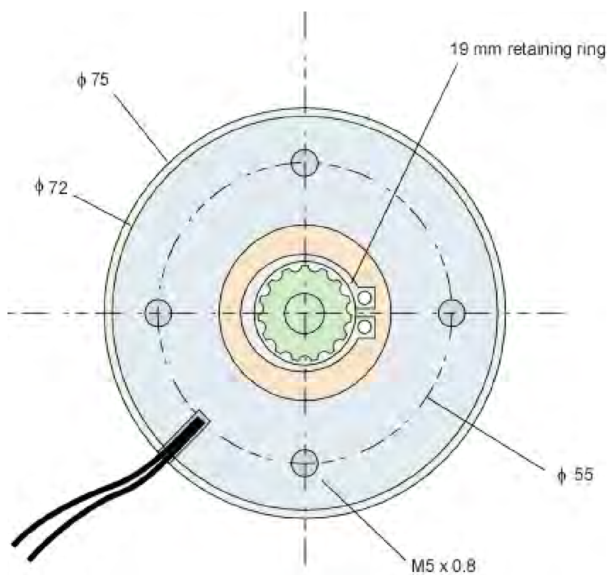
100 N-m Magnelok™ Band Brake

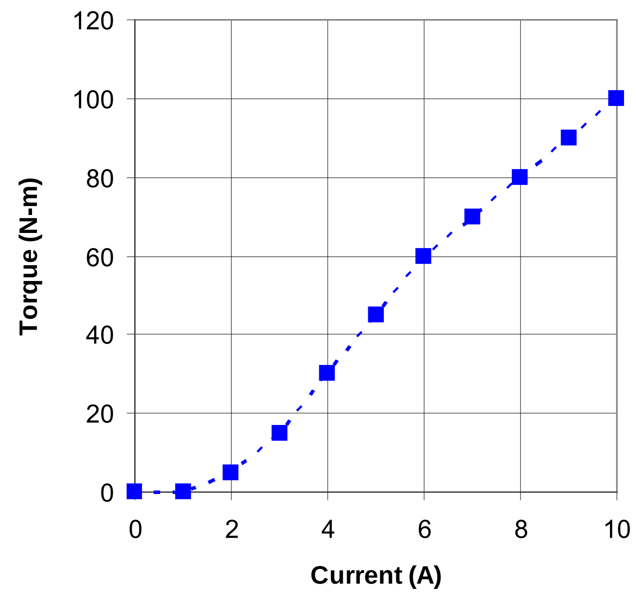
75 mm (3 in) diameter

25.4 mm (1 in) axial length

~ 0.5 kg (1 lb) weight







Magnelok™– Applications

♦ Aerospace Applications

- Control surface motor drive locking devices
- Backdrive prevention devices
- Stopping brakes and electrical brake actuators
- Control stick, knob or other human interface locks
- Cockpit door locks
- Seat recline or other articulation mechanism locks
- Retractable door step hinge locks
- Exit door hinge locks
- Kitchen galley cart wheel locks
- Cargo container wheel locks
- Thrust reverser mechanism locks
- Bin door hinge locks
- Engine door locks
- Helicopter particle separator mechanism locks
- Helicopter winch mechanism locks
- Landing gear door locks

♦ Industrial Applications

- General Industrial electric brake motors
  - Many applications from fractions of an oz-in to thousands of ft-lb have been demonstrated
- Belt tensioners
- Door hold-open locks
- Seat articulation locks

Questions?

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Lord Corporation
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919-469-2500 x-2317

Non-Incendiary Illumination Applications For Ammunition

Guns & Missiles Conference

May 17-20, 2010

CYALUME® Light Technology

GENERAL DYNAMICS

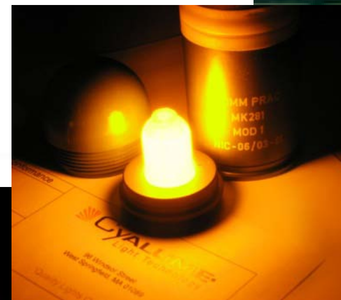
Ordnance and Tactical Systems

Overview

- GD-OTS and Cyalume Technologies are introducing several distinct low-cost projectiles that will help utilize USG existing excess hardware and offer new technologies in low-level (overt and covert) illumination and marking capabilities for artillery and mortar systems.
- Each yield non-incendiary solutions that would be inherently inert, environmentally safe, and user-friendly.

Existing Products

- MK 281 Mod 0 / 1 40mm Trainer
- 40mm High Velocity (Rheinmetall Prime Contractor)
- Day and Night Marker
- Produced Since 2006



CYALUME®
Light Technology

40mm High Velocity
Mark 281

Why Non-Incendiary?

- With current suites of marker and illuminating ammunition the warfighter is at the risk of initiating unwanted fires in non-combatant areas
- Non-Incendiary offers lower costs by eliminating hazardous burning materials
- Non-toxic, Green Ammunition

Nonflammable IR – Illumination Applications

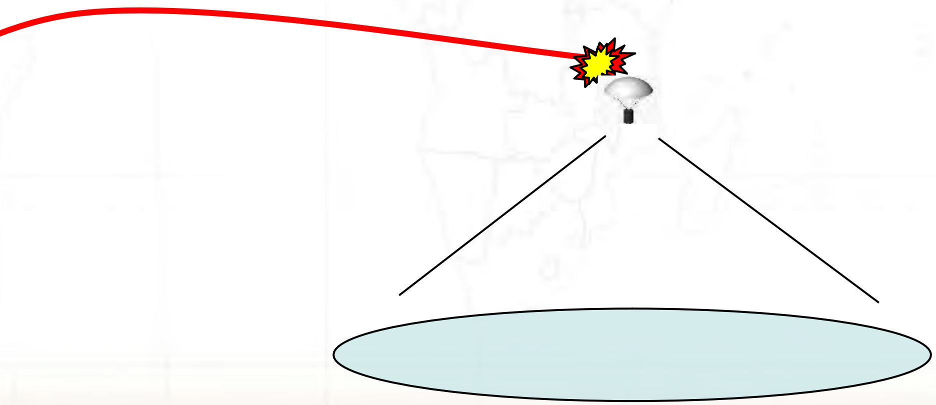
- Promoting Green Training and Operational Munition Applications that are non-toxic, nonflammable, non-energetic, non-dud producing and biodegradable
- Integrating Overt (visible) and Covert (IR/Thermal) Chemiluminescent Munitions for mortar and artillery applications
- Integrating non-toxic, nonflammable IR Illumination with extended duration times
- IR Illumination applications for Mortars and Artillery
- Enhanced capabilities and reduced collateral damage in training and noncombatant areas

Non-Incendiary IR Illumination Benefits

- Elimination of residual visible light
- Reduce operational collateral damage for noncombatants
- Means to expedite and enhance US Military range cleanup and maintenance
- Integrate an active environmental program to save taxpayer dollars at the requirements level
- Ability to train and qualify supporting amphibious and afloat operations for inland and coastal waterways
- Activate US Government Cost Savings Referral Program

Non-Incendiary IR Illumination

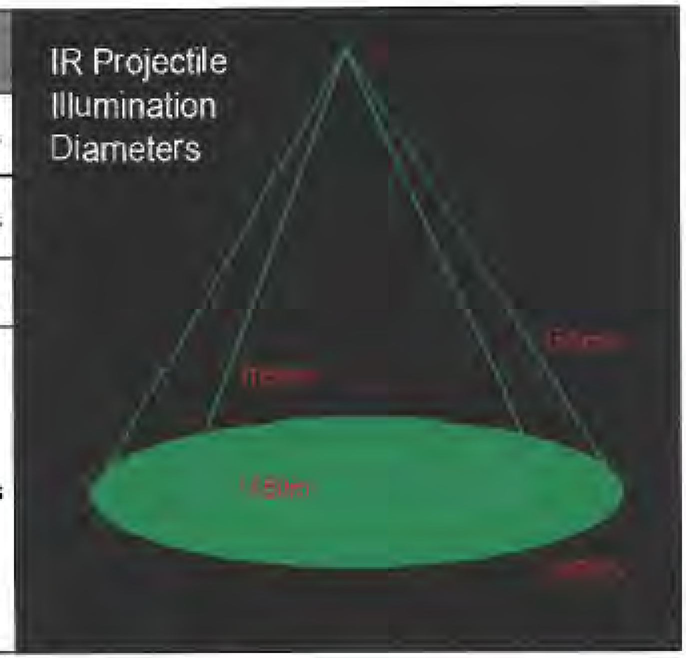
- The replacement of flare-type illuminant payloads with inert chemiluminescent candles that can produce pure IR-spectrum illumination without any residual visible light.
- Applicable to both mortars and artillery as potential illuminants
- Payloads can be tailored to meet mass and physical properties of existing cargo to ensure ballistic similitude



Current Incendiary IR ILLUM Candles

IR Cannon Projectile Illumination Diameters vs. Visible Illumination Diameters at a Height of Illumination of 650-800 meters and a Required Minimum Ground Illumination Intensity of .18 foot-candle.

Cannon SIZE	Projectile NAME	SIZE RATIO	ILLUMINATION DIAMETER
105mm [IR]	XM1064	2.75	1650 meters
155mm [IR]	XM1066	4.0	2400 meters
105mm	M314A3	1.0	600 meters
155mm	M485A2	1.7	1000 meters



This family of IR Projectiles can provide infrared illumination ground coverage of about 2.5 times more than standard illuminating Projectiles

CYALUME®
Light Technology

Day / Night Marker Simulation

Green Munitions

Cyalume Green/Eco-friendly Technology

- Chemiluminescent technologies are
  - ✓ Non-toxic
  - ✓ Not harmful to the environment
  - ✓ Biodegradable
- Enhance Training and Operational Capabilities
  - ✓ Train 24/7, 365
  - ✓ Train during Wet and Dry Range Periods
  - ✓ Reduce Contamination
  - ✓ Reduce Noncombatant Collateral Damage
- Significantly reduces USG costs for range maintenance and clean-up

Non-incendiary Munitions

- Chemiluminescent Munitions that are
  - ✓ Nonflammable
  - ✓ Non-energetic
  - ✓ Non-Dud Producing
- Enhance training and operational capabilities
  - ✓ Train 24/7, 365
  - ✓ Train during Wet & Dry Range Periods
  - ✓ Enable Combat Maneuver Training
  - ✓ Reduce Noncombatant Collateral Damage
- Significantly reduces USG costs for Range Maintenance, Clean-up and Range Fires

Points of Contact

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Director – Chemiluminescent Munitions

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RDECOM

Malcolm Baldrige National Quality Award

2007 Award Recipient

RDECOM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

XM153 CROWS
Vehicle Integration

Presented By:
Joseph M. Scheneck, PE
Lead Systems Engineer
XM153 CROWS (SOCOM Team)

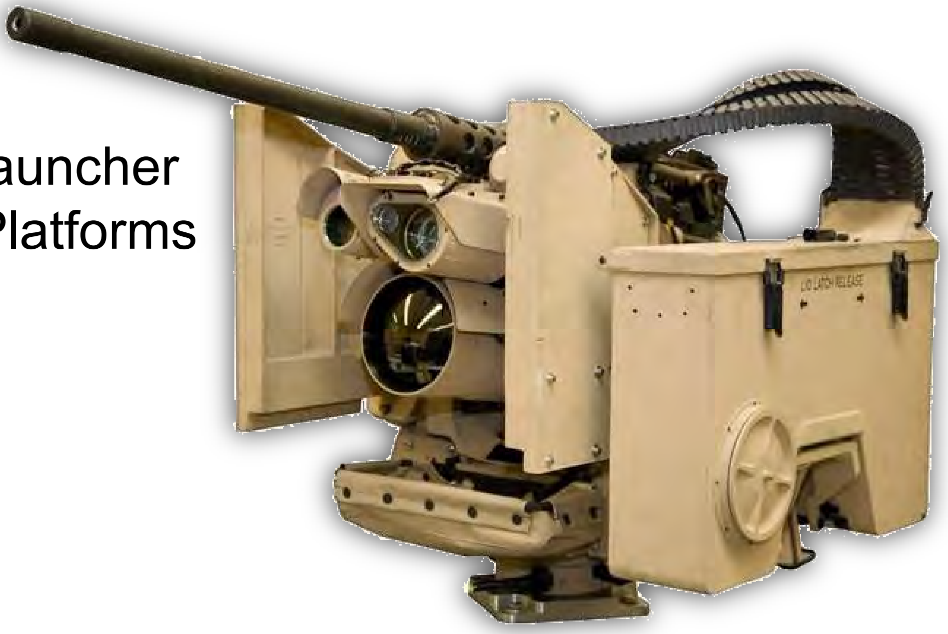
Agenda

- System General Description
- Basic CROWS Components
- XM153 CROWS Advantages
- XM153 Configurations
- Integration Considerations
- Vehicle Integration Kit
- Vehicle Configuration File
- Modeling and Simulation
- Testing
- Logistics
- Fielding and Sustainment
- Vehicle Platforms

XM153 CROWS Integration

General Description

- Stabilized Remotely Operated Weapons Station
- Capability to Aim and Fire a Suite of Crew Served Weapons
  - M2HB .50 Caliber
  - M240 7.62mm MG
  - M249 5.56mm SAW
  - Mk19 40mm Grenade Launcher
- Supports Large Number of Platforms
  - Stationary
  - Vehicle
    - US Army
    - US Air Force
    - SOCOM
    - DOE
  - Host Vehicle Power



XM153 CROWS Integration

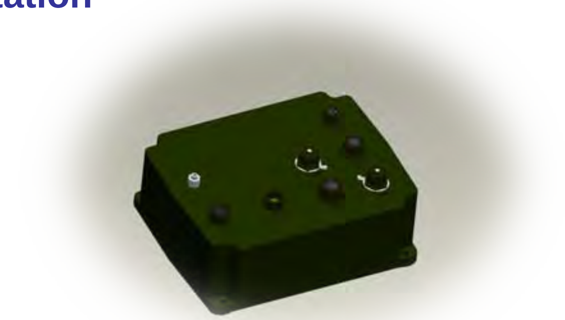
Basic Components

- Mount with Weapon Cradle
- Traverse and Elevation Drives
- Laser Range Finder
- Weapons Interface
- Remote Weapon Charger
- Ammunition Magazine Feed System
- Control Grip
- Fire Control Unit
- Viewing and Sighting Unit
    - Visual
    - Thermal

Weapons Station

Control Grip

Display & Control Panel (DCP)



Main Processing Unit (MPU)

XM153 CROWS Integration

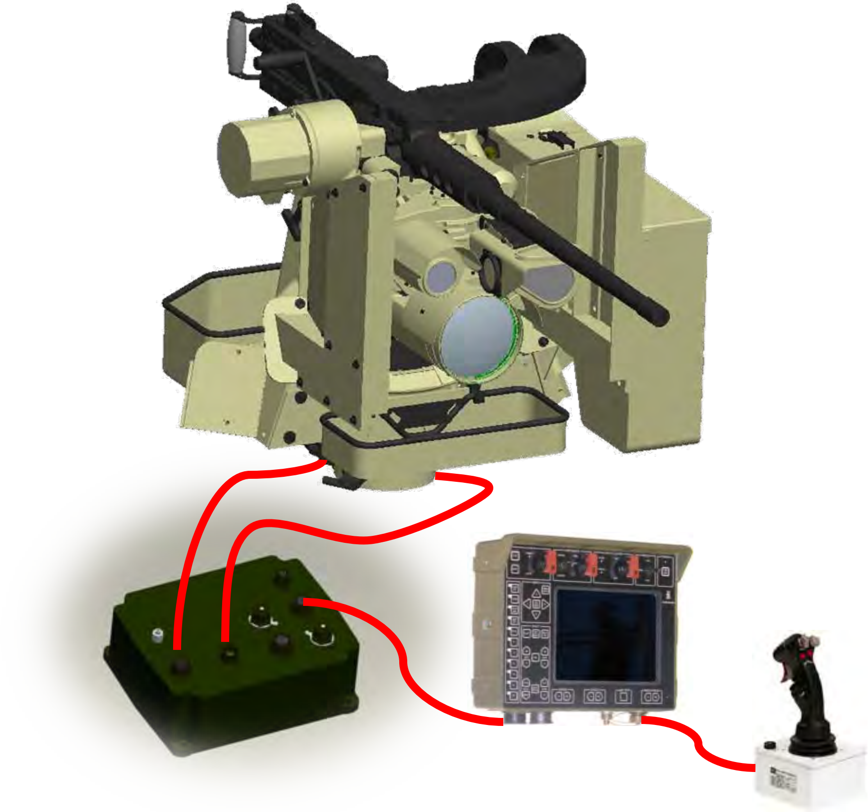
XM153 CROWS Advantages

- Gunner Protected Under Armor
- Can Be Installed on Light Armored Vehicles
- Enhanced Target Acquisition
  - Day
  - Night
- Enhanced Target Identification
- Engagement Capabilities
  - Shoot-on-the-move
  - Target Leading
- 360 Degree Capability

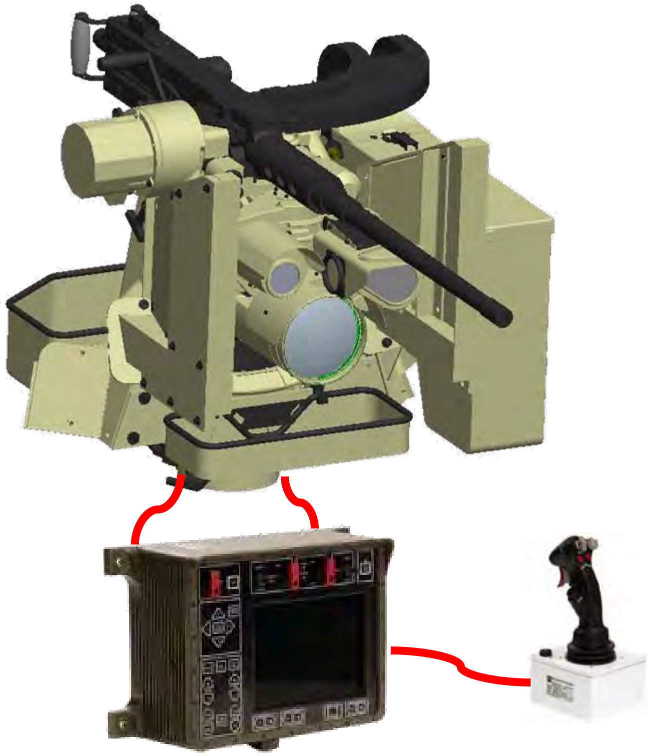
Vehicle Integration

XM153 CROWS Integration

Baseline XM153 CROWS
(aka Split Screen)



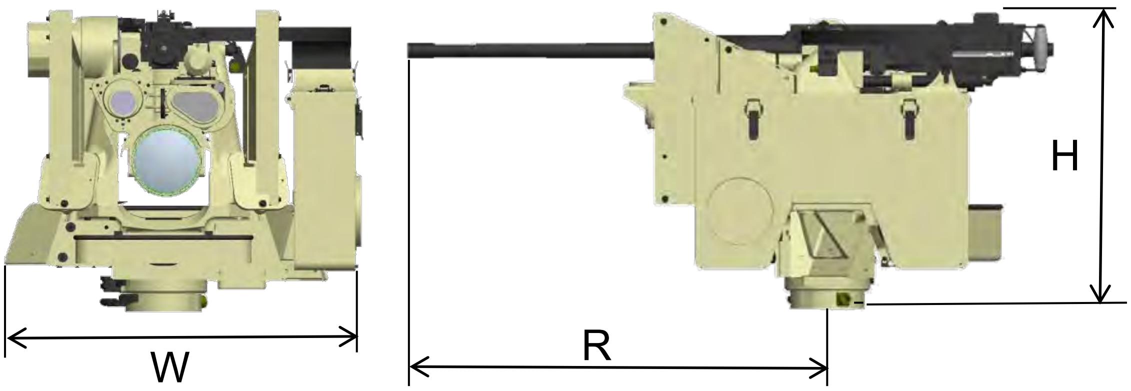
Optional XM153 CROWS
(aka Thick Screen)



XM153 CROWS Integration

Weapons Station Integration Considerations

- Height w/ M2 @ Maximum Elevation: 65” Approx.
- Height @ 0 Elevation: 30” Approx.
- Traverse Radius w/ M2 @ 0 Elevation: 43” Approx.
- Maximum Weight Above Roof : 600 lb. Approx.
- Above Height & Weight Exclude Vehicle Integration Kit
- Power Requirements
- Vehicle Egress
- Transportability
- Weapon Station Access
  - Reload
  - Clear Jams
  - Manual Firing



XM153 CROWS Integration

Interior Integration Considerations

- Human Factors
  - Control Grip Location
  - Screen Location
    - Gunner Distance
    - Two Hand Operation
- Egress
  - Control Grip Location
  - Cable Routing
- Gunner Seat Location
  - Forward/Rear Facing
  - Vehicle Side
- Vehicle Fire Suppression System

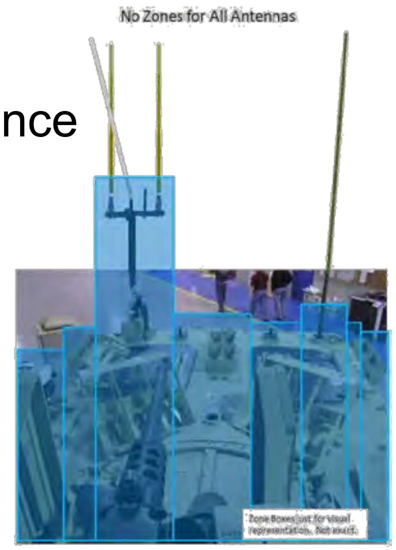
XM153 CROWS Integration

Vehicle Integration Kit (VIK) Considerations

- Mechanical and Electrical Interface Control Document
- Mounting Hardware
  - Weapon Station
    - Structurally Sound Mounting
    - RWS mounting surface > Resonance Frequency
    - 360 Degree Visibility
  - Control Unit
    - Display location relative to gunner seat
    - Egress
  - Control Grip
    - Wrist/Arm Support
    - Egress
  - Hatch/Door Interlock Sensor Mounts
  - Hatch Traverse Lock
  - Fuse Box

XM153 CROWS Integration

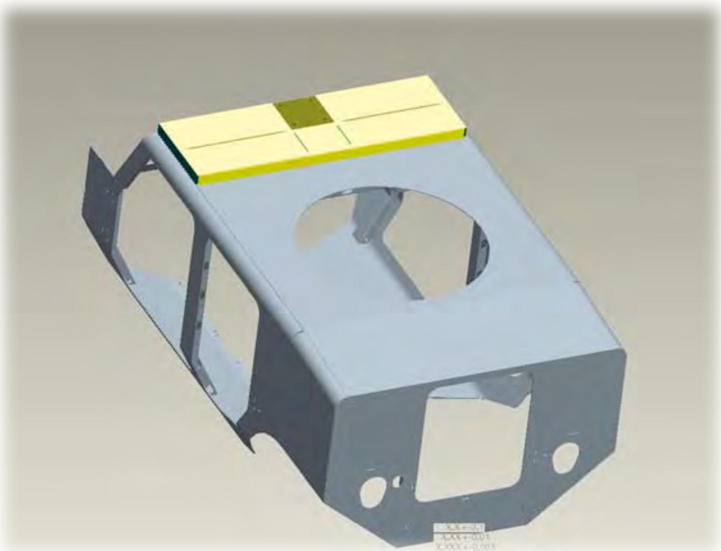
Vehicle Configuration File (XM153 CROWS II Only)

