



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



***TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.***

Advanced Technology and Precision Armaments-  
ARDEC Perspective

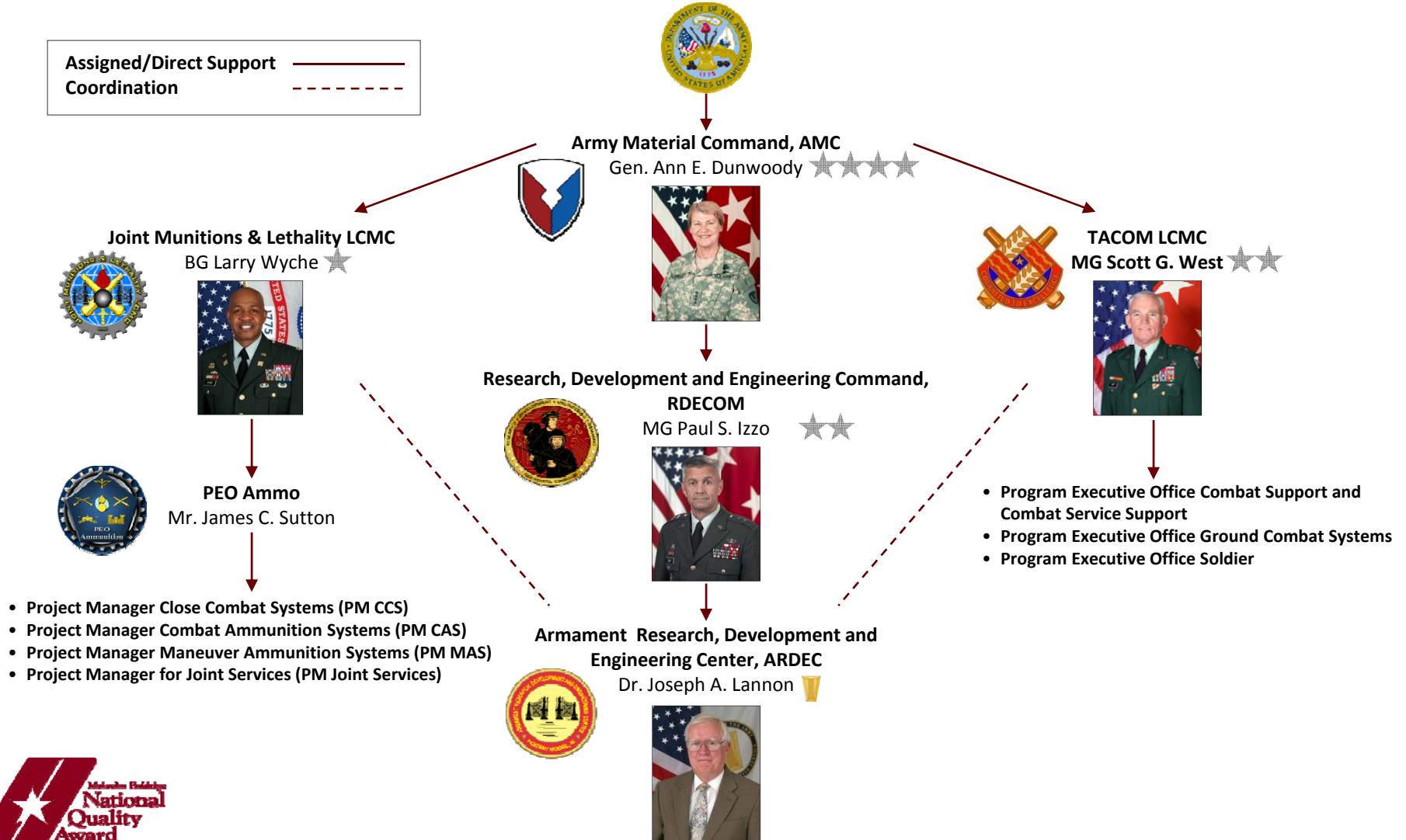
Dr. Joseph A. Lannon,  
Director, US Army ARDEC