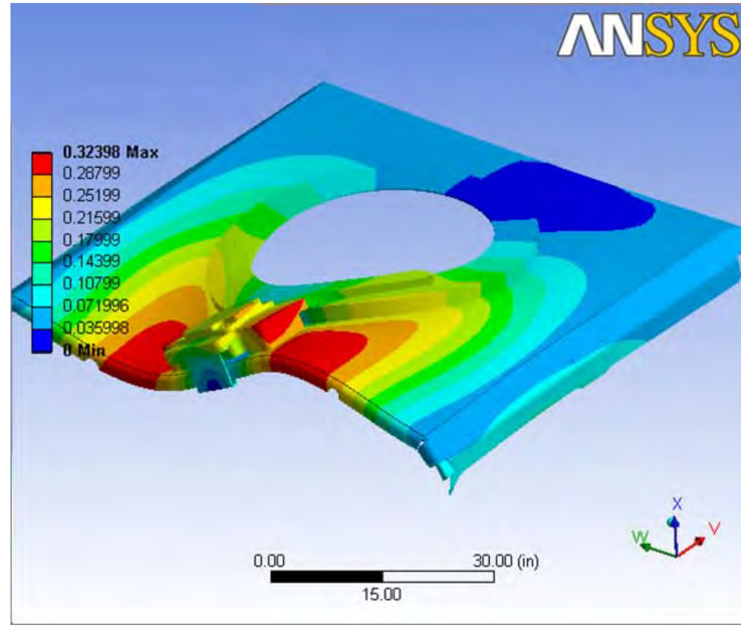


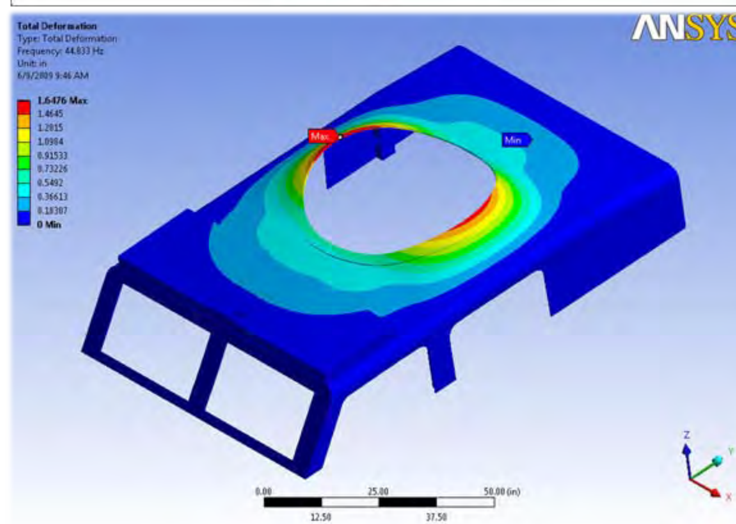
- PM CSW Maps Each Vehicle
  - No Traverse Zones: Weapons Station Physical Interference
  - No Fire Zones: Safety Inhibits, GFE Protection, etc
- All Exterior GFE Installed in Final Configuration
  - Overrideable Zones
  - Non Overrideable Zones
  - Hatch Specific Zones
- CROWS II Mounted in Fielded Configuration
- Exterior Vehicle Configuration Changes May Require Remapping
  - Bar Armor
  - Additional Antennas
  - Other GFE
  - Hardware Specific to a Single Vehicle can be Defined by the User
- PM CSW creates VCF, Platform PM Must Signoff Prior to Official Release

XM153 CROWS Integration

- Modeling and Simulation
  - Structural Analysis
  - Stiffness Analysis
  - Weapon Accuracy
  - Weight Optimization







XM153 CROWS Integration

Safety Confirmation Objective and Required Tests

- Non-Vehicle Specific
  - Accuracy
    - Mk19
    - M2
    - M240
    - M249
  - High Temperature
  - Low Temperature
  - Power Sources
  - Software Verification
  - Weapons Adapter Kit (WAK)
  - Feed Performance (Functional Firing)

- Vehicle Specific
  - E3
  - Human Factors
  - Vehicle Profile Verification (VCF)
  - Vehicle Characteristics
  - RAM
    - Durability / Reliability (500 Miles)
    - Functional Firing from Vehicle
  - Blue Jammer Interoperability/Compatibility
  - M2 Accuracy from the Vehicle

XM153 CROWS Integration

Logistics

- Operator Training
  - Training Materials
  - Tech Bulletins
- Maintenance
  - Field Service Representatives (FSR's)
  - Initial Spares
  - Depot Maintenance Support CLS oversight
- Delivery Schedules
- Installation
  - Manuals
  - Schedules
  - Sites
  - CONUS
  - OCONUS

Fielding & Sustainment

- VIK Production and Installation
  - Schedules
  - Locations
- Install Vehicle Configuration File
- New Equipment Training (NET)
- Manuals
- Spares
- Maintenance/ Repair of CROWS
- Software Updates

Platforms

RDECOM

XM153 CROWS Integration

- **Supported Vehicles**
  - M1114 Humvee
  - M1151 Humvee
  - M1116 Humvee
  - RG-33 MRAP
  - RG-31 MRAP
  - JERRV MRAP
  - Buffalo
  - Maxxpro MRAP
  - M-ATV
  - M1 Abrams TUSK
  - M93 Fox
  - Bearcat
  - MMPV
  - Caiman MRAP
  - Cougar MRAP

Customers

- United States Army
- United States Air Force
- US SOCOM
- DOE

Questions?

Environmentally Acceptable Alternatives To Existing Primary Explosives

Replacements for lead azide, lead styphnate and tetrazene

John Fronabarger
Michael Williams
Pacific Scientific EMC., Chandler, AZ USA

Magdy Bichay
NSWC-IH, Indian Head, MD USA

Technical Portions of this Presentation ITAR Approved 30Sept09 Ref. 09-S-2870

Green Energetics – Why?

Environmental:

>95% of all shooting, missile launches and explosions within the military or police force are done exclusively for training purposes in "friendly" areas.

In addition to the energetic materials themselves, one has to consider the materials used in manufacture, use and decommissioning/disposal of these materials in friendly areas.

Lead azide (LA) and lead styphnate (LS) are two widely used materials responsible for dangerously high levels of lead found at some firing ranges. Clean-up of heavy metal waste is extremely costly.

Safety:

NAVSEA Instruction 8020.3A (1986) – Limits use of LA in Navy ordnance – in non-hermetic systems LA may generate hydrazoic acid, a gas which can migrate and react to form unstable copper azide - fatalities have occurred.

Regulatory:

Executive Order 12856 (1993) – Issued to reduce/eliminate procurement of hazardous substances and chemicals by federal facilities. Included directives to use acquisition programs encouraging new technologies and building markets for environmentally friendly products.

EPA (TSCA) – frowns on the use of lead, mercury, barium and other heavy metals as well as perchlorate.

National Security:

There is currently ***NO*** U.S. Manufacturer of LA - ~ 1 ton/year is used for military items all of which comes from a diminishing stockpile produced in the 1950-60's and which has age related issues.

LS has only limited industry availability as it is made for captive use only by military/commercial ammunition facilities.

Green Energetics – Background

Lead Styphnate:

Major ingredient in stab and percussion primers, used as ignition element in hot-wire devices – high pressure output

PSEMC has synthesized/evaluated 13 different compounds in effort to find a replacement for LS

KDNP appears suitable as a drop-in replacement and offers high performance

KDNP was *approved* as safe and suitable for service use and qualified for weapons development in Feb2009

Lead Azide:

Most well known of the energetic inorganic azides, used widely in detonators/primers to initiate secondary explosives

RD1333 – Most sensitive/high performance, 98.7% with carboxymethylcellulose added to control particle characteristics

PVA – Also high performance, 96% with polyvinyl alcohol as crystal modifier

DLA – Least sensitive/best for safety/handling, 93% with dextrin crystal modifier (spherical)

Attempts to replace have been ongoing for 3 decades and include CP, ClCP, BNCP, DXN-1, cyanuric triazide

PSEMC has synthesized/evaluated 33 different compounds in effort to find a drop-in replacement for RD1333

DBX-1 appears suitable as a drop-in replacement and offers advantages over RD1333

PSEMC was awarded (with NSWC-IH and LANL) an R&D 100 award for work leading up to DBX-1 and KDNP.

Tetrazene:

Explosive high nitrogen material used for sensitization of a variety of priming compositions (mil/com ammunition)

Tetrazene is a high nitrogen material containing no heavy metals but has low hydrolytic and thermal stability

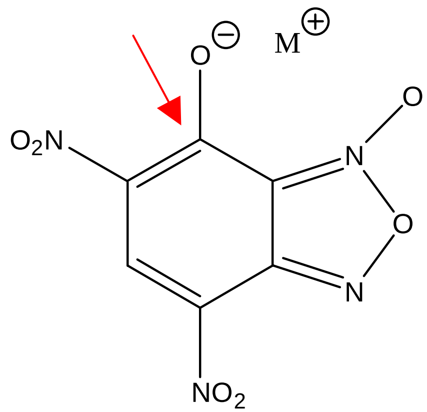
Extremely impact and friction sensitive.

PSEMC is currently involved, under contract with ONR, in a project to find a high stability replacement

Iso-DTET has sensitivity equivalent to tetrazene with high thermal and water stabilities

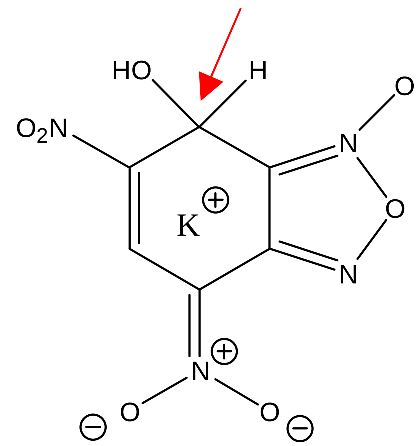
Green Energetics – KDNP

KDNP is based on KDNBF and has a similar structure but KDNBF is a Jackson-Meisenheimer adduct while KDNP is a true salt. Difference apparent when considering DSC temperatures.



4,6-Dinitro-7-hydroxybenzofuroxan, salt
MDNP
Safe Journal, Vol 35, #1, 14 (2007)

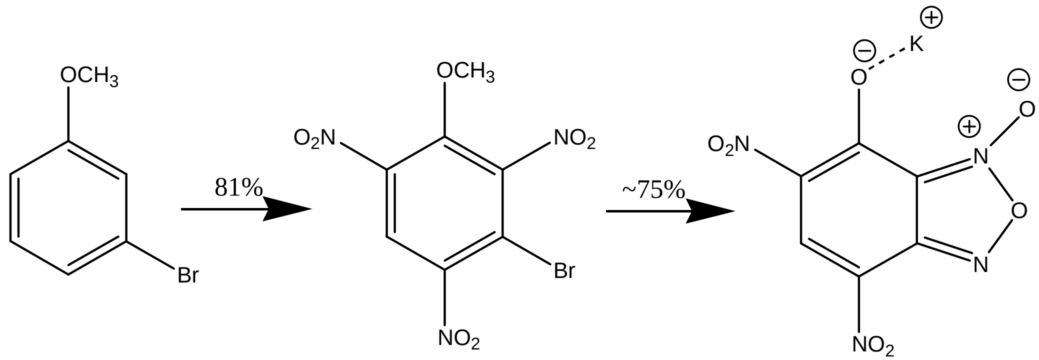
DSC exo 271°C

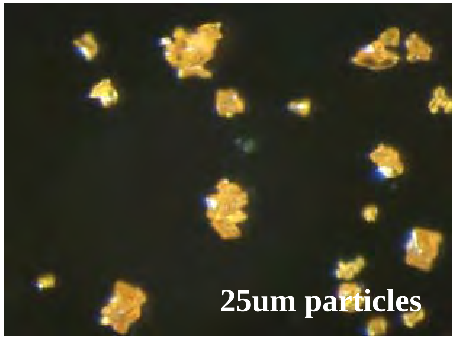


Potassium dinitrohydroxy hydrobenzofuroxan
KDNBF
Jackson-Meisenheimer adduct
Well known material introduced 1950's

DSC exo 217°C

Green Energetics – KDNP





KDNP (4,6-dinitro-7-hydroxybenzofuroxan, potassium salt) is currently prepared via a 2-step process
- a recrystallization step allows full control of particle size and tailoring for specific use (bridgewire vs. primer)
- other synthetic methods for preparation are currently being evaluated at PSEMC and NSWC-IH

Like LS, KDNP is a fast deflagrating material with good thermal stability and safe handling characteristics

KDNP has been evaluated vs. LS successfully in a variety of applications including
- CCU-63 Impulse Cartridge – in a bridgewire slurry mix
- TOW Missile Initiator Units – pressed onto bridgewire
- PVU-12/A Percussion Primers – a component of primer mix (with tetrazene)
- RSCB – as consolidated/unconsolidated output
- Various pressure-time (closed bomb) tests – has higher impetus, equivalent ignition time and faster rise time vs. LS
  - KDNP will easily ignite common propellants (Black Powder, $BKNO_3$, Red Dot, HiTemp, etc)

PSEMC completed Compound Qualification Testing on KDNP per NAVSEAINST 8020.5C in 2008
PSEMC and NSWC-IH are currently working alternate syntheses/MANTECH scale-up projects KDNP

Green Energetics – KDNP

DEPARTMENT OF THE NAVY
Naval Sea Systems Command
1333 ISAAC HULL AVE, SE
WASHINGTON NAVY YARD, DC 20376

IN REPLY REFER TO
8020
Ser N831/183
9 Feb 09

From: Commander, Naval Sea Systems Command

Subj: QUALIFICATION OF KDNP PRIMARY EXPLOSIVE

Ref: (a) NAVSEAINST 8020.5C of 5 May 00
(b) Technical Manual SW010-AG-ORD-010

Encl: (1) NAVSURFWARCENDIV Indian Head ltr 8020 Ser E216/12 of 14 Apr 08

1. KDNP (potassium 5, 7-dinitro-[2, 1, 3]-benzoxadiazol-4-olate 3-oxide) is a new primary explosive developed as a possible replacement for lead styphnate. KDNP has the potential for use in a wide range of explosive component applications and offers significant improvements in its environmental characteristics.

2. Based on the technical data provided in enclosure (1), the Naval Sea Systems Command hereby qualifies KDNP as a primary explosive in accordance with the requirements of reference (a). Qualification does not imply Final (Type) Qualification. Final (Type) Qualification requires further testing and approval in accordance with reference (a).

3. To date, KDNP has only been synthesized in small batch sizes. It is reasonable to expect that some changes in purity and morphology may be encountered when the synthesis is scaled up to production level batch sizes, possibly affecting sensitivity or performance properties. These possible changes must be investigated during any subsequent Final (Type) Qualification process.

4. For Commander, Naval Surface Warfare Center, Indian Head Division: Request incorporate KDNP into reference (b) identifying it as safe and suitable for service use and qualified for weapon development.

Laura M. DeSimone

LAURA M. DESIMONE
By direction

PATENTS PENDING

→ “KDNP is a green replacement for lead styphnate”

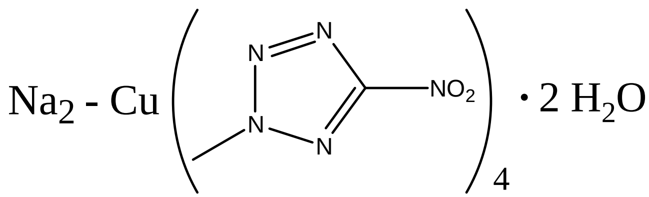
→ “Naval Sea Systems Command hereby qualifies KDNP as a primary explosive in accordance with the requirements of NAVSEAINST 8020.5C”

→ “Request incorporate KDNP into SWO10 identifying it as safe and suitable for service use and qualified for weapons development.”

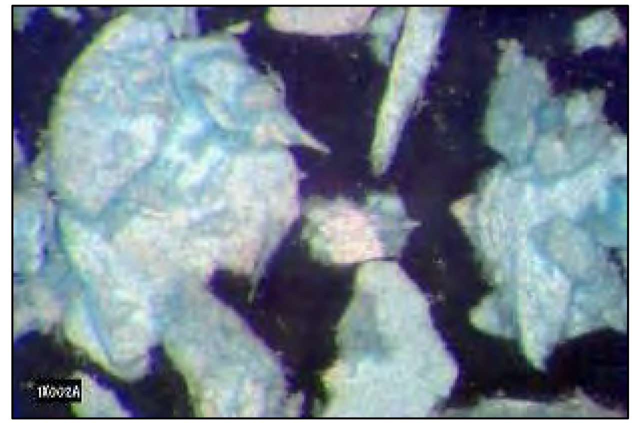
Green Energetics – DBX-1

DBX-1 Background

Composition:



Four nitrotetrazoles are complexed with Cu(II)



This material has lower output compared to LA - dead presses at high loading pressures
***Terrible* particle habit/morphology**

Attempts to reduce Cu(II) to Cu(I) with hydrazine gave crude DBX-1 (Sept 05')
Attempt substitute water with coordinating ligand (carbohydrazide) (Nov 05')
(Dr. Al Stern – NSWC-IH)

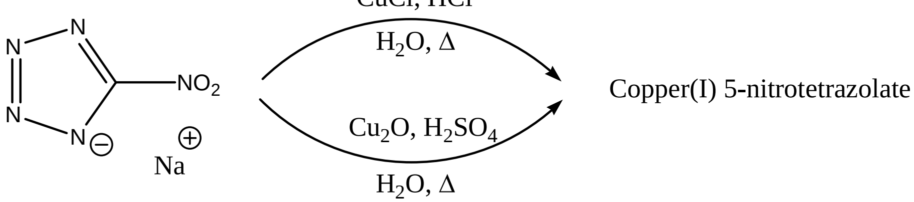
Modifications of these studies led to discovery of DBX-1

LANL-*Proceedings of the National Academy of Sciences* DOI: 10.1073/pnas.0600827103

Green Energetics – DBX-1

Copper(I) Complex of 5-Nitrotetrazole

NaNT



Use of conventional laboratory techniques & equipment…

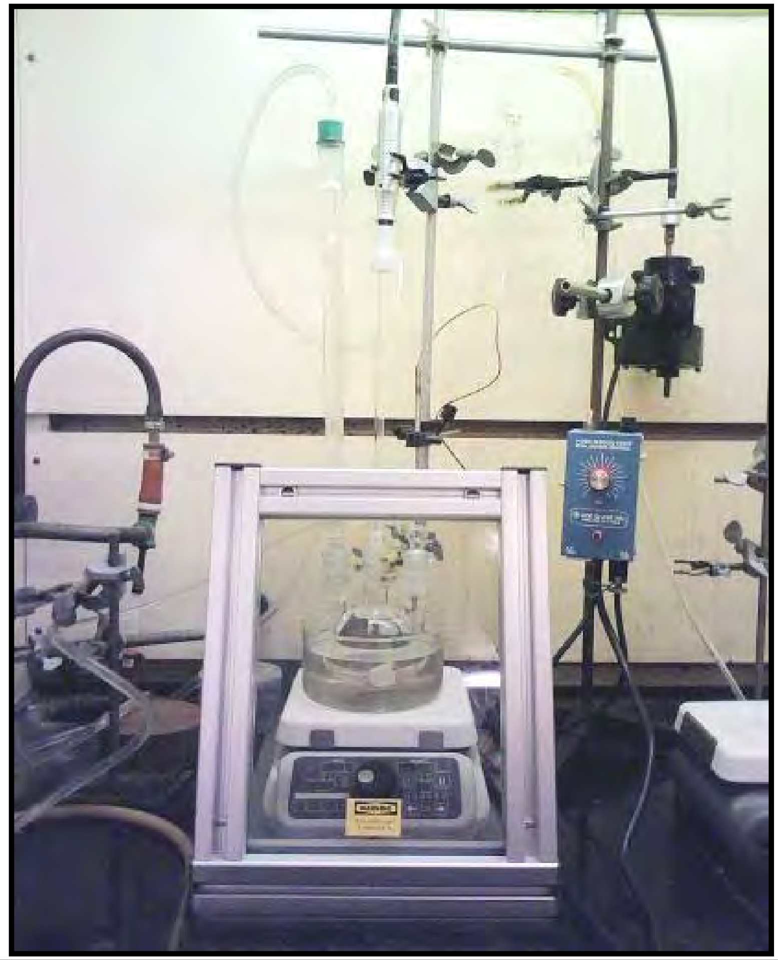
Starting materials added at front end

Unusual reaction – brown slurry to crystals

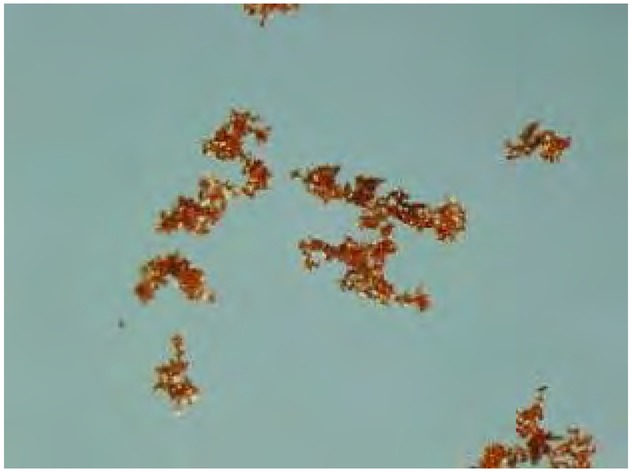
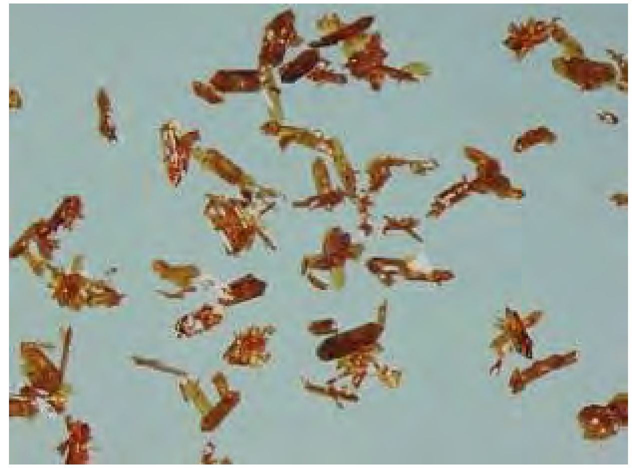
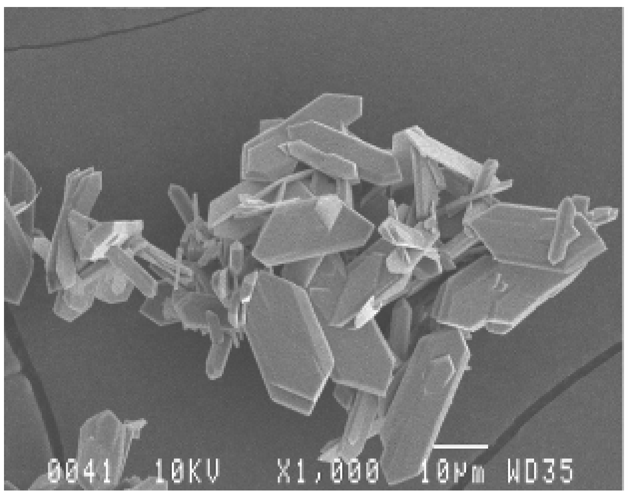
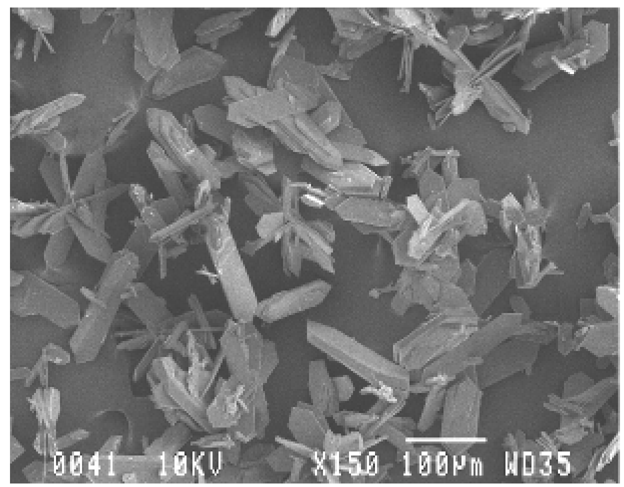
variable crystallization induction periods

DBX-1 isolated ~1 hour

Have evaluated variations – ratios, heating, acid etc.



Green Energetics – DBX-1

	EL3C098A	EL3C106A	
Optical 77x			77x
SEM 1000x			150x

Copper(I) Complex of 5-Nitrotetrazole (DBX-1)

Analysis of DBX-1:

- 5-Nitrotetrazolate content:

  UV-Vis analysis of NaOH extract:

  NT: 65.30 (257nm, pH ~8.0); Theory 64.22 (1:1, 5-NT:Cu)

- Estimated Copper Content:

  Residue (assumed to be Cu_2O) from UV analysis:

  Cu: 35.06; Theory: 35.78

  (Filtered solution from NaOH treatment was slightly blue before dilution, slight loss of Cu)

- Electrolytic Copper Content

  Platinum cathode 35.60%

X-Ray confirmed 1:1 of 5-NT and Cu

- Density: (He pycnometry) 2.59g/cm^3, (X-ray) 2.58g/cm^3

DBX-1 Sensitivity Testing

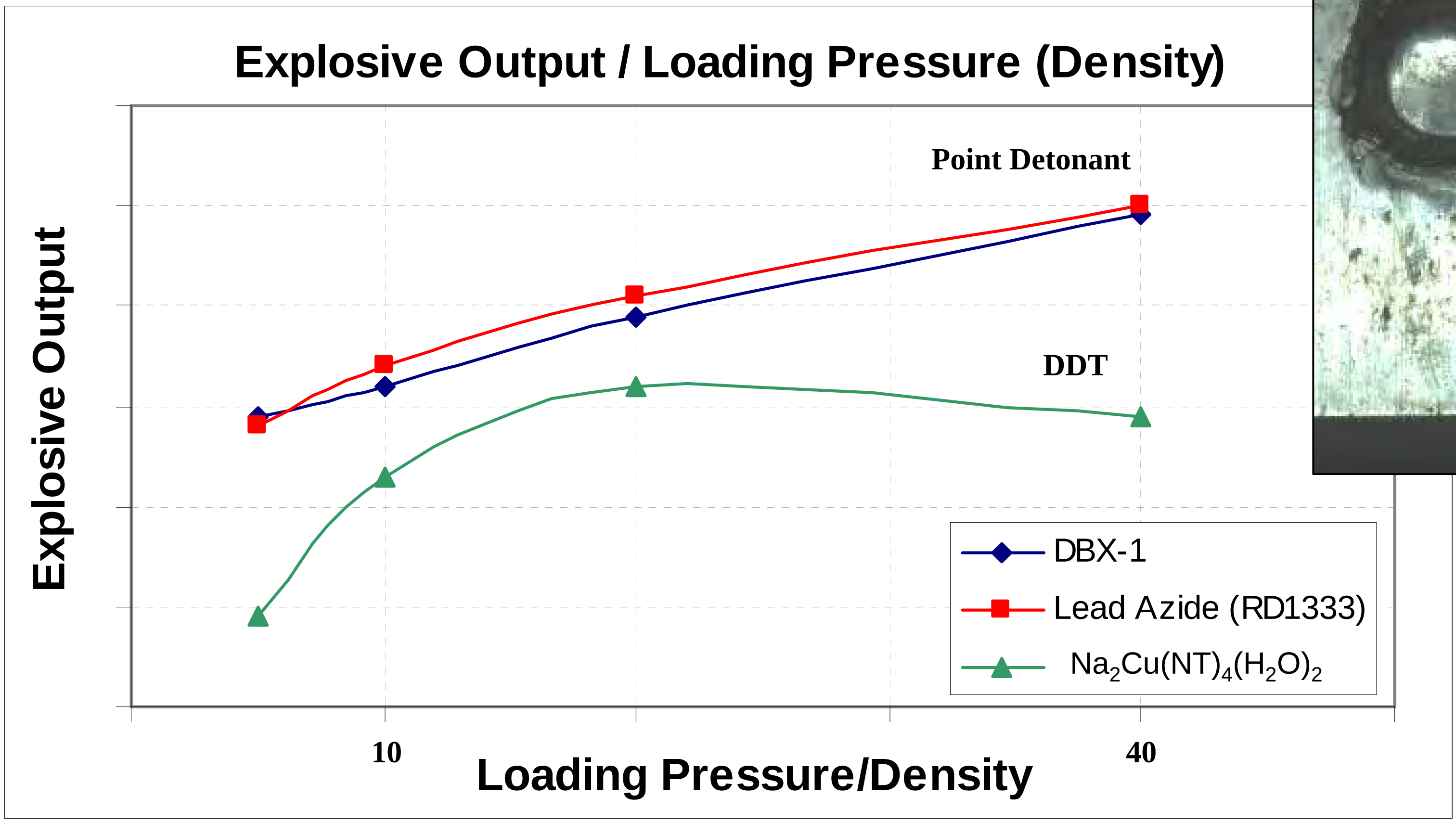
Essentially Equivalent to Lead Azide

SAMPLE	DSC (20ºC/minute)		IMPACT (J) (Ball Drop)	FRICTION (Small BAM)		DENSITY (g/cc) TMD	High Res TGA Onset of Wt. Loss	ESD (LEESA)
	Onset	Peak		No Fire	Low Fire			
DBX-1	329ºC	337ºC	0.040±0.010	0g	10g	2.59 (Cu)	260 ºC	12µJ
LA (RD1333)	332ºC	341ºC	0.050±0.004	0g	10g	4.80 (Pb)	166 ºC	6.75µJ

Low temperature weight loss for lead azide due to trace oxygen present in TGA system
An apparent disadvantage of lead azide compared to DBX-1

Green Energetics – DBX-1

DBX-1 Output Testing

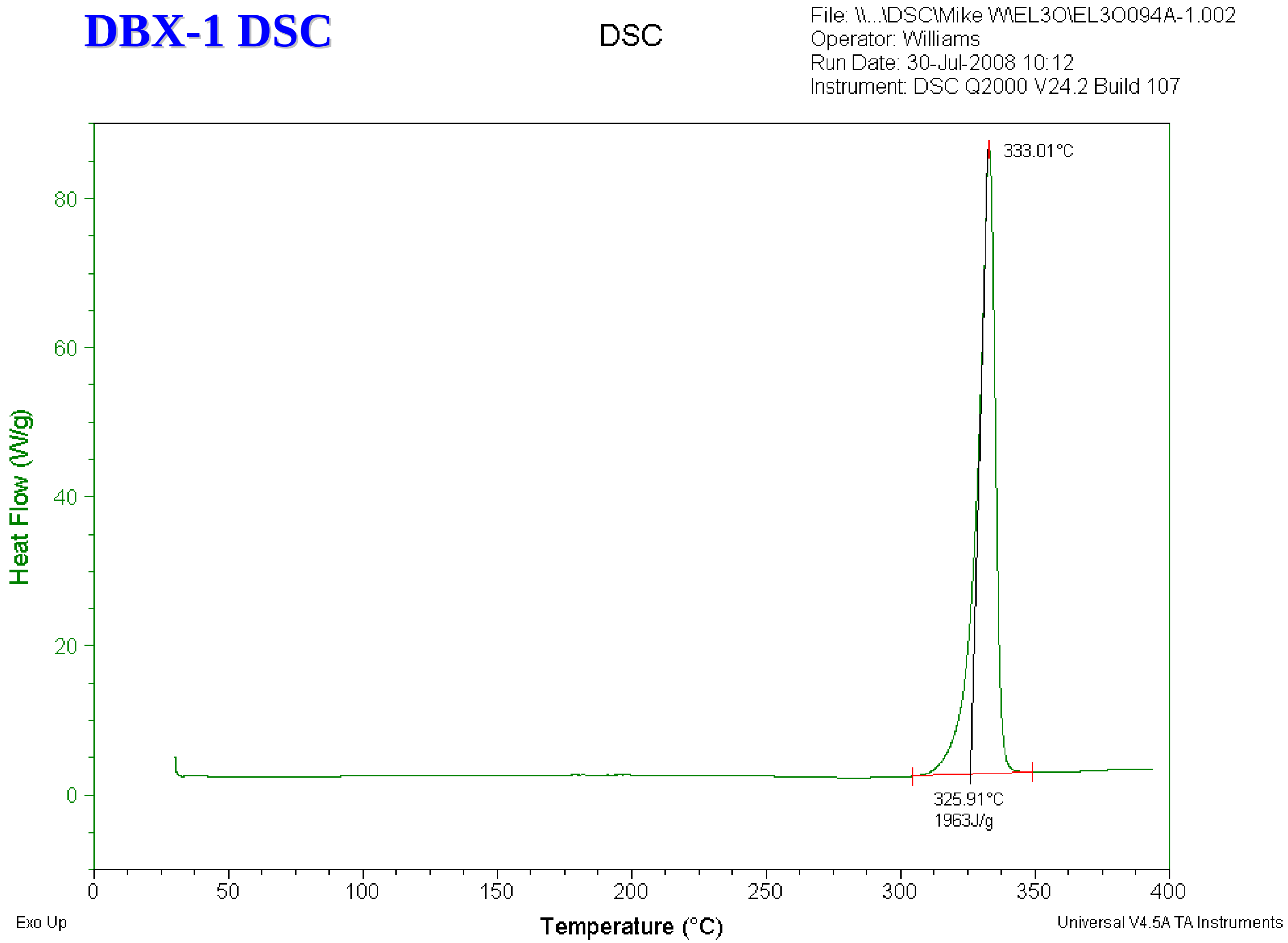


ZPP (24mg) was pressed into a header having a 1 ohm 0.0022" stablohm bridgewire at 10 kpsi.
Materials were loaded into stainless steel cans having a 7 mil wall thickness and pressed 5,10,20,40.
The units were loaded into fixtures and fired (4uf cap, 300V) onto 1" aluminum blocks

For DDT processes, explosive output increases with loading pressure until a maximum is reached then explosive output decreases (dead pressing). Not the case with LA OR DBX-1.

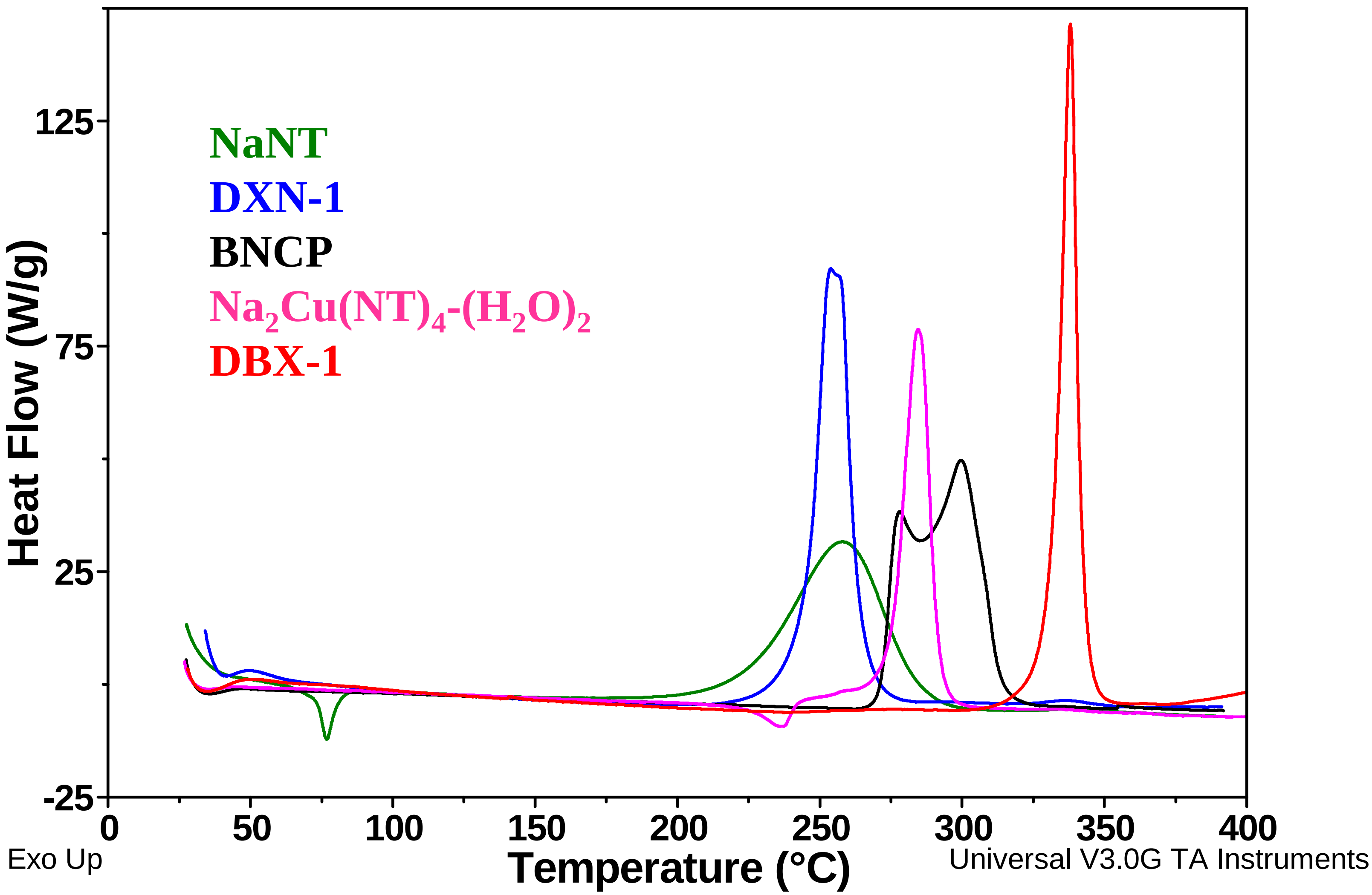
Green Energetics – DBX-1

DBX-1 DSC



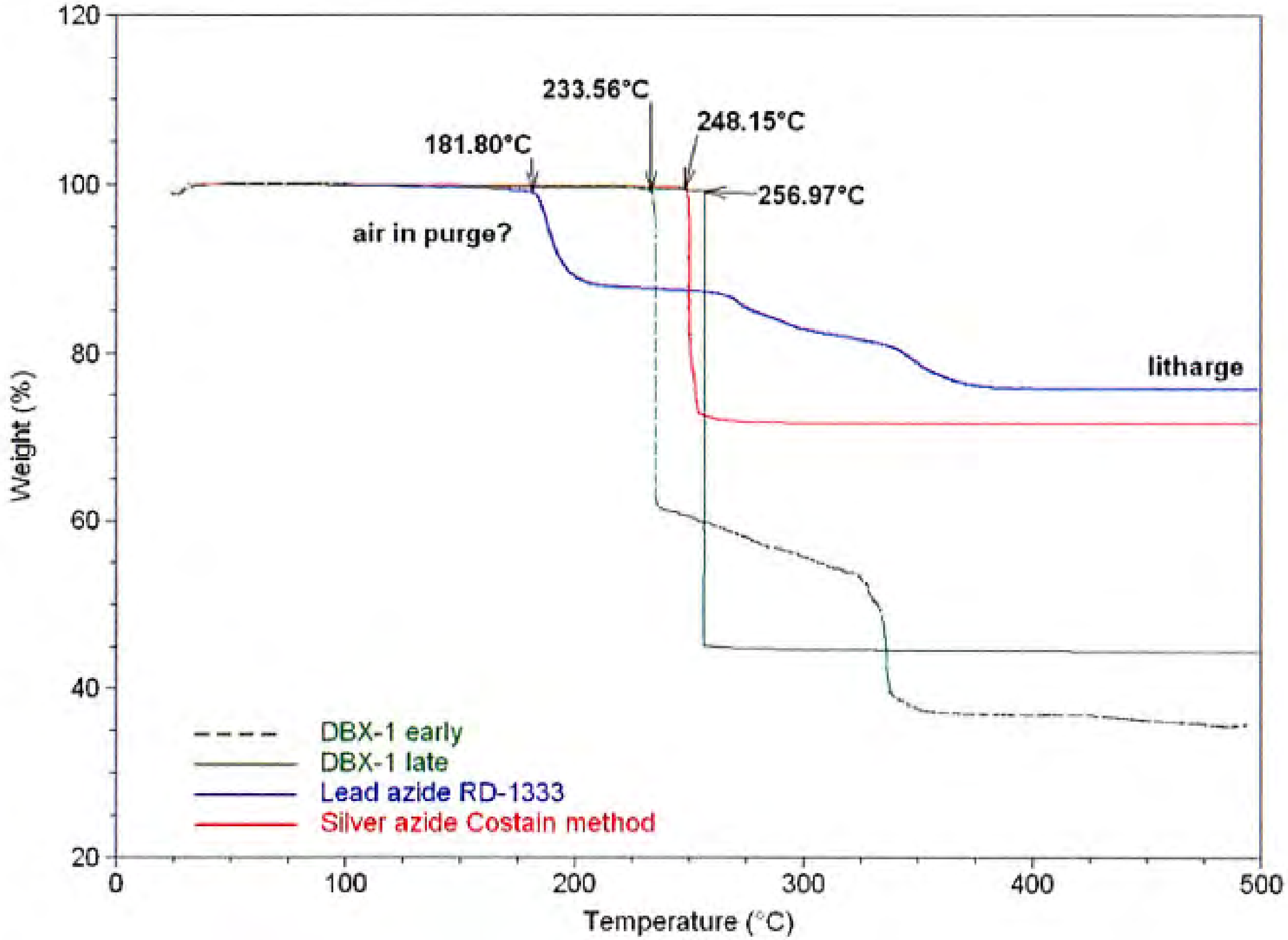
Green Energetics – DBX-1

DBX-1 DSC Comparison



Green Energetics – DBX-1

High Resolution TGA

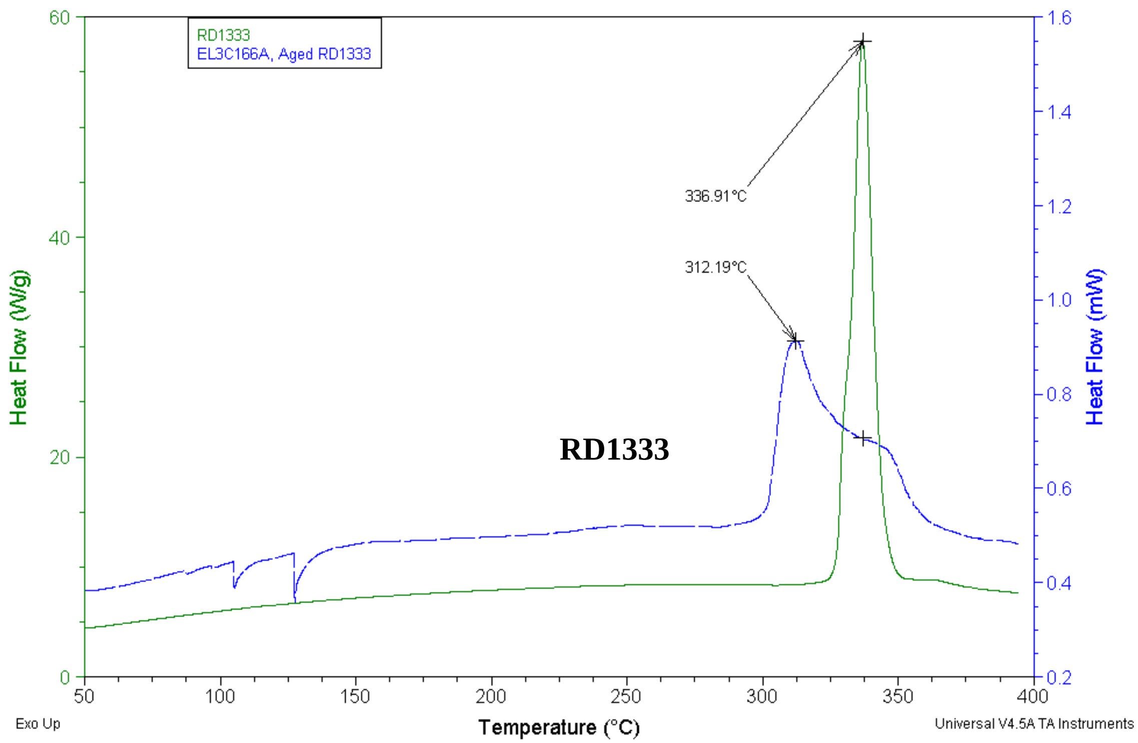


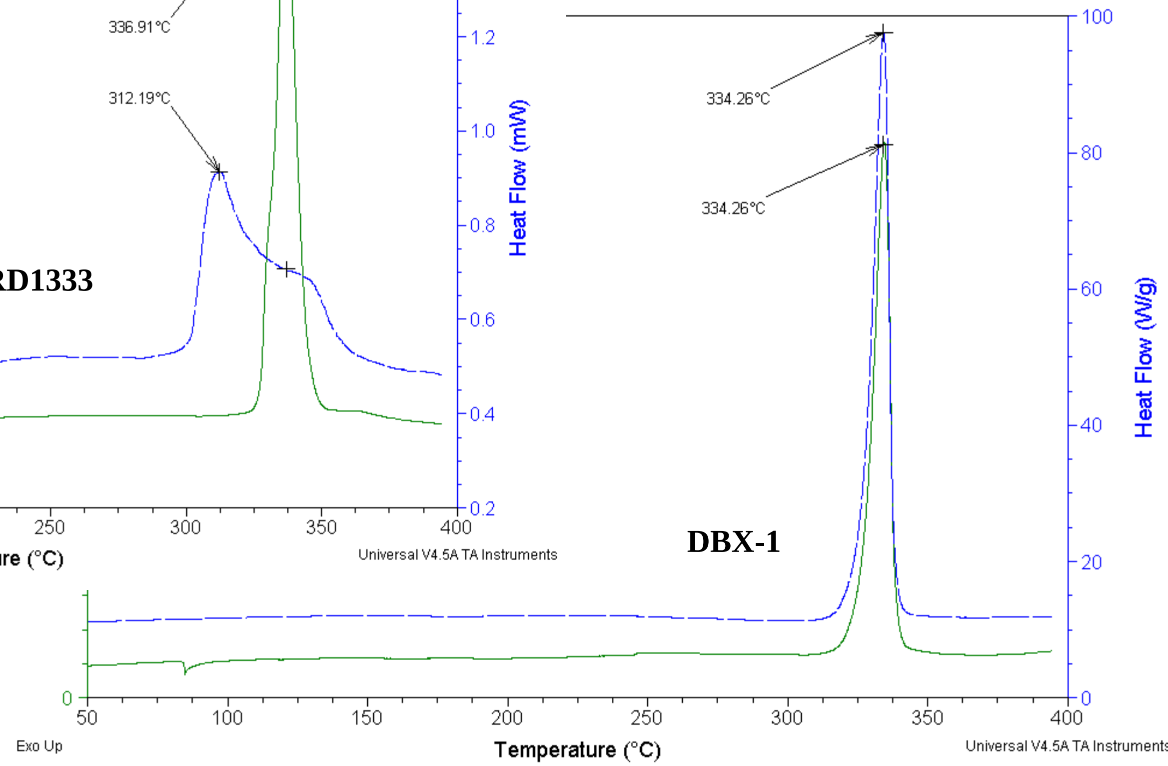
Green Energetics – DBX-1

RD1333/DBX-1 Stability Comparison
(High Temperature)

Weight loss after 24hr @ 181ºC (358ºF):
RD1333: 14.57%
DBX-1: 0%

Oven Input: 25%RH/ambient air





Green: Before heat treatment
Blue: After heat treatment

Green Energetics – DBX-1

Compound Qualification 8020.5C Project

Test procedures called out in MIL-STD-1751 (NATO AOP-7)

NSWC-IH Contracts:
N00714-06-C-0079
N00178-04-D-4149

60g of DBX-1 prepared and crossblended in appropriate solvent
age material at 70°C and ambient humidity for 1 year
Investigate safety characteristics (impact, friction, DSC, ESD)
at T=0, T=6mo. and T=12mo. + "normally aged" at T=12mo.
Run hot wire initiation tests (P12 units, constant current and cap. discharge) at each time
compare to RD1333
Investigate compatibility with various bridgewires/metals/secondary explosives
Priming ability test (RDX, DBX-1 as in MIL-STD-1751)

Additional Testing:

Prepare 104477-202 detonators with LA "normal" and DBX-1 transfer charges for comparison
Prepare NOL-130 primer mix with both DLA and DBX-1 and perform side by side safety tests
Investigate a variety of chemical properties (hygroscopicity, solubility, density, etc.)

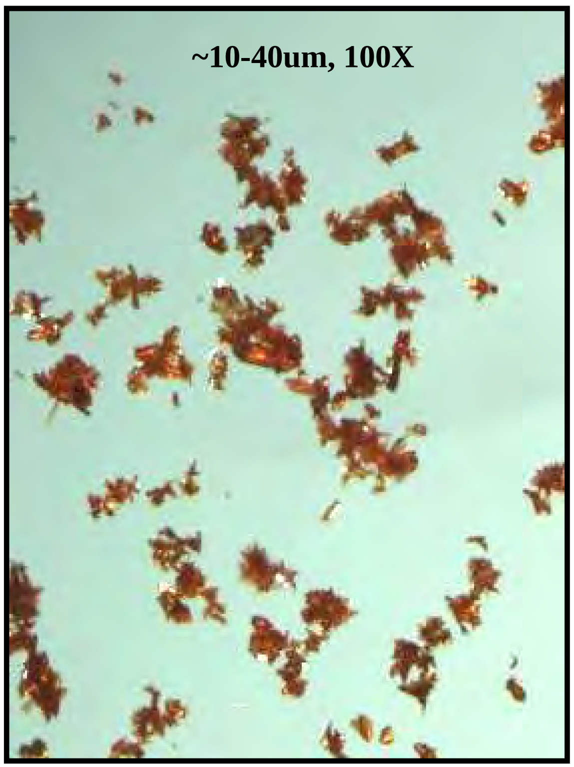
PSEMC Internal R&D:

Extensive work on the temperature capability of DBX-1 vs. RD1333 in oil patch hardware

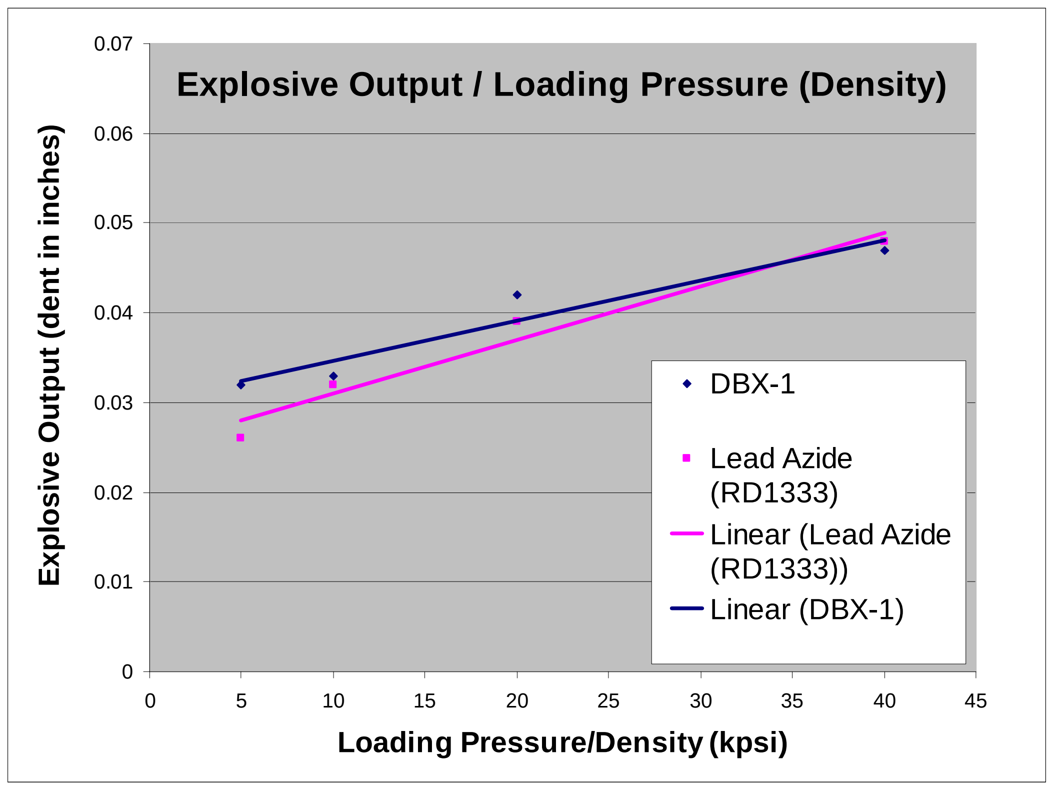
Green Energetics – DBX-1

DBX-1 8020.5C Study

60.2g - 20 lots (3-4g ea.) of DBX-1 were prepared and evaluated (DSC, FTIR, photomicrograph) for acceptability
18 of these were crossblended while IPA moist
4 lots/15g each – unaged (T=0), aged 6 months @ 70C, aged 12 months @ 70C and "aged" 12 months at ambient temp/ 31% RH.