9 June 2009

- **ARDEC Overview**
- **Advanced Technology & Precision Armaments**
  - Increased Precision
  - Force Protection / Survivability Needs
  - Longer Standoff
  - Affordability
  - Reduced Logistics Burden
  - Adaptive Lethality / Reduced Collateral Damage
  - High Reliability
- **Modeling and Simulation**
- **ARDEC Accomplishments**
- **BRAC Added Capabilities**
- **Rewards and Recognition**
- **Summary**



## Headquarters, Department of the Army





# Armament Research, Development & Engineering Center



## • Research



## • Development



## • Production



## • Field Support



## • Demilitarization



## Vision:

Innovative Armaments Solutions for Today and Tomorrow

## Mission:

To develop and maintain a world-class workforce to execute and manage integrated life-cycle engineering processes required for the research, development, production, field support and demilitarization of munitions, weapons, fire control and associated items

Advanced Weapons – line of sight/beyond line of sight fire; non line of sight fire; scalable effects; non-lethal; directed energy; autonomous weapons

Ammunition – small, medium, large caliber; propellants; explosives; pyrotechnics; warheads; insensitive munitions; logistics; packaging; fuzes; environmental technologies and explosive ordnance disposal

Fire Control – battlefield digitization; embedded system software; aero ballistics and telemetry

Provides the Technology for Over 90% of the Army's lethality; Significant support to other services' lethality