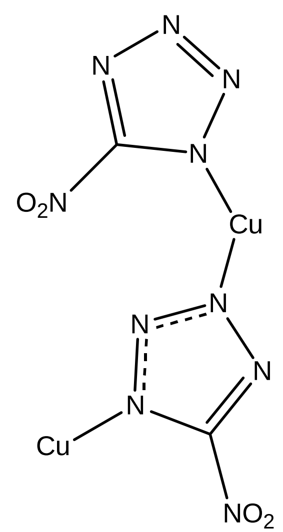
Repeated strong confinement to *confirm* crossblend's output properties

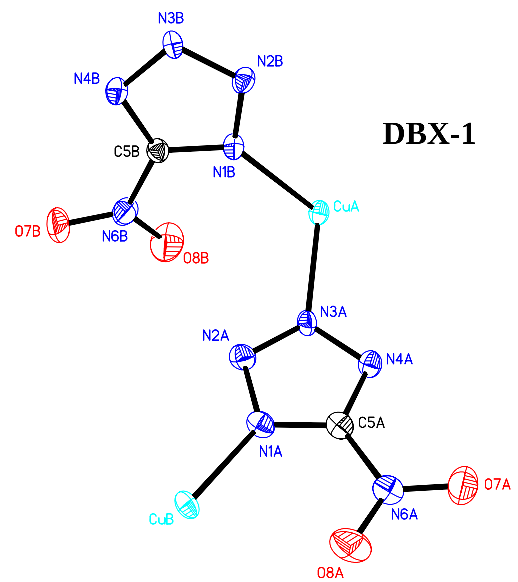


Green Energetics – DBX-1

Molecular Formula: $C_2Cu_2N_{10}O_4$
Molecular weight: 355.20
Heat of Explosion: 911.59 cal/gm
Density by pycnometry: 2.59 g/cc, (2.58 g/cc x-ray)
Oxygen balance: 0% (to Cu)
-9.01% (to Cu_2O)
-18.02% (to CuO)
Solubility: next slide
Particle size: (EL3O094 crossblend) 10-40 μm
Ignition temperature via hot stage: 1sec 356ºC
5sec 351ºC
10sec 345ºC
X-ray structure: at right
Heat of formation: 67.08 cal/gm
Vacuum Stability: 0.025g 100°C 48hrs: 0.470 mL/gram
Thermal Conductivity: free powder 29.5°C: 0.03 W/mK
Hygroscopity:

Properties of DBX-1





DBX-1

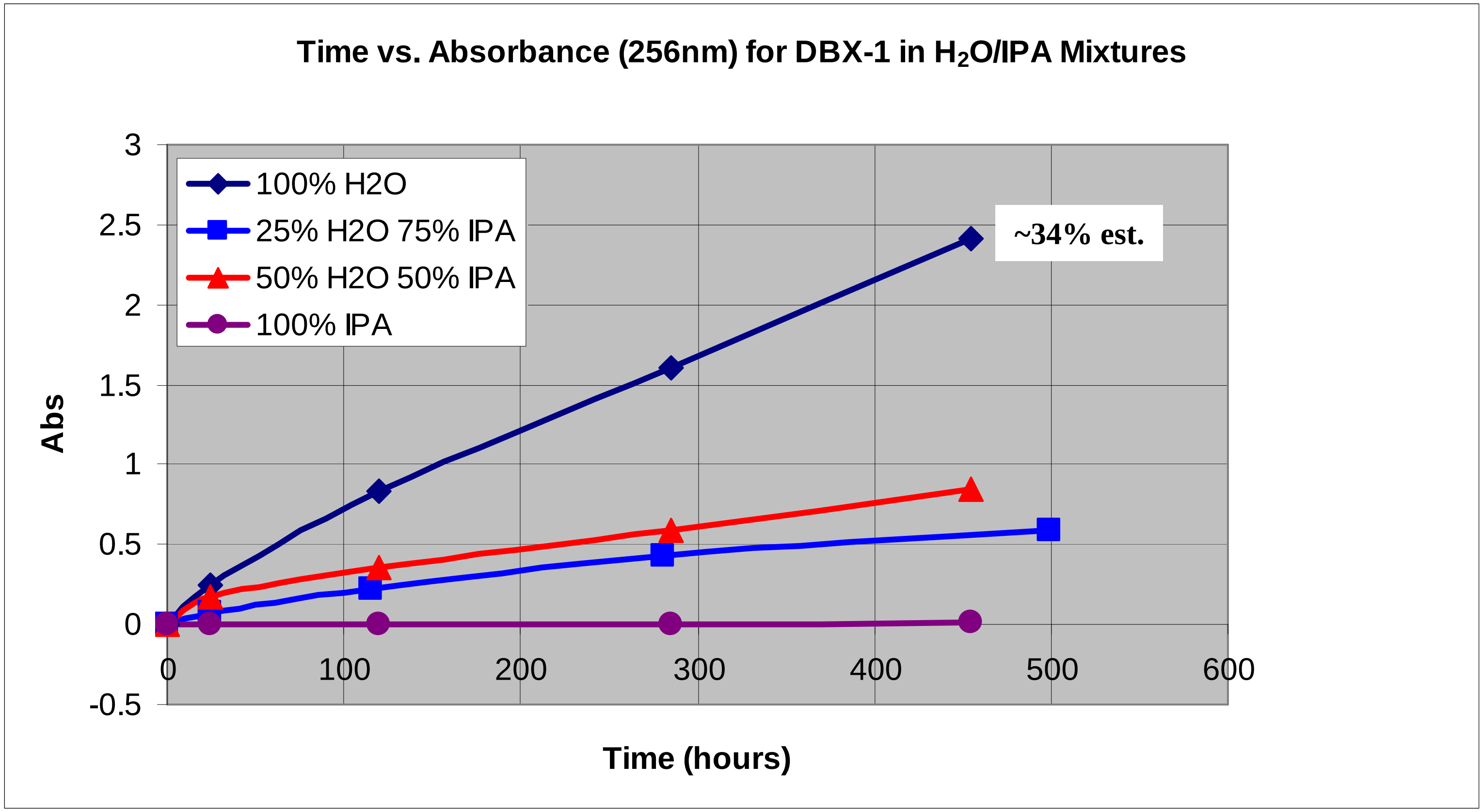
Damon Parrish, NRL

Hygroscopicity at 25ºC	Large Particle (EL3C106A) ~110um	Small Particle (EL3O009B)~20 um
24 hrs @ 31% RH	0.01%	0.02%
72 hrs @ 31% RH	0.05%	0.07%
7 days @ 31% RH	0.07%	0.07%
24 hrs @ 74% RH	0.03%	0.03%
72 hrs @ 74% RH	0.03%	0.05%
7 days @ 74% RH	0.03%	0.06%

Green Energetics – DBX-1

DBX-1 Stability/Solubility in IPA and Water

DBX-1 slowly dissolves and decomposes to 5-nitrotetrazolate when put in direct contact with water. Observed by ultraviolet absorption spectroscopy at 256nm. Pronounced for small particle DBX-1 samples. The residual undissolved solids were determined to be unaffected DBX-1 as demonstrated by FTIR and DSC.



Increased 2-propanol content suppresses the decomposition of DBX-1 with neat 2-propanol having **no reactive effect.**

Green Energetics – DBX-1

Friction Testing – Julius Peters small BAM

CANDIDATE	NO-FIRELEVEL (gms)	MIN. FIRE LEVEL (gms)
DBX-1, T=0	**0**	**10**
DBX-1, T=6 months	**0**	**10**
DBX-1, T=12 months	**0**	**10**
DBX-1, T=12 months (un-aged)	**0**	**10**
DBX-1, previous contract	**0**	**10**
RD1333	**0**	**10**

Impact Testing – Ball Drop Instrument

CANDIDATE	IMPACT (J)
DBX-1, T=0 months	**0.036±0.012**
DBX-1, T=6 months	**0.042±0.003**
DBX-1, T=12 months	**0.038±0.013**
DBX-1, T=12 months, (un-aged)	**0.037±0.004**
DBX-1, previous contract	**0.040±0.010**
RD1333	**0.089±0.054**

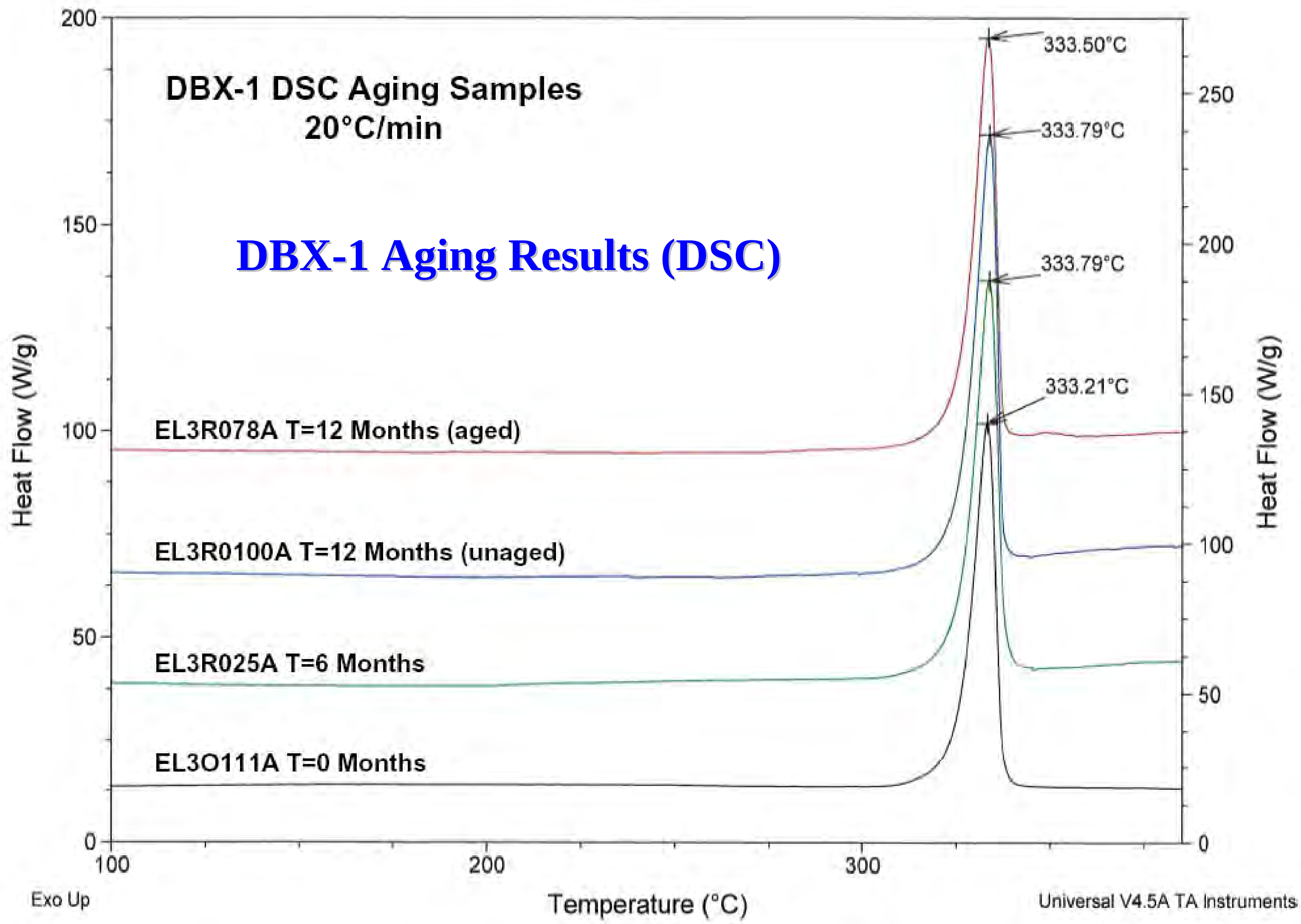
ESD Testing - LEESA

CANDIDATE	MINIMUM FIRE LEVEL (μJ)
DBX-1, T=0 months	**12**
DBX-1, T=6 months	**12**
DBX-1, T=12 months	**12**
DBX-1, T=12 months, (un-aged)	**12**
DBX-1, previous contract	**12**
RD1333	**6.75**

DBX-1 8020.5C Results

Green Energetics – DBX-1

DBX-1 Aging Results (DSC)



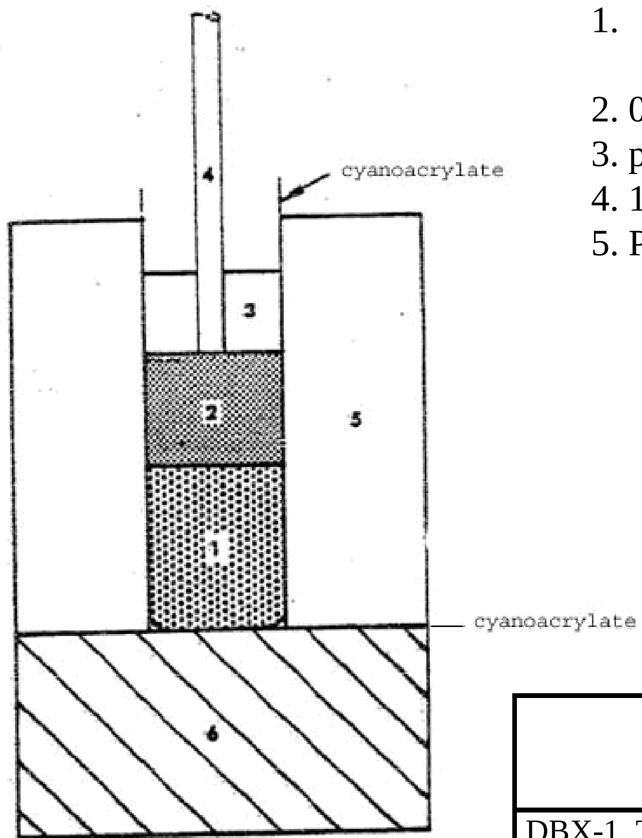
Green Energetics – DBX-1

Hot Wire Initiation Test on DBX-1 per 8020.5C

Material	Aging	Bridge	Constant Current			Cap. Discharge	
		Tophet C	Mean (amps)	AF 99.9% (amps)	NF 0.1% (amps)	Mean (volts, mf)	Stored Energy (mJ)
RD1333		0.001	0.299±0.009	0.326	0.272	79.99±3.44, 1.0	3.20
		0.0005	0.132±0.008	0.157	0.108	143.55±35.84, 0.1	1.03
DBX-1	T=0	0.001	0.252±0.017	0.304	0.201	77.62±0, 1.0	3.01
		0.0005	0.106±0.005	0.121	0.092	122.89±6.42, 0.1	0.76
DBX-1	T=6 m	0.001	0.244±0.010	0.276	0.212	79.62±10.94, 1.0	3.17
		0.0005	0.105±0.005	0.120	0.090	126.77±7.82, 0.1	0.80
DBX-1	T=12 m	0.001	0.228±0.014	0.272	0.183	80.74±1.08, 1.0	3.26
		0.0005	0.106±0.007	0.127	0.086	138.23±1.10, 0.1	0.96
DBX-1	Controlled	0.001	0.246±0.028	0.332	0.160	85.31±1.01, 1.0	3.64
		0.0005	0.110±0.007	0.131	0.090	130.32±1.09, 0.1	0.85

30 unit Bruceton run with P-12 units (BuOrd Drawing 1386180) loaded with 20mg of test material
Constant Current Bruceton: current applied for 10s in steps of 10mA, current constant to ±2%
Capacitor Discharge Bruceton: used 0.1 OR 1.0 mfd capacitor and 0.3 log unit voltage steps

Priming Ability Test on DBX-1 per 8020.5C



1. 200mg RDX, pressed at 10kpsi in an 5052 aluminum cup (0.295” OD, 0.262” ID, 2.985” length)
2. 0.01g to 0.10g RD-1333 or DBX-1 samples, weight determined by Bruceton
3. plastic spacer to hold fuze, seal can – positioned at top of can
4. 1020 Steel plate dent block, 1” OD, 0.5” think
5. PMMA holder 1.25” long, 1” OD

A charge of between 0.10g and 0.010g of primary (either RD1333 or DBX-1) was weighed out and poured into the can (loose loaded) on top of the RDX charge. Safety fuze lit with electric match.

In both the RD1333 (MIL-L-46225, LN40148) and DBX-1 tests it was determined that a loose charge of 0.010g was insufficient to cause detonation of the RDX charge. Larger loads (0.025 or 0.040g) gave go/no-go results.

CANDIDATE	Priming Ability Test (Bruceton Analysis)	
	Level 50_0 (gms)	**σ_0**
DBX-1, T= 0 months	**0.0263**	**0.0066**
DBX-1, T= 6 months	**0.0279**	**0.0059**
DBX-1, T= 12 months	**0.0256**	**0.0067**
DBX-1, T= 12 months (un-aged)	**0.0250**	**0.0108**
RD1333	**0.0288**	**0.0093**

Green Energetics – DBX-1

DBX-1 Compatibility with Various Secondaries

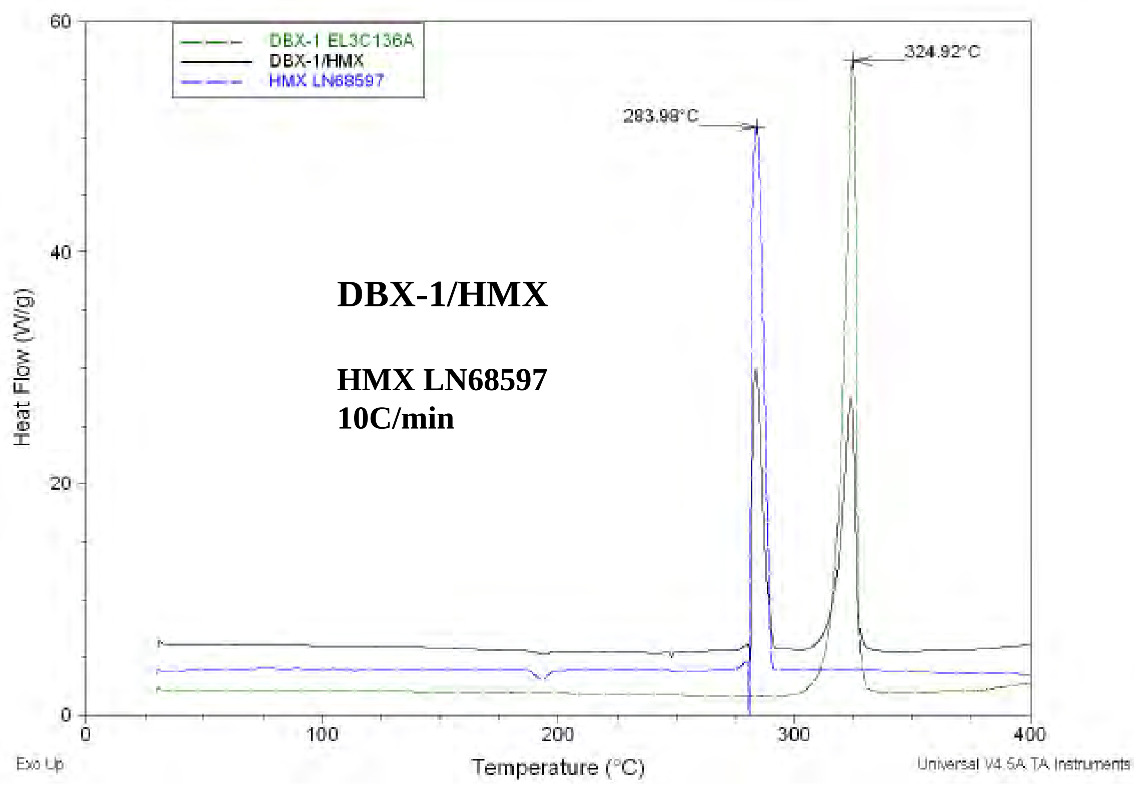
DBX-1 has demonstrated compatibility with:

Secondary explosives:
RDX
HMX
NOL-130
CL-20
HNS
PYX
ZPP
No incompatibility with any materials tested

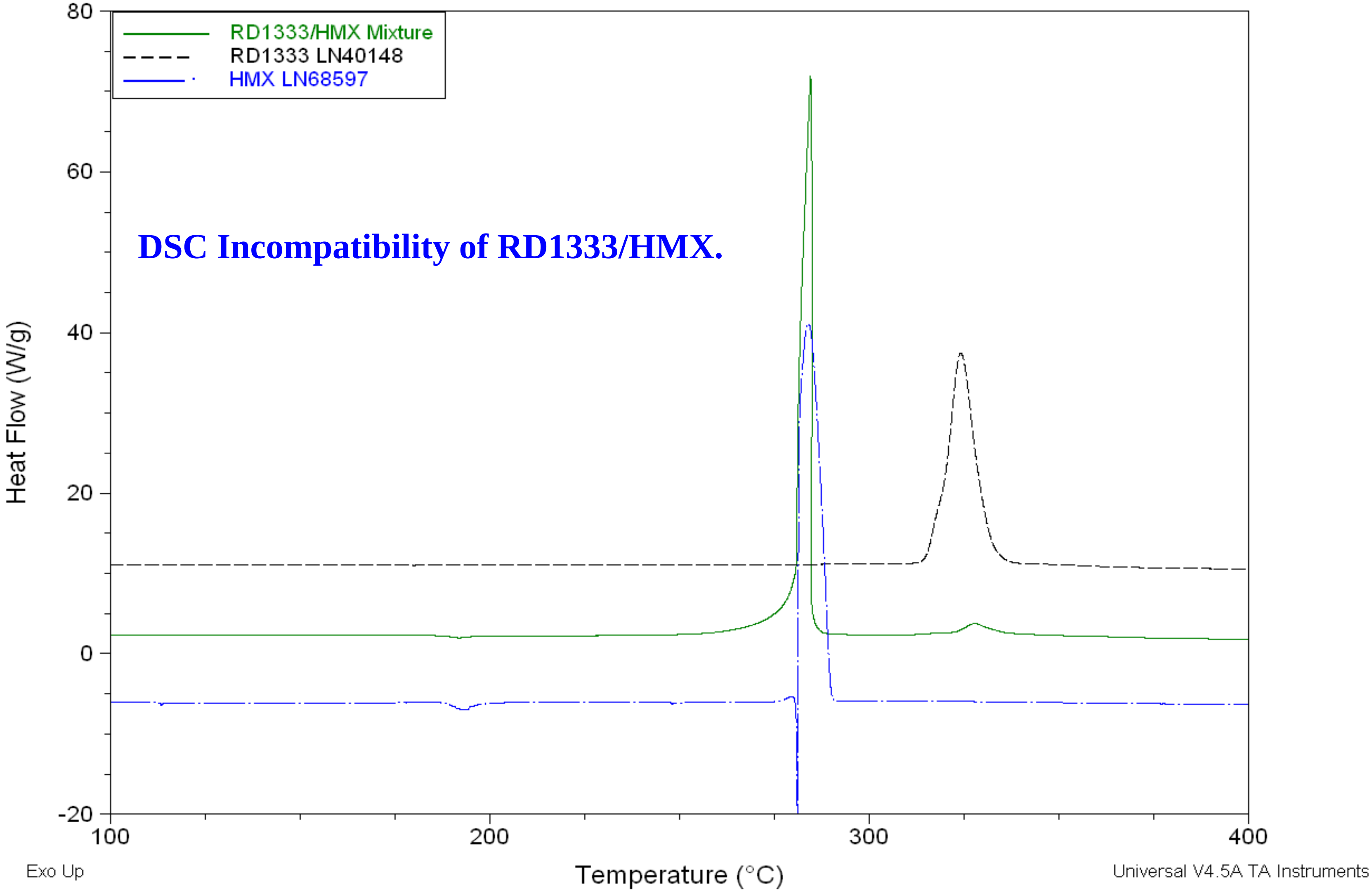
Metals:
Bridge materials:
Tophet A, Tophet C, EvenOhm

Coupon Tests:
Al, Brass, SST, Guilding metal, copper in-process

LA is not compatible with some of the above metals and various secondaries.



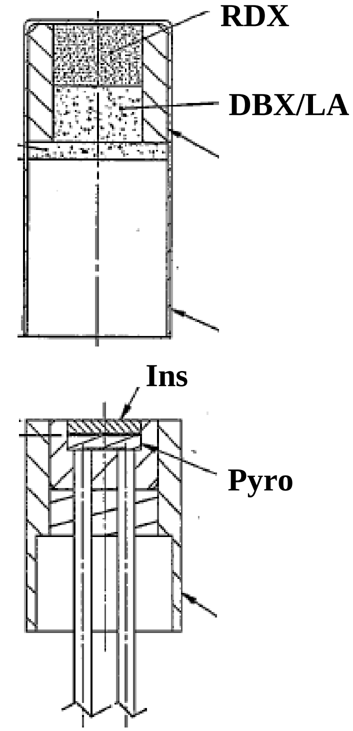
Green Energetics – DBX-1



Green Energetics – DBX-1

DBX-1 104477-202 Detonator ATP Results

Samples	Temperature	I (amp)	Function Time (DLA)	Function Time (DBX-1)	Dent (DLA)	Dent (DBX-1)
1-10	Ambient	3.9	3.71 0.58	3.68 0.33	0.0141	0.0149
11-20	200°C	4.0	3.24 0.32	3.17 0.15	0.0134	0.0138
21-30	-65°C	3.8	4.44 0.59	4.14 0.51	0.0136	0.0140

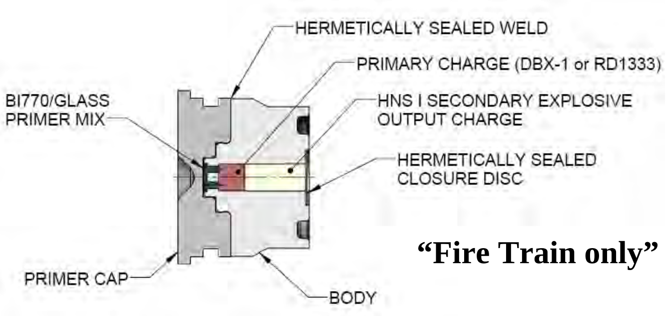


ALL UNITS FUNCTIONED NORMALLY
DBX-1 = HIGHER OUTPUT

PSEMC In-House Study to Evaluate Temperature Capabilities and Compatibility for DBX-1 Containing Components

F-18 Directed Tests – Cookoff Testing

Time (hrs)	DBX-1/HNS-I (°F/Dent – mils)	RD1333/HNS-1 (°F/Dent – mils)
1 (MIL-I-23659)	500/fired 475/no-fire (31 mils)	525/fired 500/no fire (20,2 mils)
12 (MIL-I-23659)	450/fired 400/no-fire (31 mils)	450/fired 400/no-fire (22 mils)
50	340/no-fire (30 mils)	340/no-fire (24 mils)
Untreated	29 mils	27 mils



"Fire Train only"

PSEMC Oilfield Component

F-18 Requirement: 300°F for 50hours (MIL-DTL-32122, 2005)
Had issues with RD1333/HNS at 340°F for 50 hrs so the requirement was reduced to 300°F.

During 50hr. high temp exposure (340°F/50hr), DBX-1 domes far less and has a greater dent compared to RD1333.
No Compatibility Issues **between DBX-1 and common secondary explosives were discovered during thermal conditioning**
DBX-1 is very stable alone, or as the primary explosive with secondary explosives at extremely high temperatures.

DBX-1/HNS combination *exceeds* the 50 hour 300ºF requirement of the F-18 FIREX cartridge.

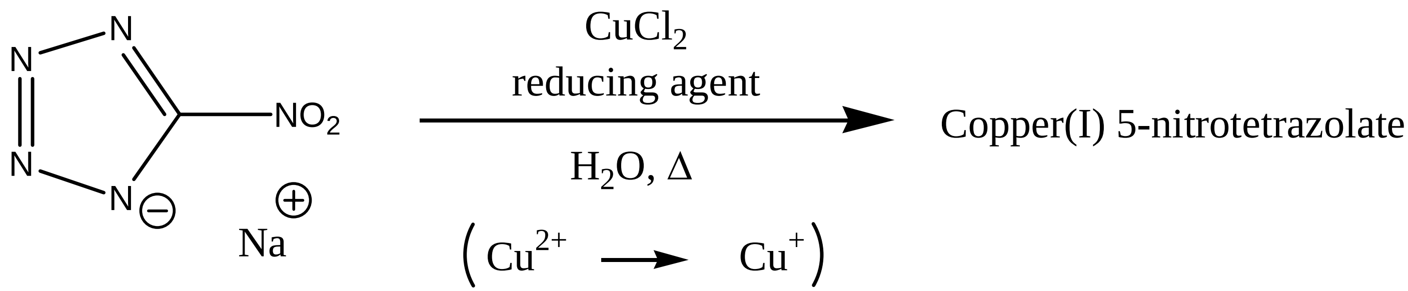
DBX-1/HNS combination will exceed 50 hour 339ºF.
DBX-1 will allow use of original 340ºF for 50 hr requirement……

PACIFIC SCIENTIFIC

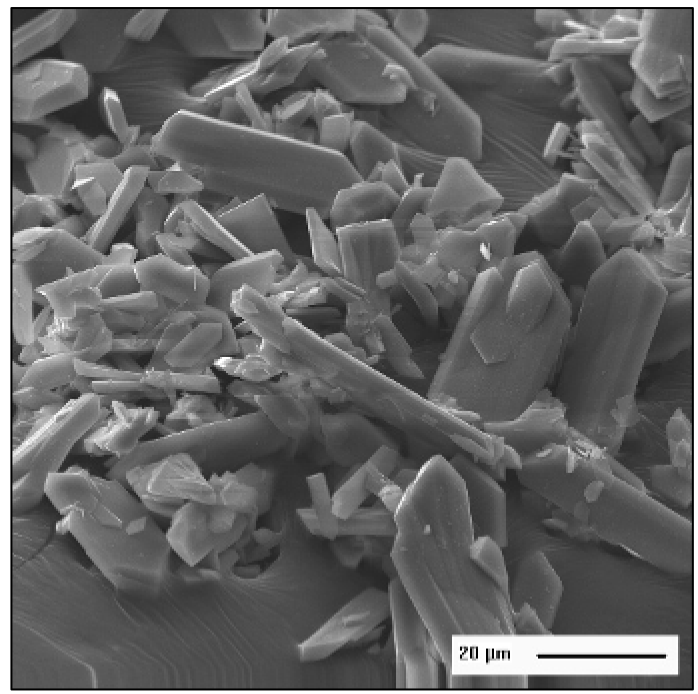
Green Energetics – DBX-1

NAVSEA INDIAN HEAD Surface Warfare Center Division

New Preparation of DBX-1



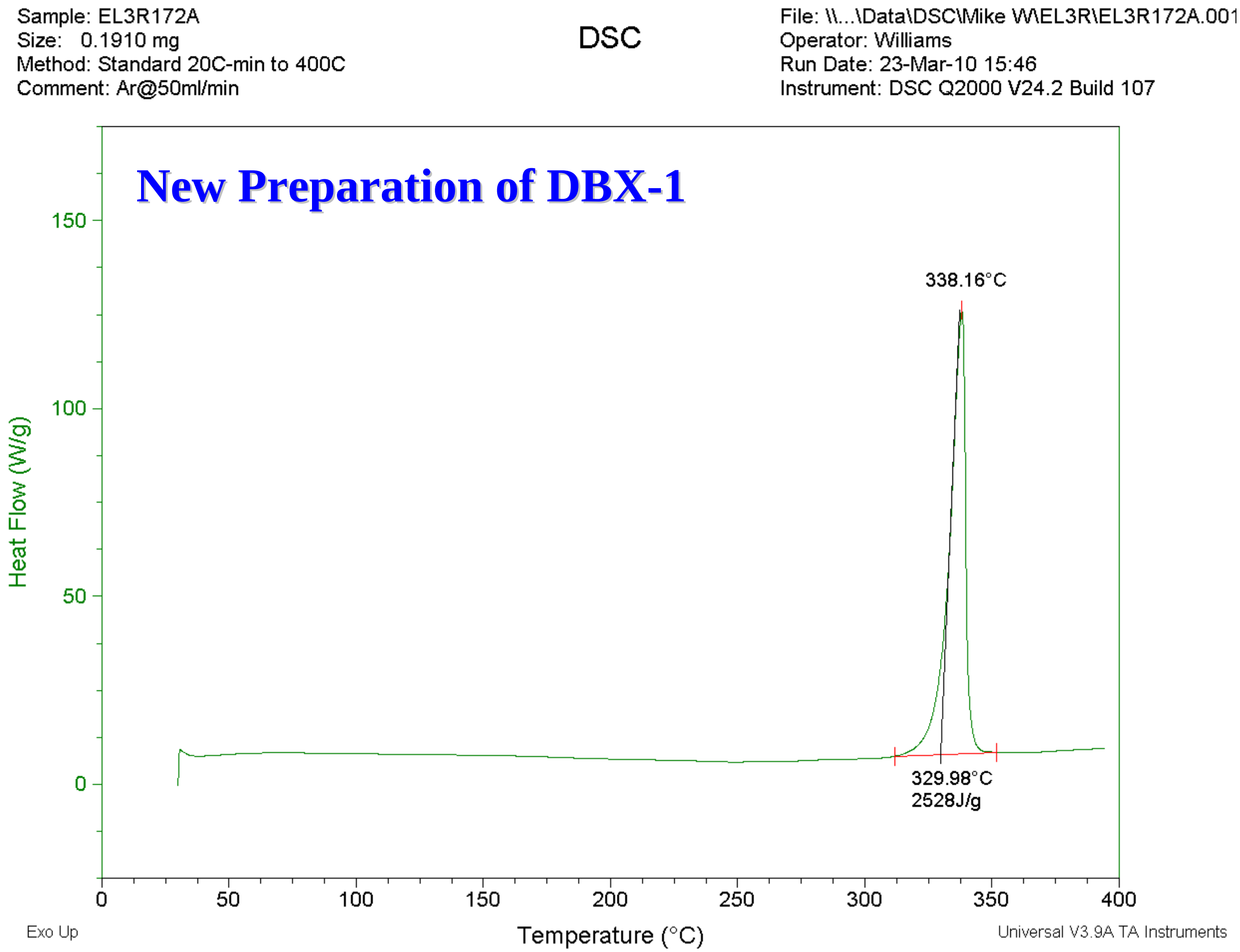
No induction period for crystallization
Reaction time 10-15 minutes
Yield: 80%
Particle size may be modified (larger)



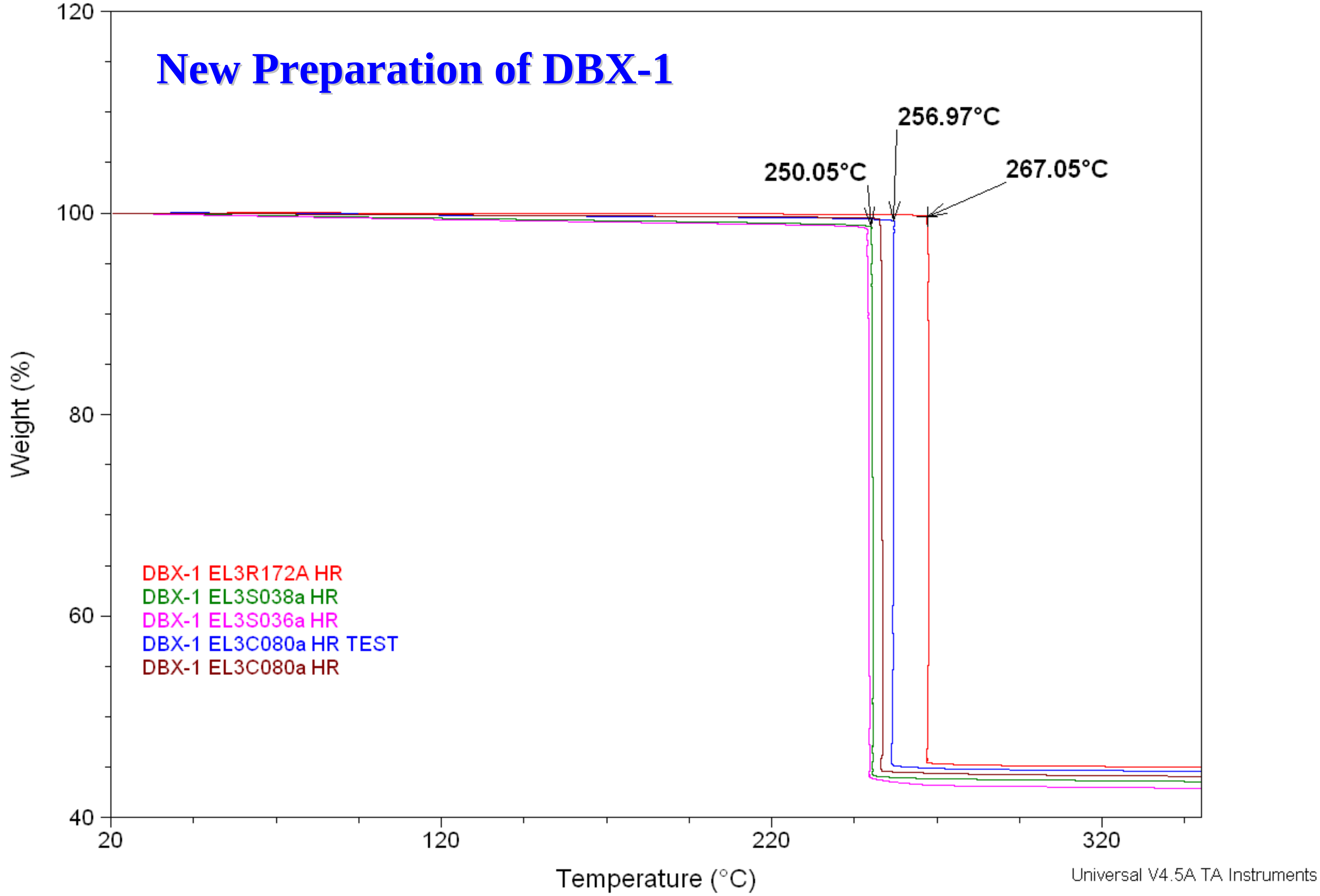
This process *is* suitable for scale-up

Normal analysis for DBX1 indicates this material made by this method is as good or better than previous lots

Green Energetics – DBX-1



Green Energetics – DBX-1



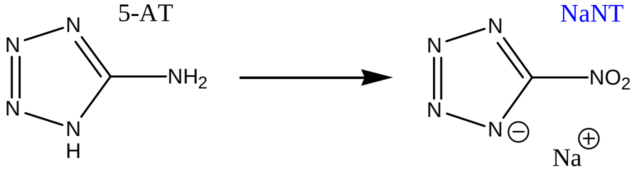
DBX-1 Scale-Up

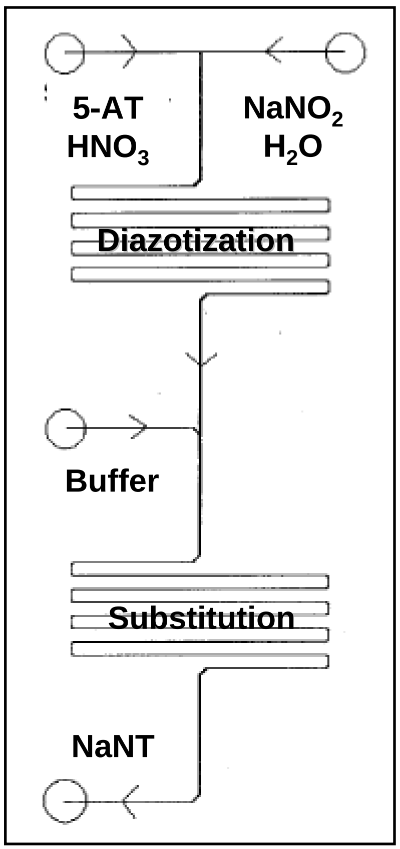
Remote Control
- **Reactors – 1, 3, 20L**
- **Reaction –**
  Addition and Reaction
  Filtration and Washing
  Dispensing and Weighing

Progress
- **~10g**
- **~25g**

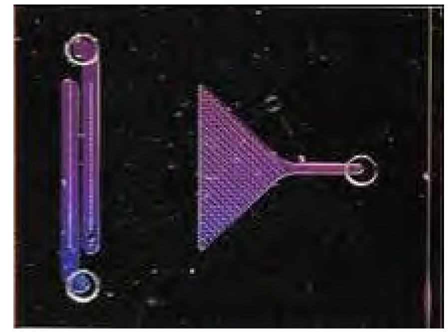
Designed and Fabricated by
Franklin Engineering

Green Energetics – DBX-1





MIT/I2CHEM Reactor System



A silicon/glass based system which avoids use of (batch) copper(II) salts used to stabilize diazonium intermediate (only small amounts present)

A continuous flow system which:

Dramatically increase safety – smaller quantities = reduced risk

Increase quality – faster heat and mass transfer, no lot variability

Improve efficiency – computer monitored, incorporation of analytical tools

Kinetics analysis of both diazotization/substitution are finalized

Temperature, pH, ionic strength, etc. assessed for maximum yield

Safe production of 4.5 gm/hr NaNT achieved in single reactor system (83%)

US 7,253,288 August 2007

Production System: 40-50gm/hr

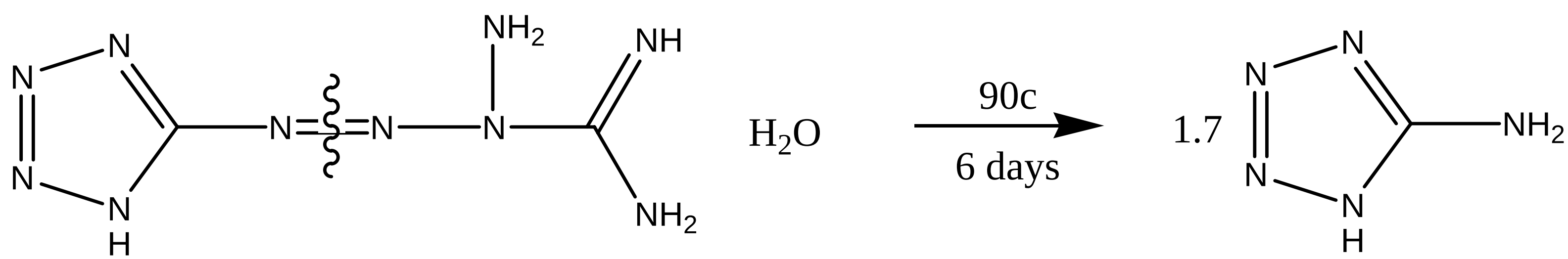
Completion of 8020.5C Program

- **8020.5C program completed Oct 2009, submitted for qualification**

Tetrazene

Initially Prepared in 1910 by Roth and Hoffman
Has found use as primer sensitizer as it is "non-toxic" (mercury fulminate) and non-corrosive
Current primer mixes (NOL-130) generally contain 40% LS, 20% LA, 20% BaNO3 and 15% Sb_2S_3
Tetrazene is used as a sensitizer due to low impact and friction sensitivity levels

Tetrazene has *low thermal and hydrolytic stabilities*
decomposes completely at 90°c in 6 days
decomposes completely in boiling water



via guanyl azide intermediate

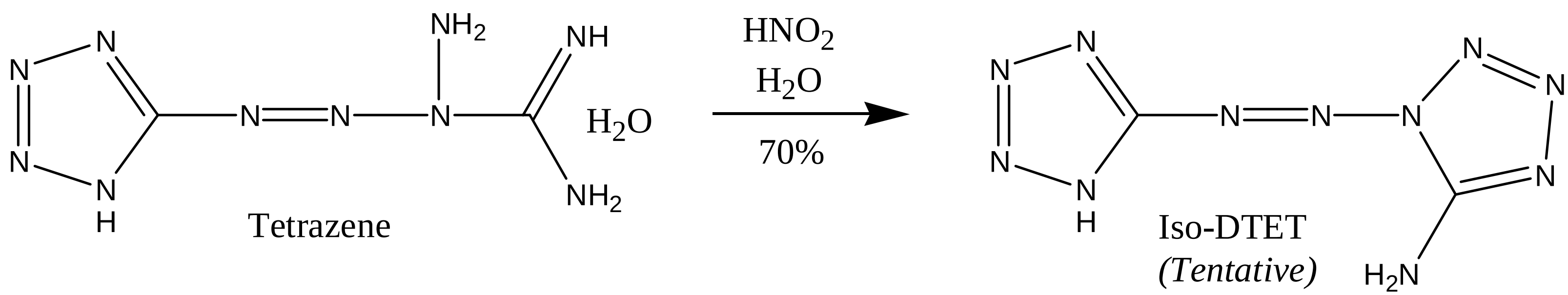
PSEMC Project – Improve thermal stability used in normal or high temperature applications
Generate new materials cheaply and without utilizing toxic reactants or effluents

"Thermal Decomposition of Tetrazene at 90ºC", Bird, R. and Power, A.J., Materials Research Laboratories Report MRL-R-710 (1978).

"The Kinetics and Thermochemistry of the Thermal Decomposition of the Initiating Explosive, Tetrazene,…", Whelan, D.J. and Fitzgerald, M.R., DSTO Aeronautical and Maritime Research Laboratory Report DSTO-TR-0450 (1996).

"Iso-DTET"

Preparation of Iso-DTET



Structure of Iso-DTET

Structure is undetermined at this time – structure elucidation in progress
•iso-DTET dissolves in 1N NaOH and is regenerated on treatment with concentrated HCl (weakly acidic?)
•iso-DTET exhibits partial solubility in concentrated hydrochloric acid
•iso-DTET is unaffected by the extended exposure to neat acetic anhydride or neat acetyl chloride at ambient
•refluxing of iso-DTET with acetic anhydride for 4 hours degrades it providing a non-energetic material melting at 210°C.
Does iso-DTET have an amino group shown in the iso-DTET structure?

Equivalent weight based on KOH titration data is estimated at 160-175 (181)

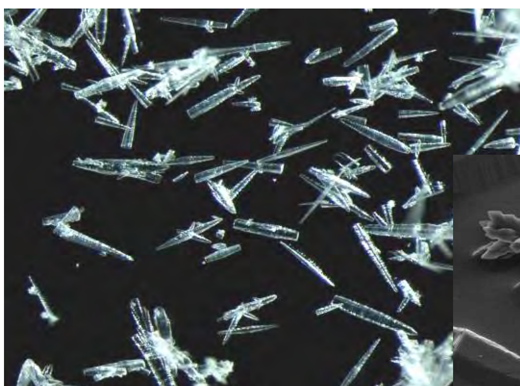
X-ray structure: varying results with salts of Cu(II), Fe(II), Fe(III), Mn(II) and Cs – gives only starting material or hydrates
working tetramethylammonium and tetraphenylphosphonium salts
NMR: material very insoluble in common deuterated solvents, salts may offer better properties

Tetrazene Replacement Project

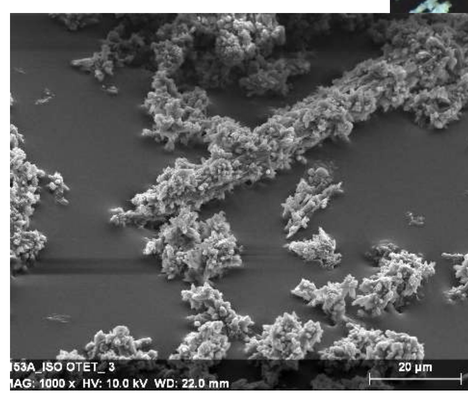
“Iso-DTET”

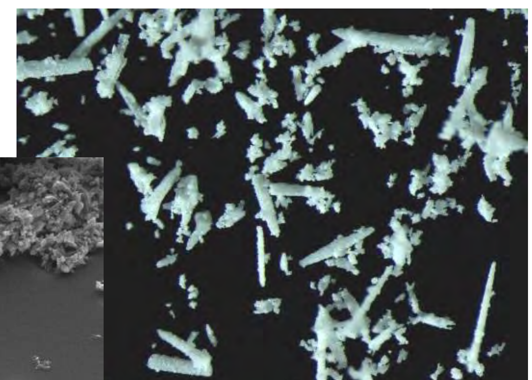
Sensitivity of Iso-DTET

SAMPLE	DSC (20ºC/minute)		IMPACT (J)	FRICTION (grams)		ESD (mJ)		TGA % Wt Loss @ 167 hrs
	Onset	Peak		No Fire	Low Fire	No Fire	Low Fire	
Tetrazene	138ºC	144ºC	0.021	1100	1200	>7.43	NA	36.1%
Iso-DTET	208ºC	214ºC	0.016	800	900	3.30	4.18	3.5%



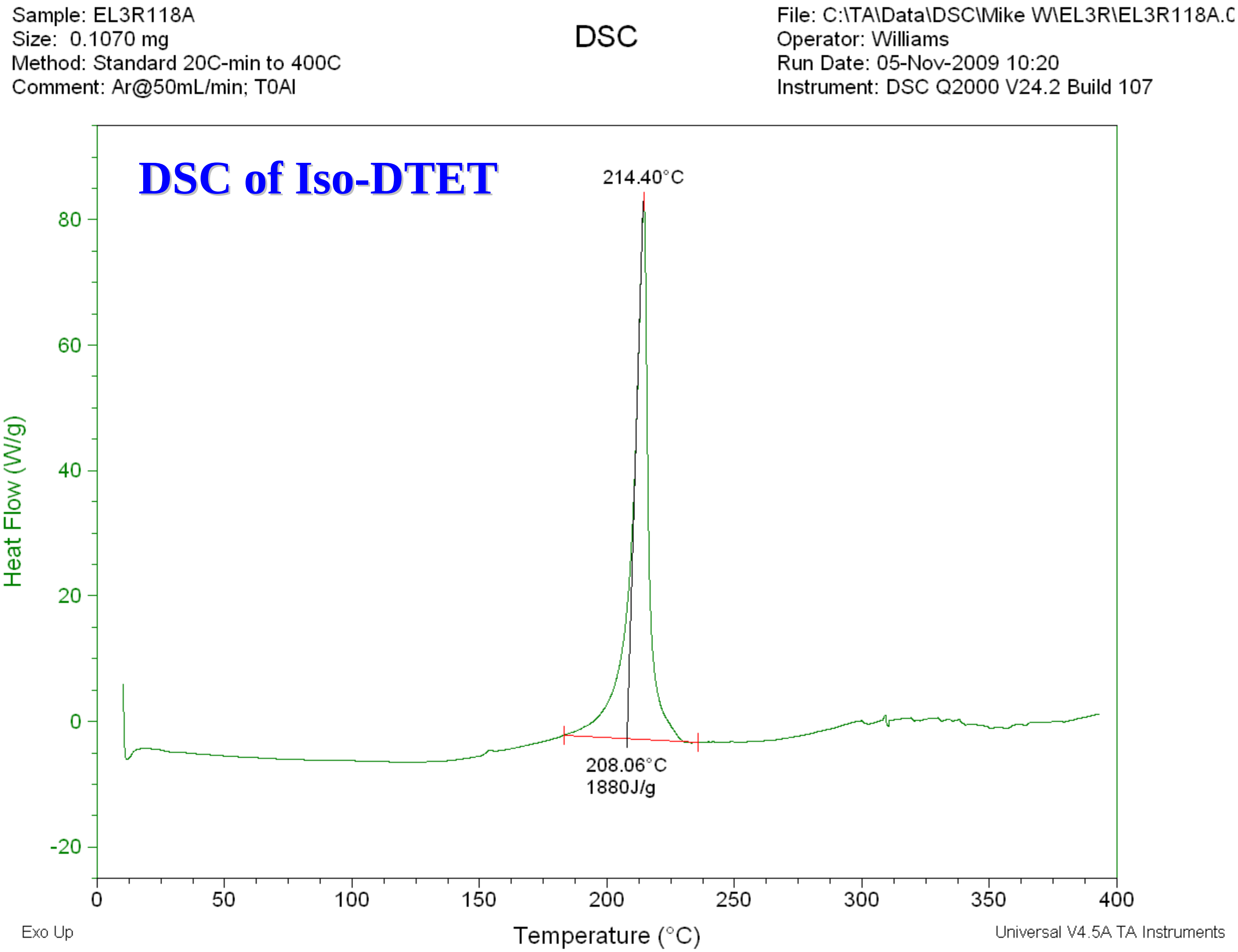
Similar crystal morphology



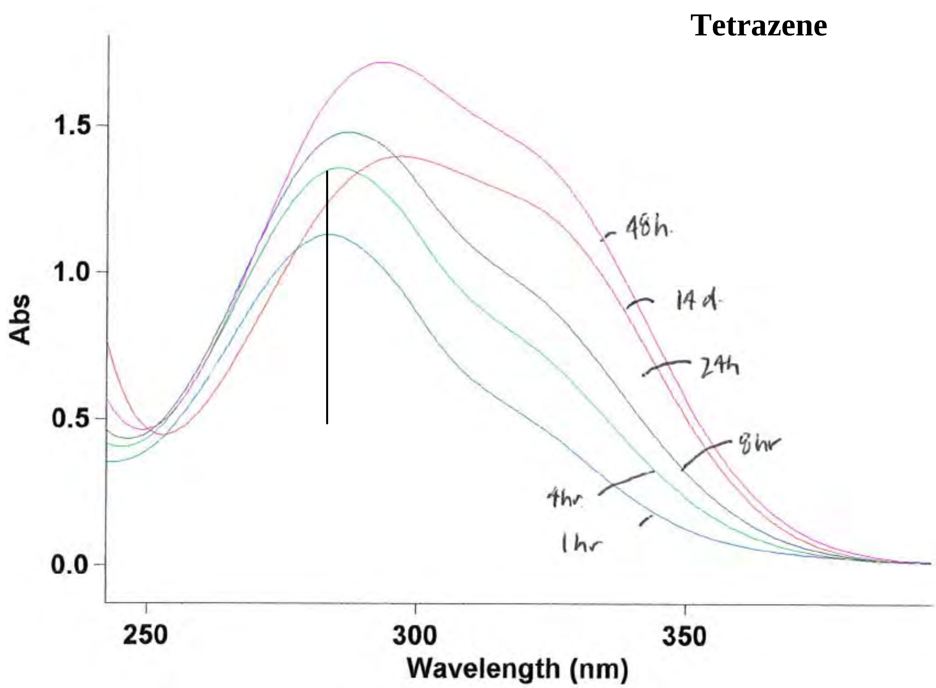


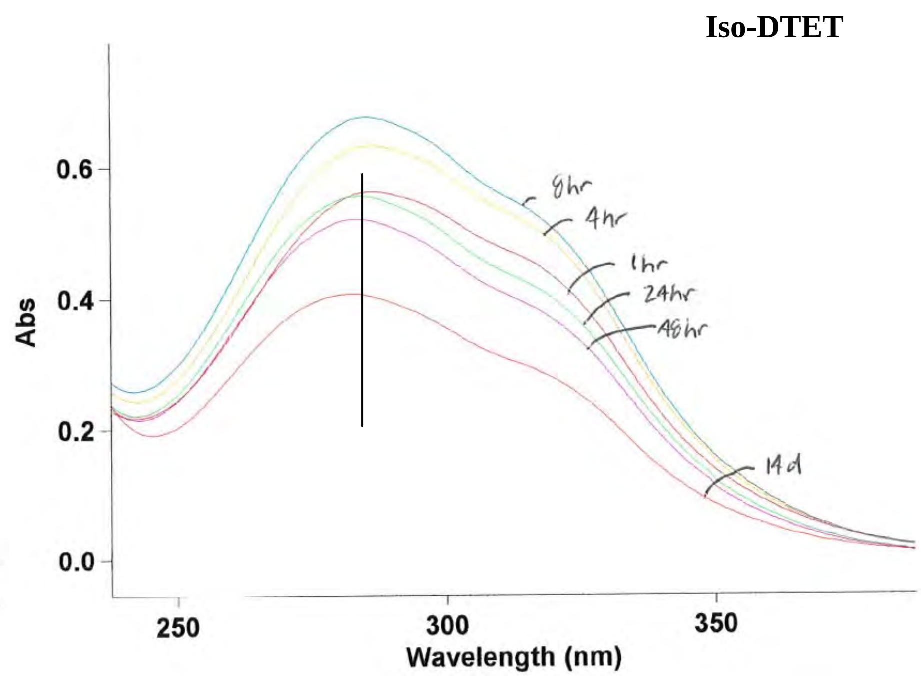
Tetrazene
100X Optical
1000X SEM

Iso-DTET
100X Optical
1000X SEM


Sample: EL3R118A
Size: 0.1070 mg
Method: Standard 20C-min to 400C
Comment: Ar@50mL/min; T0Al
DSC
File: C:\TA\Data\DSC\Mike W\EL3R\EL3R118A.0
Operator: Williams
Run Date: 05-Nov-2009 10:20
Instrument: DSC Q2000 V24.2 Build 107
DSC of Iso-DTET
214.40°C
208.06°C
1880J/g
Heat Flow (W/g)
80
60
40
20
0
-20
0
50
100
150
200
250
300
350
400
Exo Up
Temperature (°C)
Universal V4.5A TA Instruments

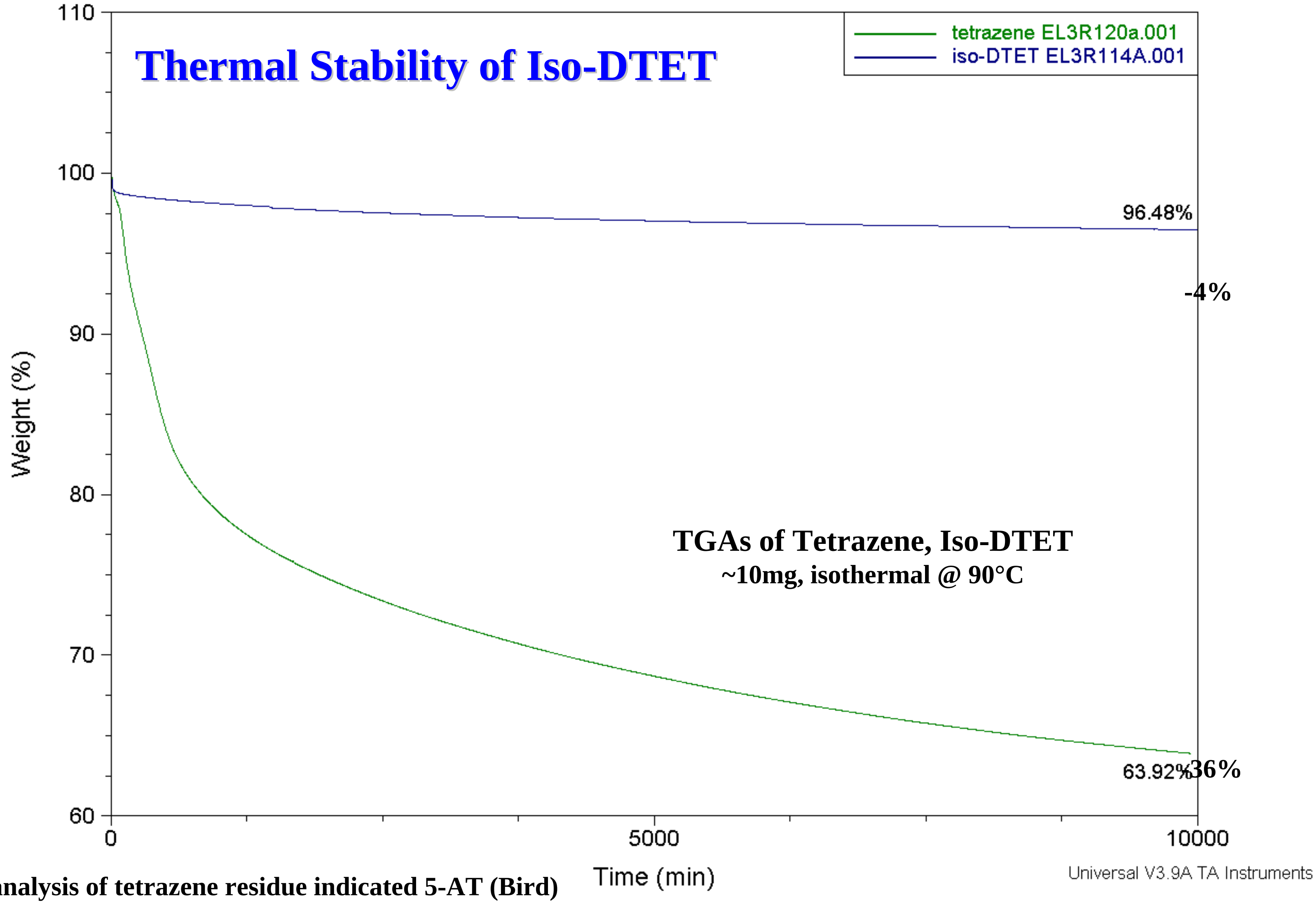
Hydrolytic Stability of Iso-DTET





~0.50g suspended in 250mL of water, ambient conditions, sampled at indicated intervals
Tetrazene – change in conc. over 8 hrs with bathochromic shift to 350nm and increased extinction below 250nm -degrades
Iso-DTET – no shift over time
Residue

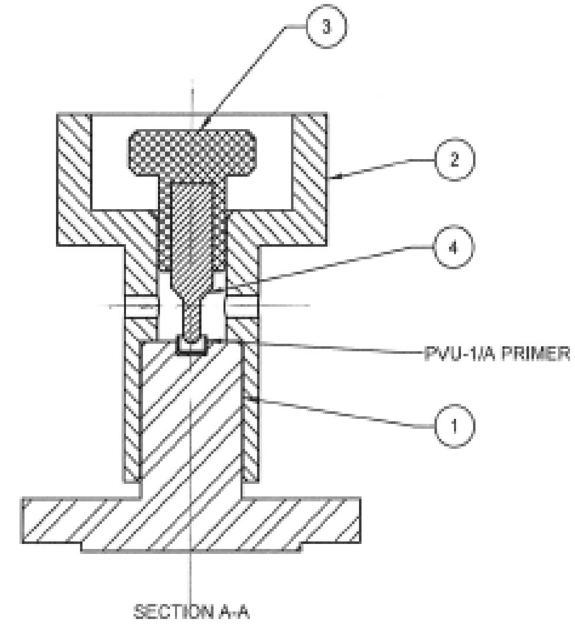
Confirms hydrolytic instability of tetrazene while storage of Iso-DTET under aqueous conditions *may* be possible



FTIR analysis of tetrazene residue indicated 5-AT (Bird)

Output Performance of DTET

0.048" firing pin, no closure over primer



30 primer cups were loaded with 21±2mg of mixture, pressed at 160lbs (10s dwell) into primer cups

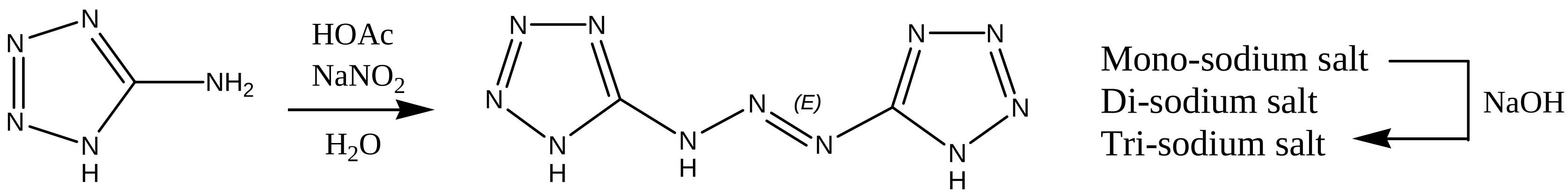
20 shot Neyer analysis was performed with 3.35oz stainless steel ball, pin changed every 10 shots

BLS PN51-8593E LN GY19862 – un-milled, -#100 sieve Tetrazene, Iso-DTET - -#40 sieve

Sample	Mu±σ	0.001 Level	0.999 Level
100% BLS (EL3Y003)	12.5”±0”	12.5	12.5
95% BLS/ 5% Tetrazene	4.92”±1.41”	0.56	9.28
95% BLS/ 5% Iso-DTET	5.91”±0.42”	4.60	7.21

DTET

Preparation of DTET



DTET

Structure of DTET

DTET structure confirmed by X-ray analysis of calcium complex (Mike Sitzmann NSWC-IH)

DTET suffers from severe hydration issues (monosodium is ≥monohydrate)
Di- and Tri- sodium salts are insensitive to impact and friction, also heavily hydrated
Salt formation (Rb, Cs, Sr) have been attempted – varying hydration, poor particle morphology
Attempting to prepare free acid, structure confirmation by NMR (material soluble in DMSO-d6)

DTET

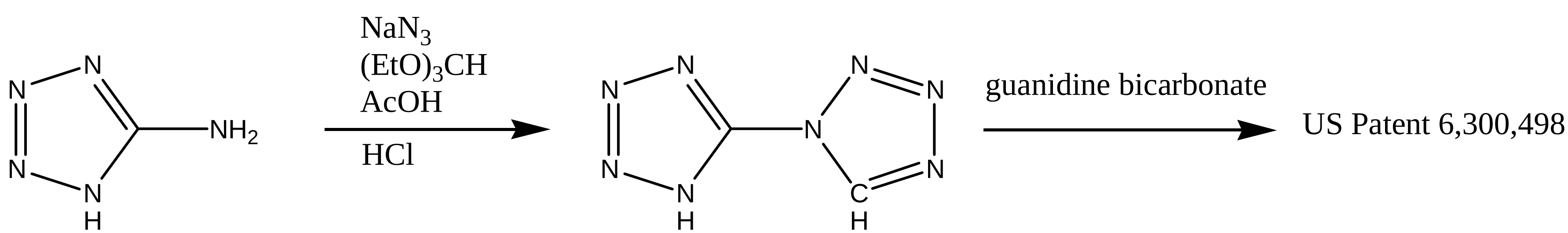
Sensitivity of DTET

SAMPLE	DSC (20ºC/minute)		IMPACT (J)	FRICTION (grams)		ESD (mJ)		TGA % Wt Loss @ 167 hrs
	Onset	Peak		No Fire	Low Fire	No Fire	Low Fire	
Tetrazene	138ºC	144ºC	0.021	1100	1200	>7.43	NA	36.1%
DTET	139ºC	156ºC	>0.056	>2075	>2075	-	-	-

DTET (monosodium) has little thermal benefit, is lower friction/impact sensitivity compared to tetrazene

1,5'-Bitetrazole

Preparation of 1,5'-Bitetrazole



Prepared guanidine and triaminoguanidine salts
Still under investigation

Acknowledgments

- Dr. Bill Sanborn - PSEMC
- Dave Grum, Diane Ross, Paul Garber - PSEMC
- Dr. Alfred Stern – NSWC-IH
- Travis Thom – NSWC-IH
- Dr. Brad Sleadd- NSWC-IH
- Dr. Pete Ostrowski - Energetic Materials Technology
- Mike Sitzmann – NSWC-IH (Ret.)
- Gerald Laib - NSWC-IH
- John Hirlinger - Picatinny
- Alex Schuman - NSWC-IH
- Frank Valenta – NSWC-IH
- Dr. Robert Chapman - NAWC-CL
- Dr. Farhad Forohar - NSWC-IH
- Dr. Phil Pagoria – LLNL
- Dr. Damon Parrish – NRL
- Dr. Mike Hiskey
- Dr. Jeff Bottaro

John Fronabarger

Author: Michael Williams
Company: Pacific Scientific Energetic Materials Co.
Contact: 480.763.3063, mwilliams@psemc.com

Bio Summary: Mike Williams is a Senior Chemist at Pacific Scientific Energetic Materials Company (PSEMC) in Chandler, AZ and is currently the manager of Green Energetic Materials development. Prior to joining PSEMC in 2002, Mike was manager of the Nuclear Magnetic Resonance Lab at Arizona State University specializing in multinuclear solid state and 1 and 2D liquids experiments for determination of molecular structure. From 1995 to 1997 he was an Assistant Research Professor at the Cancer Research Institute at ASU and was involved with the isolation/structure elucidation and synthesis of natural products with antineoplastic properties.

Mike has a Ph.D. in Synthetic Organic Chemistry from Rensselaer Polytechnic Institute (Troy, NY) and a BS in Chemistry from St. Michaels College (Colchester, VT).

Hovering Precision Weapons:
Enabling Precise Surgical Strike and Collocated Close Air Support from Tactical to Strategic Distances

Professor Ron Barrett
Director of the Adaptive Aerostructures Laboratory (AAL)
Aerospace Engineering Department
The University of Kansas, Lawrence, Kansas USA

AAL ...Backroom for the Innovation-Driven Aerospace Organizations of the world...

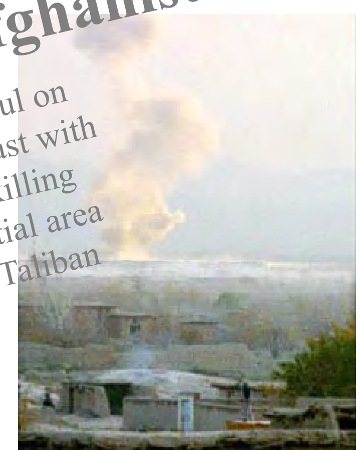
Joint Armaments Conference, Exhibition and Firing Demonstration
Dallas, Texas 19 May 2010

Motivation:

- ***Current tactics and weapon systems often induce unacceptable levels of collateral damage and Coalition casualties***

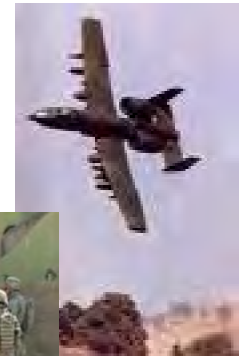
Costly collateral damage in Afghanistan

"a US bomb flattened a flimsy mud-brick home in Kabul on Sunday blowing apart seven children as they ate breakfast with their father. The blast shattered a neighbour's house killing another two children …..the houses were in a residential area called Qalaye Khatir near a hill where the hard-line Taliban militia had placed an anti-aircraft gun."[18]



Paradigm Shift:

Now…



Hmmm…

Outline:

I. Hovering Precision Weapon History

II. Current Platform Configuration & Performance

III. The Paradigm Shift…
New Systems with New Capabilities

Conventional UAV "Challenges"

Operation Allied Force
Kosovo 1999
(source: Yugoslav armed forces)

UAVs Lost in Kosovo:

Britain: 14 (14 Phoenix)

United States: 17 (3 Predators, 9 Hunters, 4 Pioneers, 1 UAV of undetermined type)

Germany: 7 (presumably all CL-289 turbojet drones)

France: 5 (3 Crecerelle, 2 CL-289)

By Jan. 2003, 30 of 70 RQ-1 Predators crashed or were shot down
(source: Mike Mount CNN Washington Bureau)

4 UAVs of undetermined origin (possibly U.S., German, or Italian)

Advanced Convertible UAVs: Why??

"2/3 of eligible targets went undetected, let alone unengaged because of our reconnaissance deficiencies."

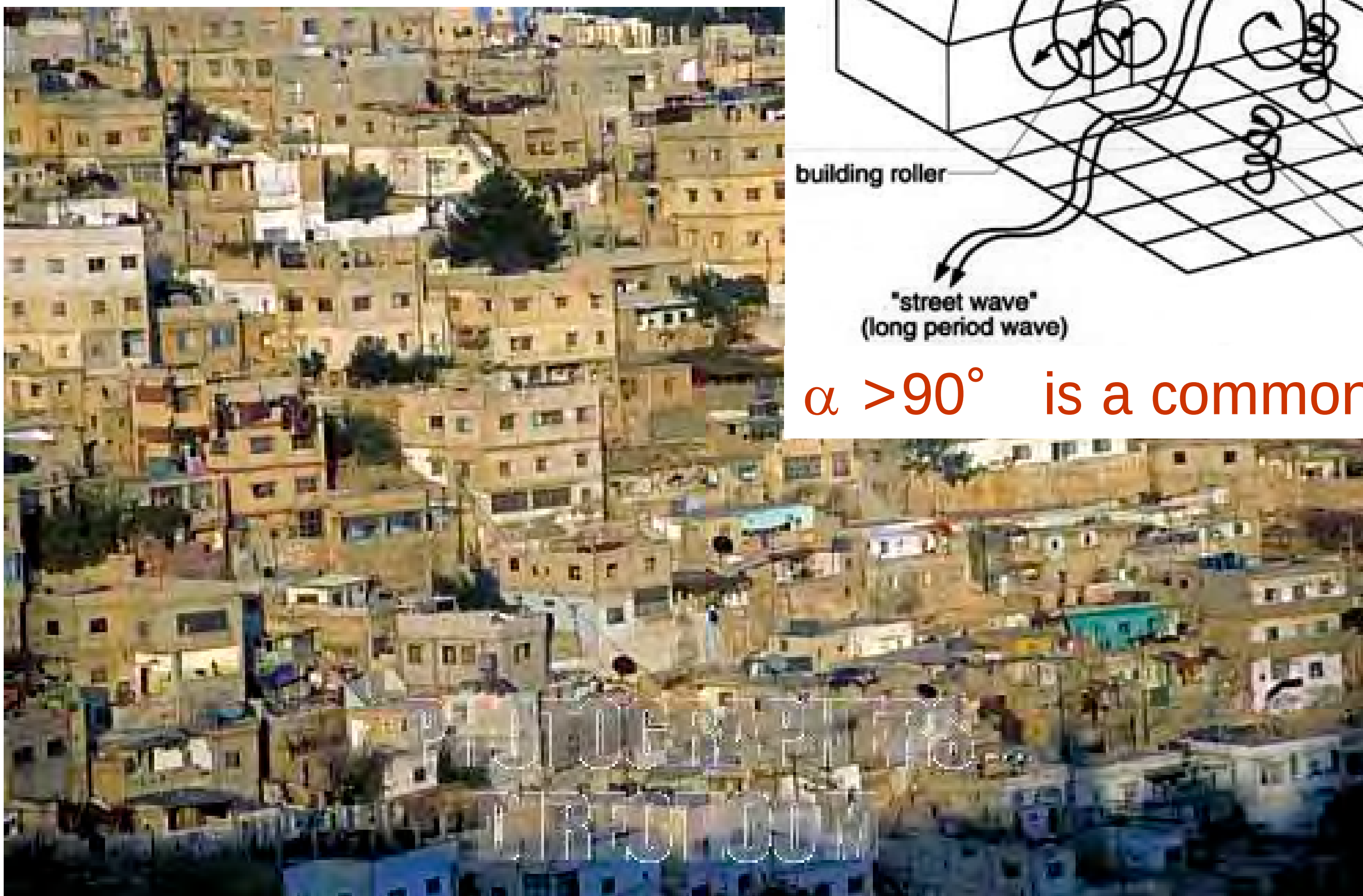
"Folks… it's going to take something new to fix this problem."

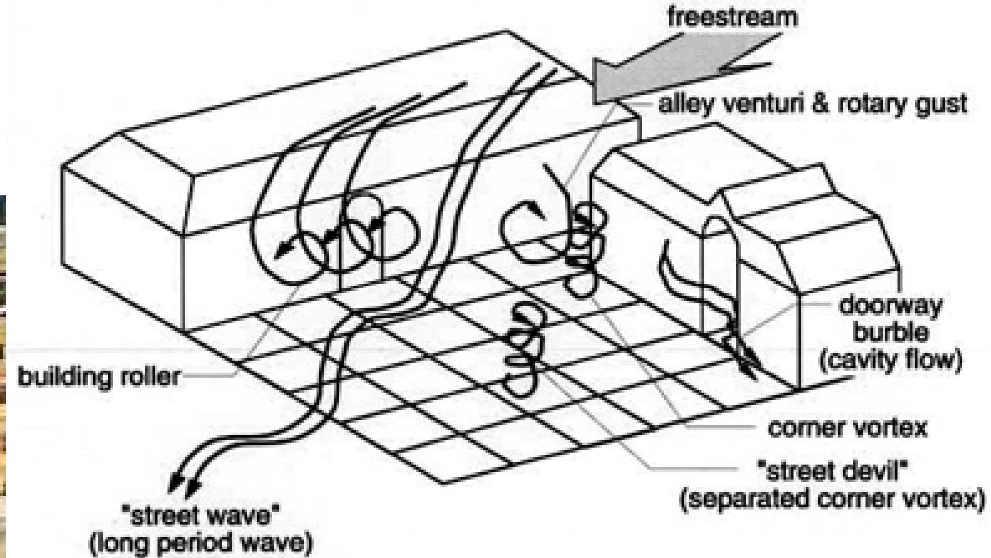
-Lt. Gen. Bruce Knutson, USMC

Low-Level Operations:

Serious trouble for UAVs...

DARPA Urban & Sub-Canopy
Atmospherics Survey 1998



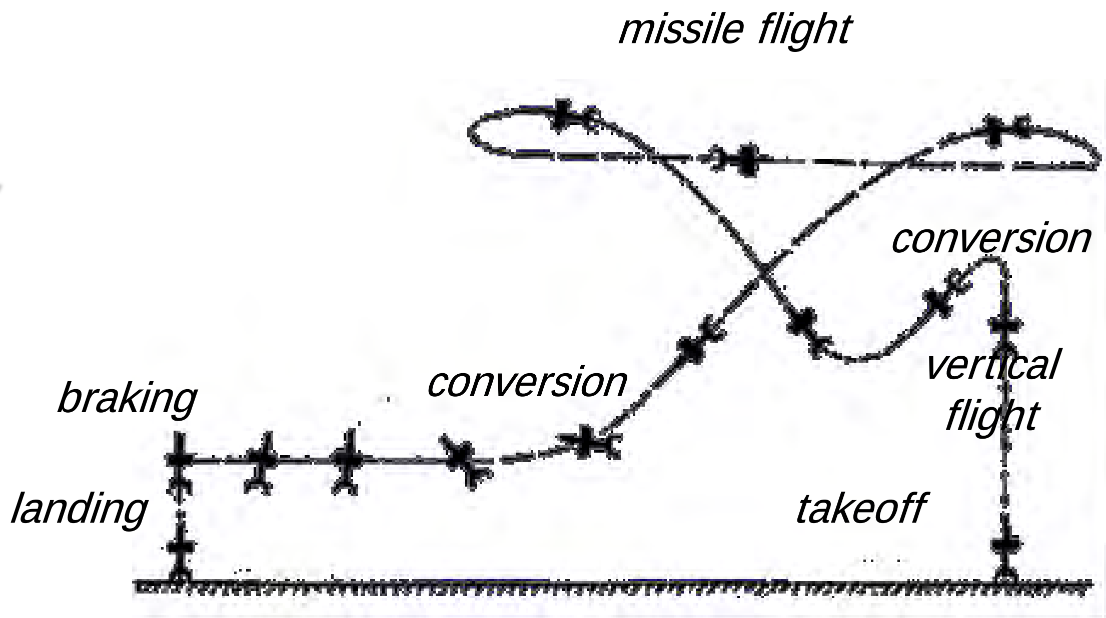


α >90° is a common event

Paradigm Shift...
Hypermaneuverable UAVs

Hover in more places than a helicopter

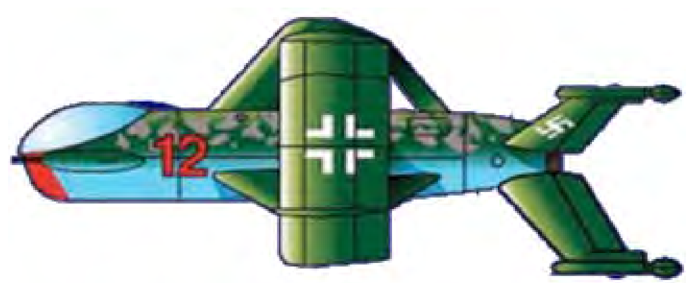
Fly as fast as a missile



Convertible Coleopter Configurations

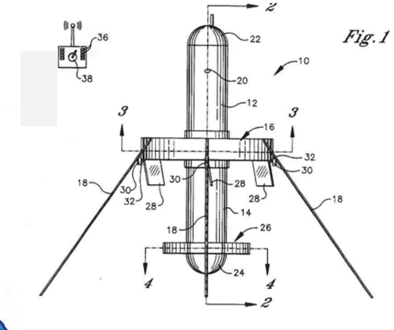
Heinkel Wespe 1944
(concept only, never built)

Heinkel Lerche 1944 (concept only, never built)



US Pat. 6,502,787

Hypermaneuverable UAVs

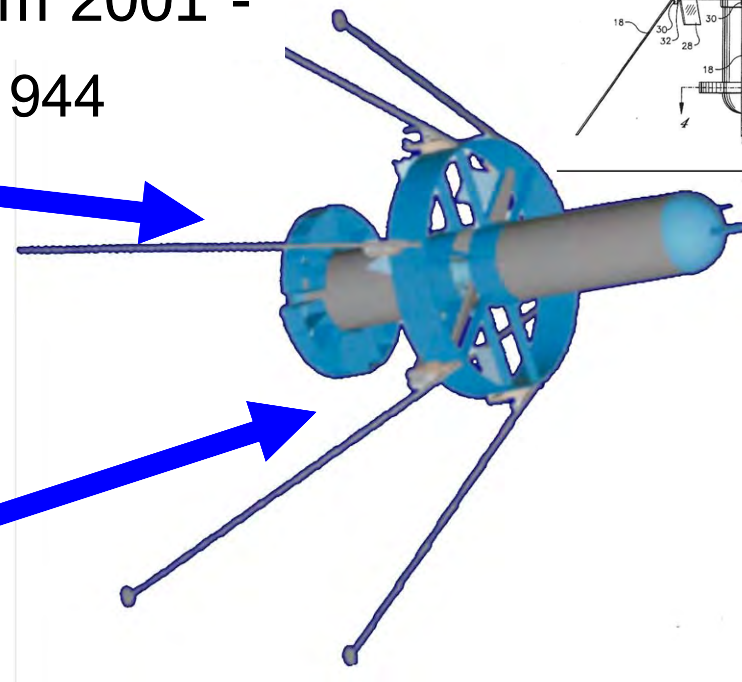


XQ-138 Program 2001 -

Heinkel Wespe 1944

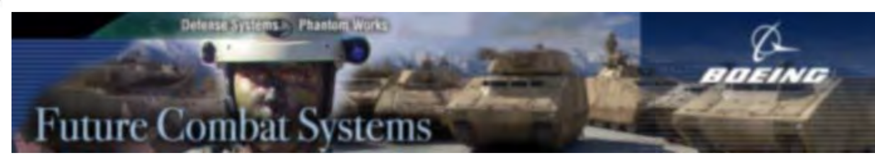
more control authority

needed for MOUT environment



AA-12 (R-77)
(Aamraamski)

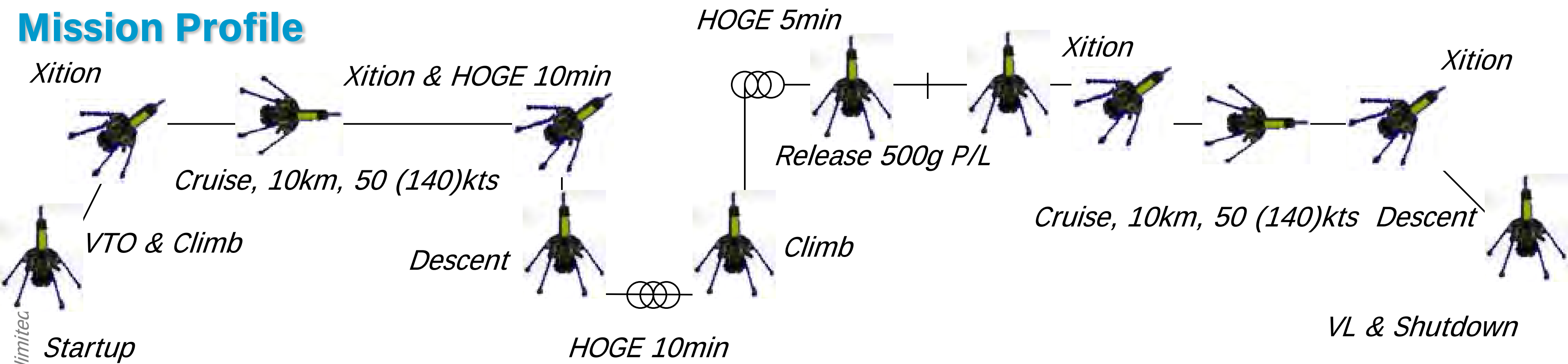
high control authority grid/lattice fins



Singapore Technologies Aerospace

XQ-138 Hypermaneuverable UAV

Mission Profile



Mission Specification:

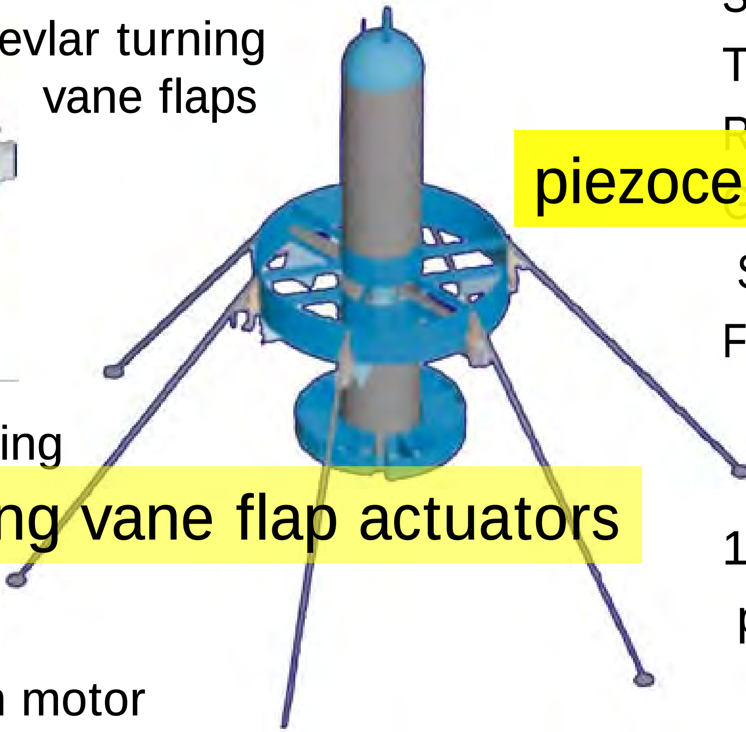
- Max. gross weight: 6.8lb (3.1kg)
- Max.payload weight: 2.2 lb (1kg)
- All weather capable
- 12”/hr (31cm/hr) rain
- 25+ kt gust penetration
- Sensors: B/W 0.001 lux, Color 0.1 lux,FLIR
- Sandstorm capable to 100kts
- Vmax 140kts for 1hr (blue sky)
- -40/100° F (38° C), 100% humidity
- Combat shotgun resistant @5m
- 15g MOUT wall strike
- Land + autostart
- Flight modes: 1st, 3rd person, fully autonomous w/waypoint nav.

XQ-138

MDO using best currently available technology

ballistic graphite & boron structure

Kevlar turning vane flaps



Sensor
Transmitter
Receiver
GPS navigator
SAS system
Fuel tank

piezoceramic gyros

titanium powerplant housing

piezoceramic turning vane flap actuators

1.3hp (970W) powerplant

magnesium motor mount/fuselage coupler
flight control actuators

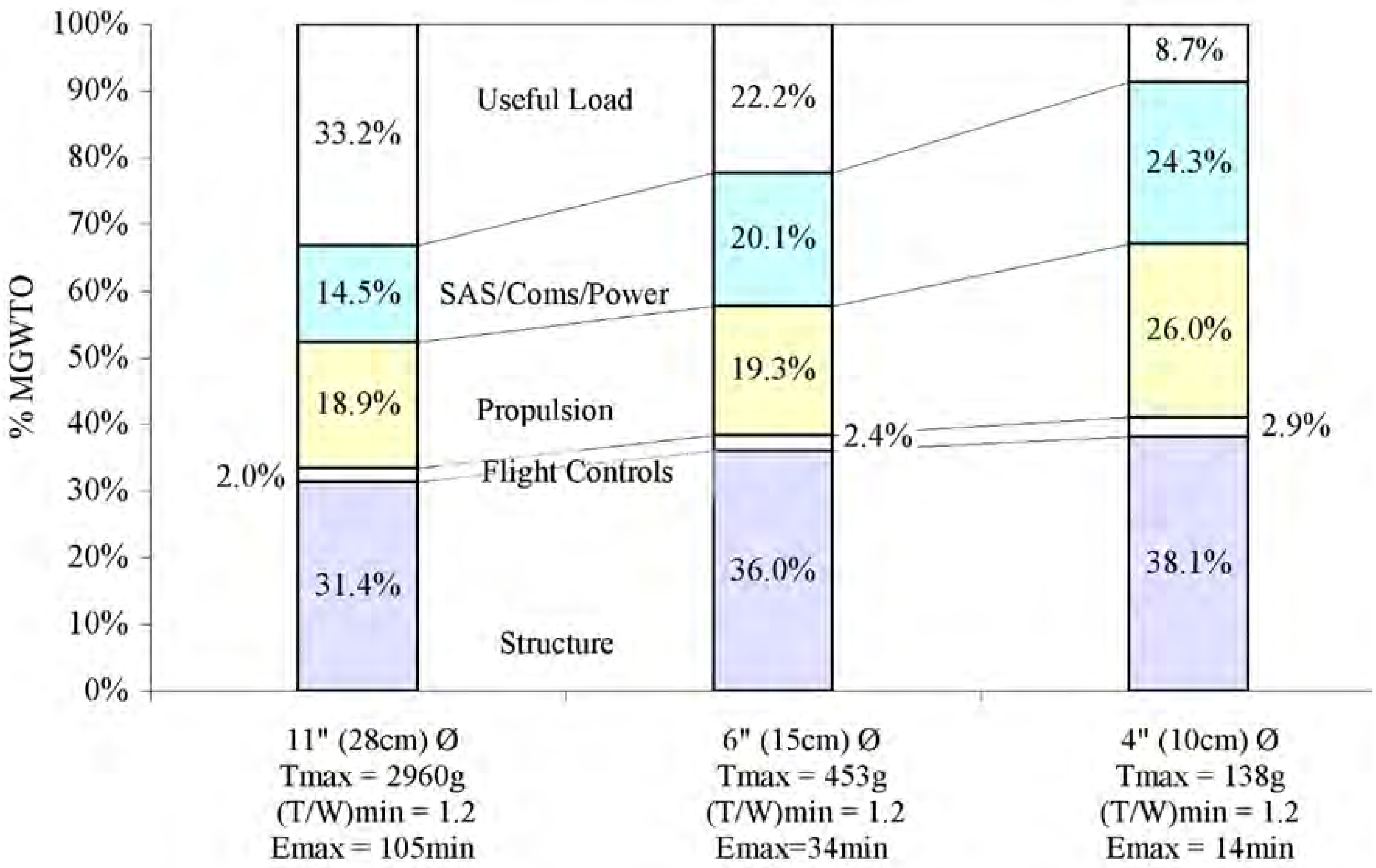
Muffler ass'y

graphite racking grid fins

piezoceramic grid fin actuators

XO-138 Weight Fraction Trends...

Adaptive FCS

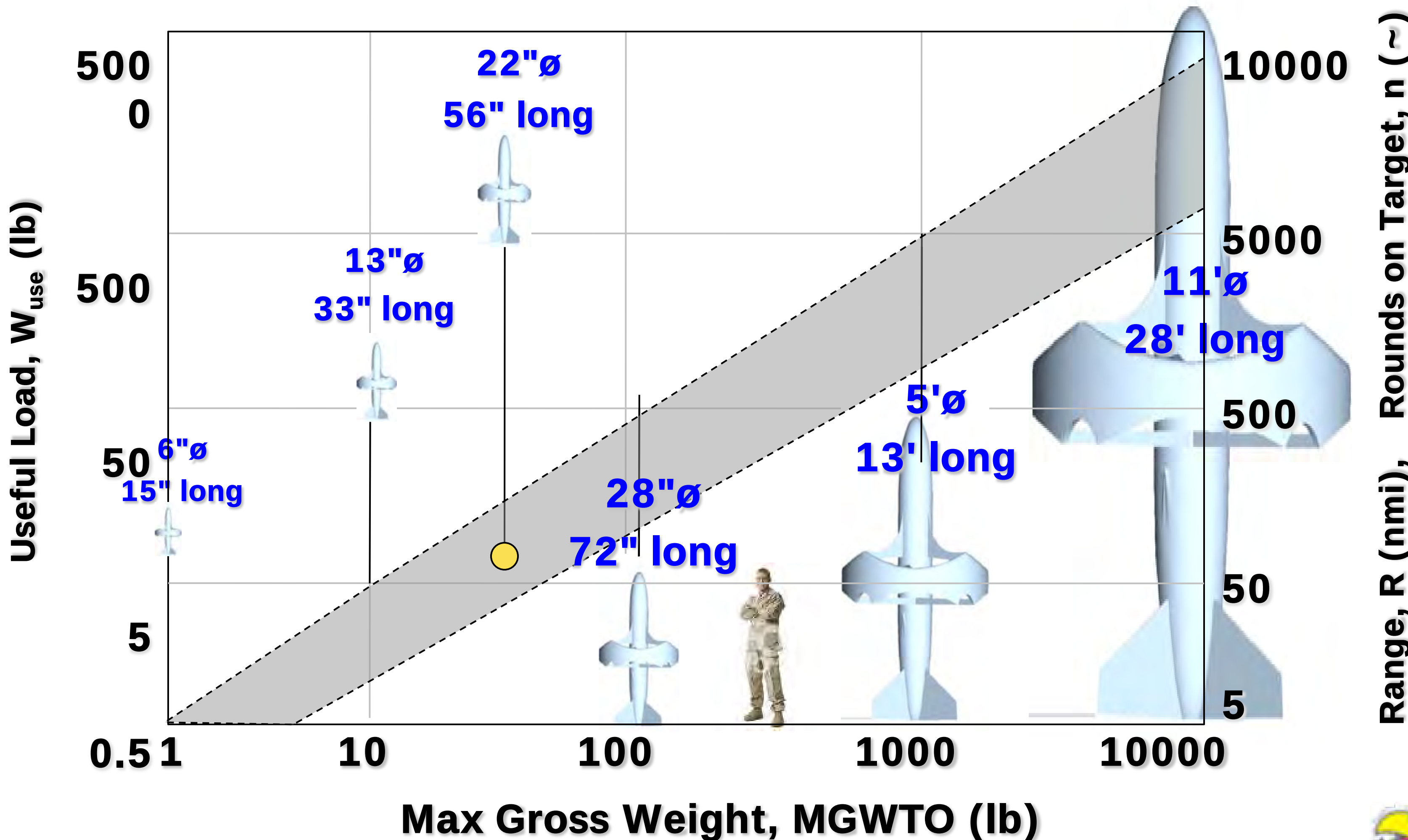


What's Next???

FAQ-381

Collocated Close Air Support (CCAS) Hovering Precision Weapon (HPW)

XQ-381 Rubber Design General Sketch
Growth, Range, Payload



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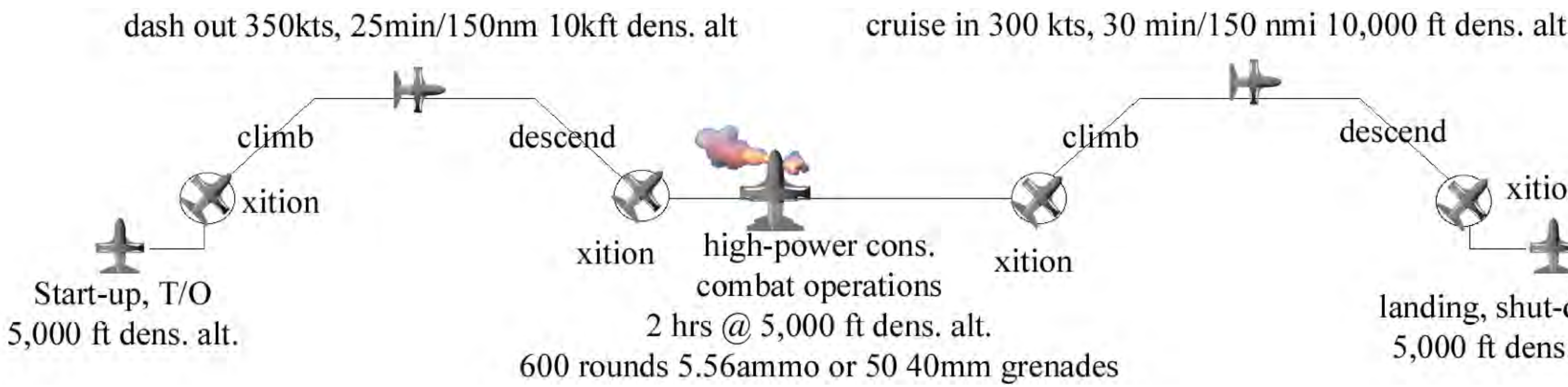
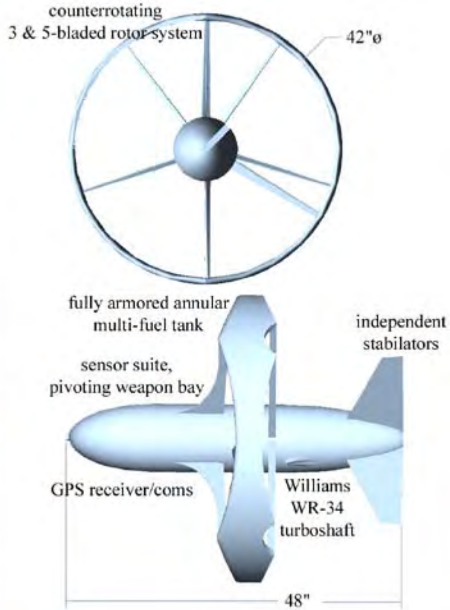
FAQ-381 Design Point 1

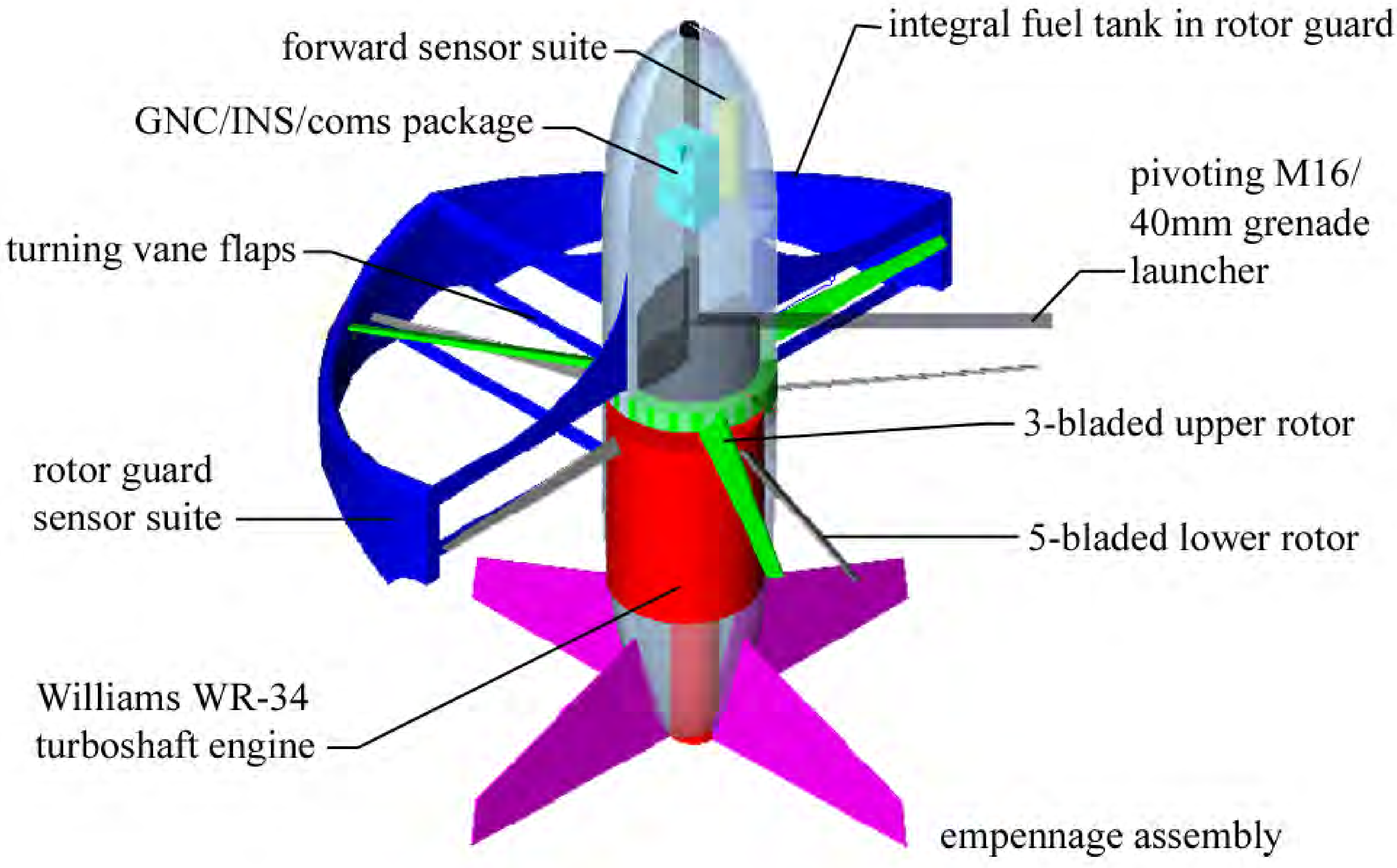


Enhanced Mission Specs:

- MGWTO ~50 lb
- Vmax >380kts
- >3hr HOGE
- >5hr Vbr Loiter
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant



The Next Generation: FAQ-381$_{DP1}$



FAQ-381$_{DP1}$ CCAS 20 min Response

Iraq:

4 Base Coverage for 20min Response

Afghanistan:

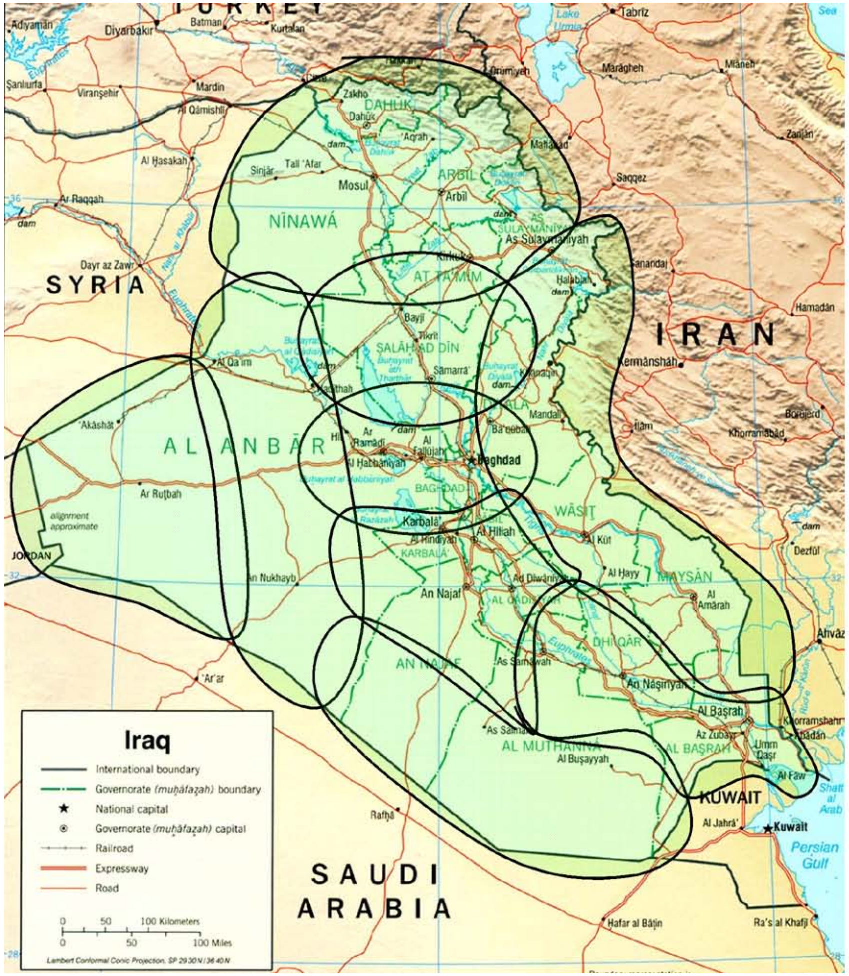
5 Base Coverage for 20 min Response

FAQ-381$_{DP1}$ CCAS Refueling Concept

Tankers enable "indefinite" loiter/orbit

FAQ-381$_{DP1}$ 5 min CCAS

9 Track Coverage for Iraq



10 Track Coverage for Afghanistan

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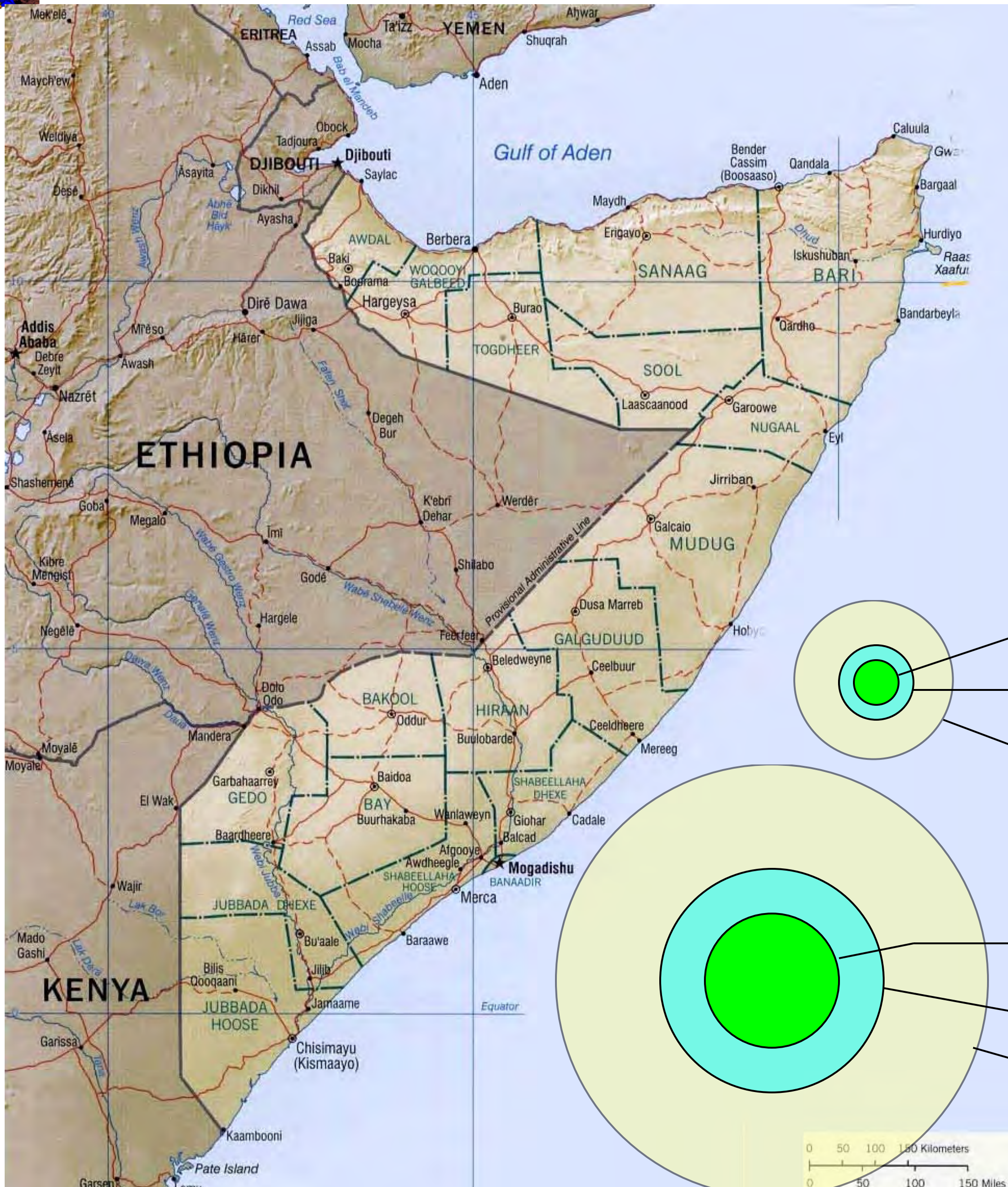
The Next Generation: FAQ-381$_{DP1}$ Counterpiracy



SH-60 Intercept Range

15 min

30 min

1 hr

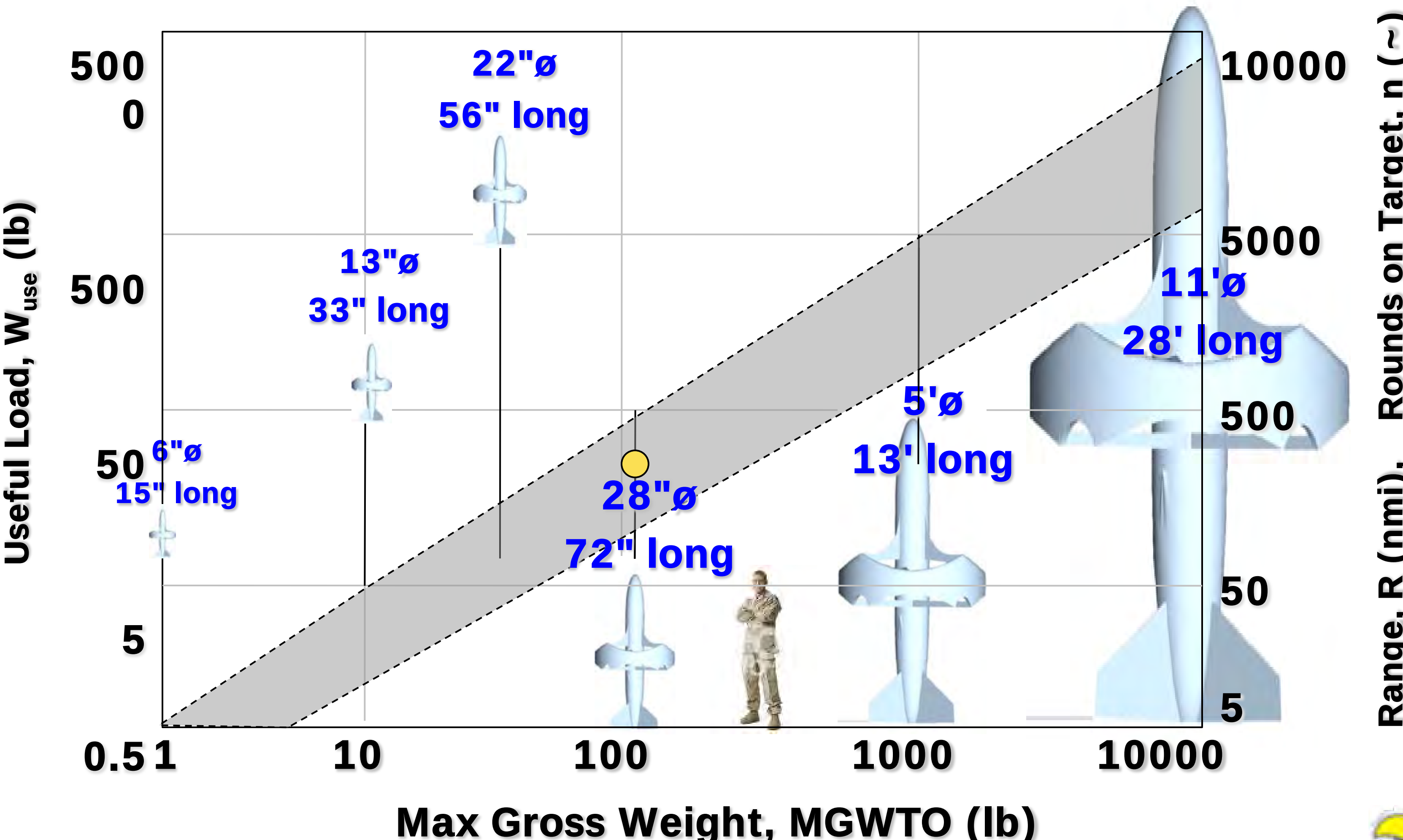
FAQ-381 Intercept Range

15 min

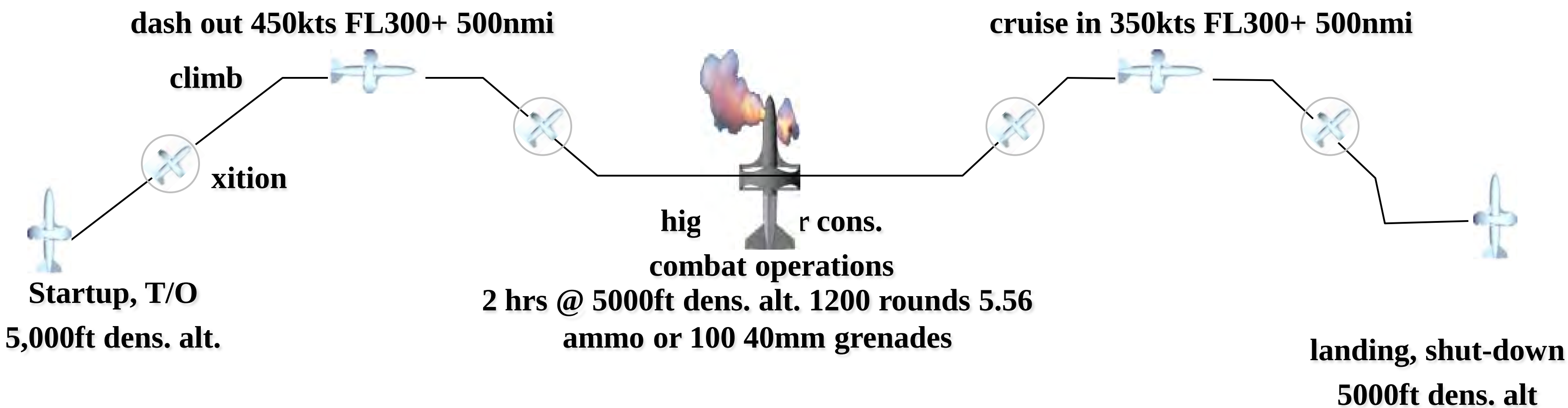
30 min

1 hr

XQ-381 Rubber Design General Sketch Growth, Range, Payload



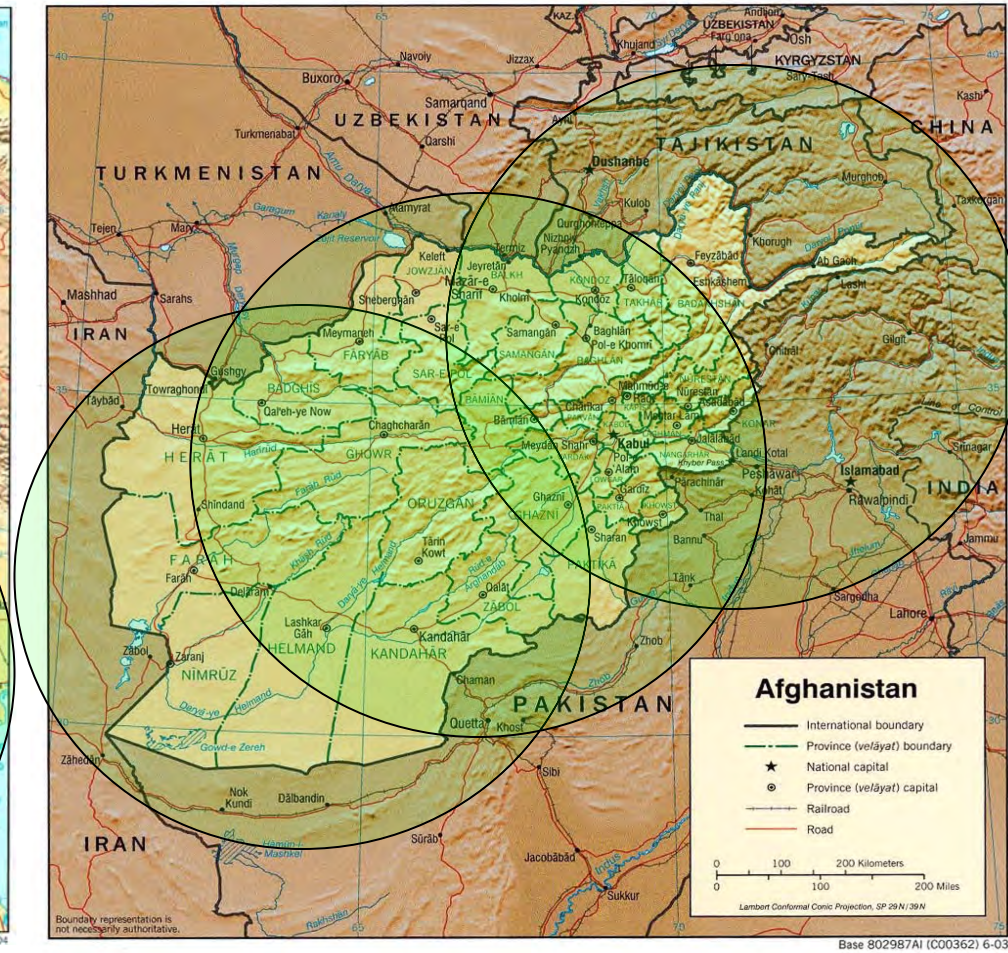
FAQ-381 Design Point 2 – 100lb MGWTO



Enhanced Mission Specs:

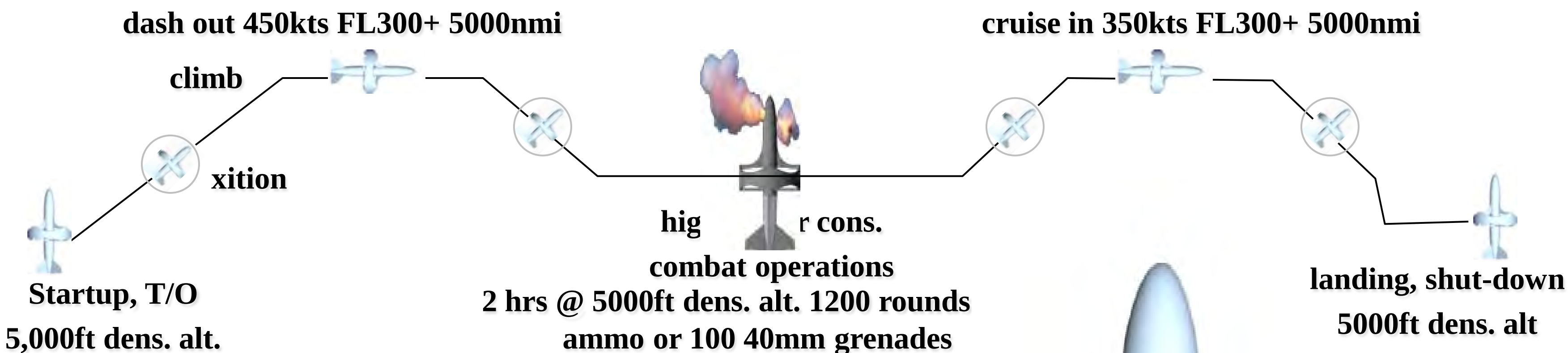
- MGWTO ~100 lb
- Vmax >450kts
- >3hr HOGE
- >5hr Vbr Loiter
- 500nmi radius @ V_{BR}
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant

FAQ-381 Design Point 2 – 100lb MGWTO



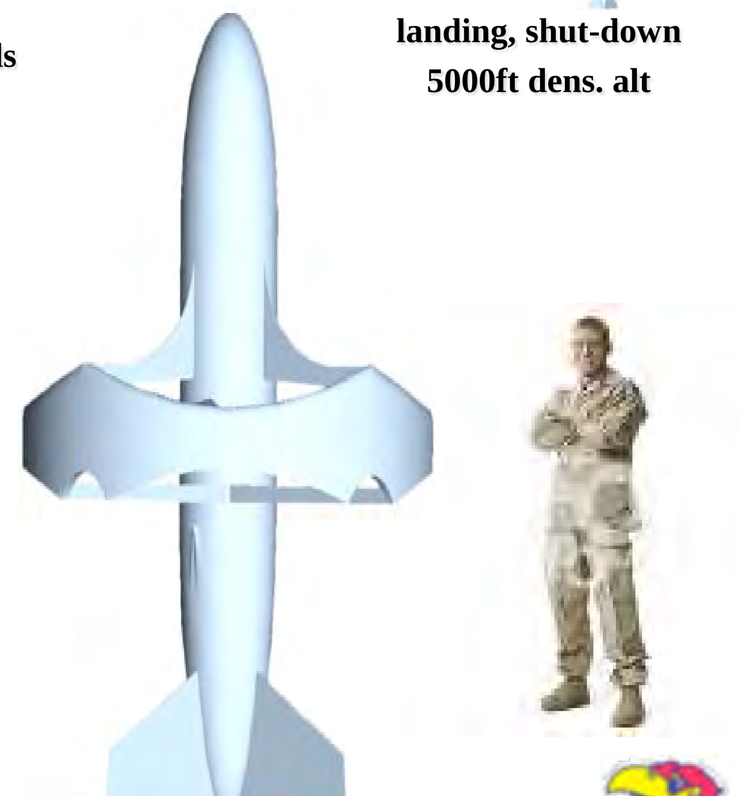
R. M. Barrett 20 May 2010 Unclassified Distribution Unlimited

FAQ-381 Design Point 3 – 1000lb MGWTO



Enhanced Mission Specs:

- MGWTO ~1000 lb
- Vmax >450kts
- >3hr HOGE
- >5hr Vbr Loiter
- 5000nmi radius @ V_{BR}
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant



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Now where...

- Battle Labs
- Brief Decision Makers
- Industry Consortium

Questions?