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# ARDEC Executive Team



**Director/Deputy Director**  
Dr. Joseph A. Lannon/COL Scott Flynn



**Enterprise & System Integration Ctr.**  
COL Scott Flynn/Mr. Tony D'Agosto

**Munitions Engineering Technology Ctr.**  
LTC Bosworth/John Hedderich III



**Tech Base/MANTECH**  
Ms. Barbara Machak



**Senior Research Scientist for Warhead Technologies**  
Mr. Richard Fong

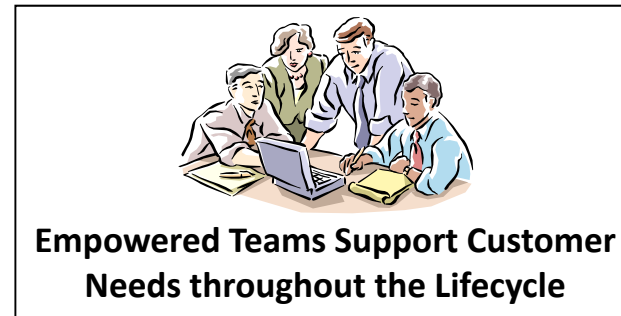
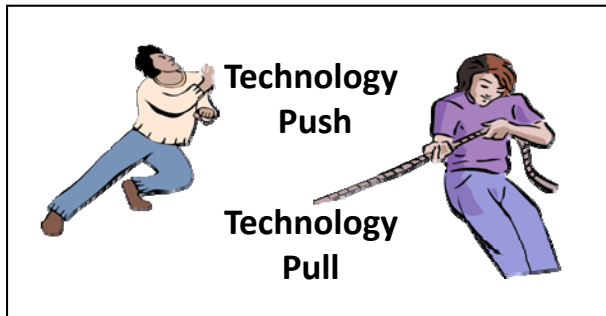
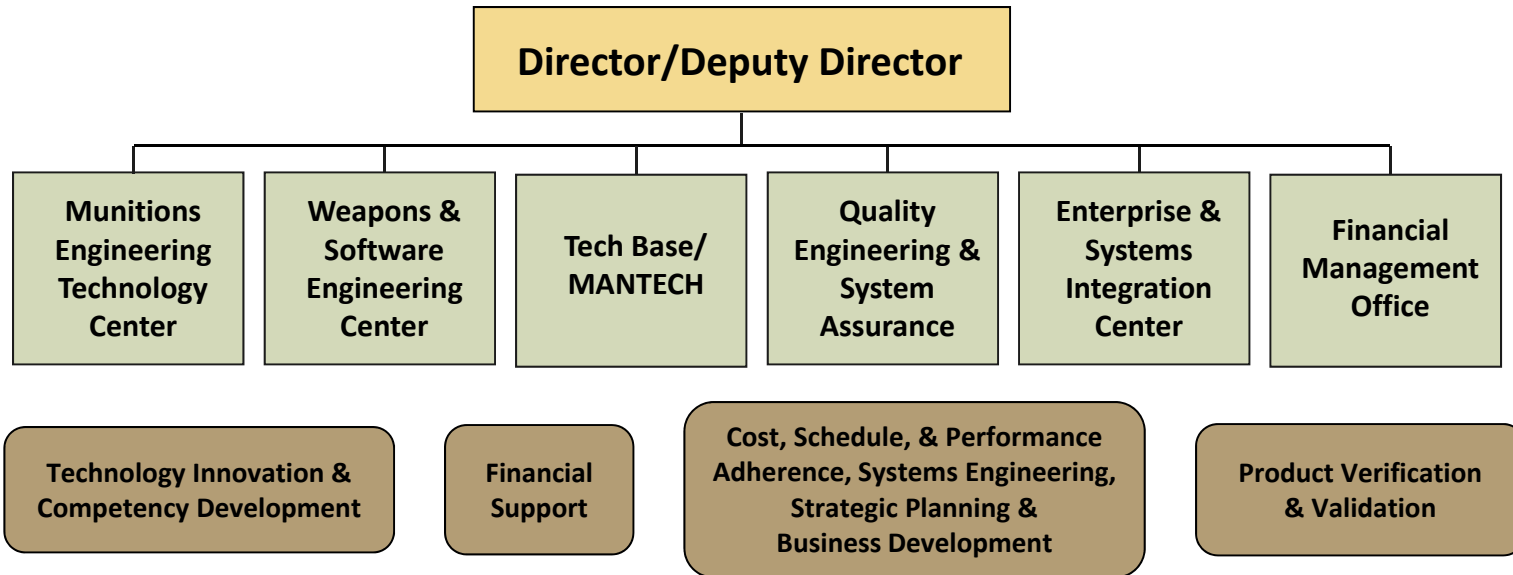
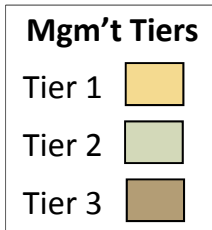


**Quality Engineering & System Assurance Directorate**  
Mr. Dominick Carra

**Weapons & Software Engineering Center**  
Mr. David Castellano

**Financial Management Office**  
Ms. Mary Manser





**Collaboration Drives Success**



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# ARDEC at a Glance



- Established “Center of Mass” for Armament Systems and Munitions for Joint Services
- ARDEC is the largest tenant at Picatinny Arsenal
  - Over 800 Buildings/64 Laboratories
- Proven track-record supporting transition of technologies to the field; in FY08...
  - >14 Materiel Releases (MR)
  - >13 Urgent MR
- > ARDEC & Partners Fielded 134 New Weapons, Ammunition and Equipment since 9/11
- Recruiting and Nurturing Top Talent- Onsite Armaments Training Facility
- ARDEC Government Personnel ~ 3321; [1191 new hires since FY99\\*](#)
  - Picatinny Site = 2880
  - Benet (Watervliet Arsenal) = 239
  - Rock Island Arsenal = 144
  - Adelphi & APG = 58
- >\$120M invested in “World Class” experimental R&D facilities since mid-90’s; Additional \$75M planned
- Strong partnerships with Industry, Academia, and other Government agencies - Growth and Success through Cooperative Research and Development Agreements (CRADAs) = 121
- Intellectual Property: Invention Disclosures – 12; Patent Applications – 16; Patents Issued – 8; Patent License Agreements – 14
- In-house rapid prototyping initiatives demonstrating new desired capabilities, supporting production prove-out and initial fielding demands
- > \$100M Tech Base portfolio addressing Joint needs (Core Tech Base/ManTech only; does not include SBIR or Congressional Plus-ups)

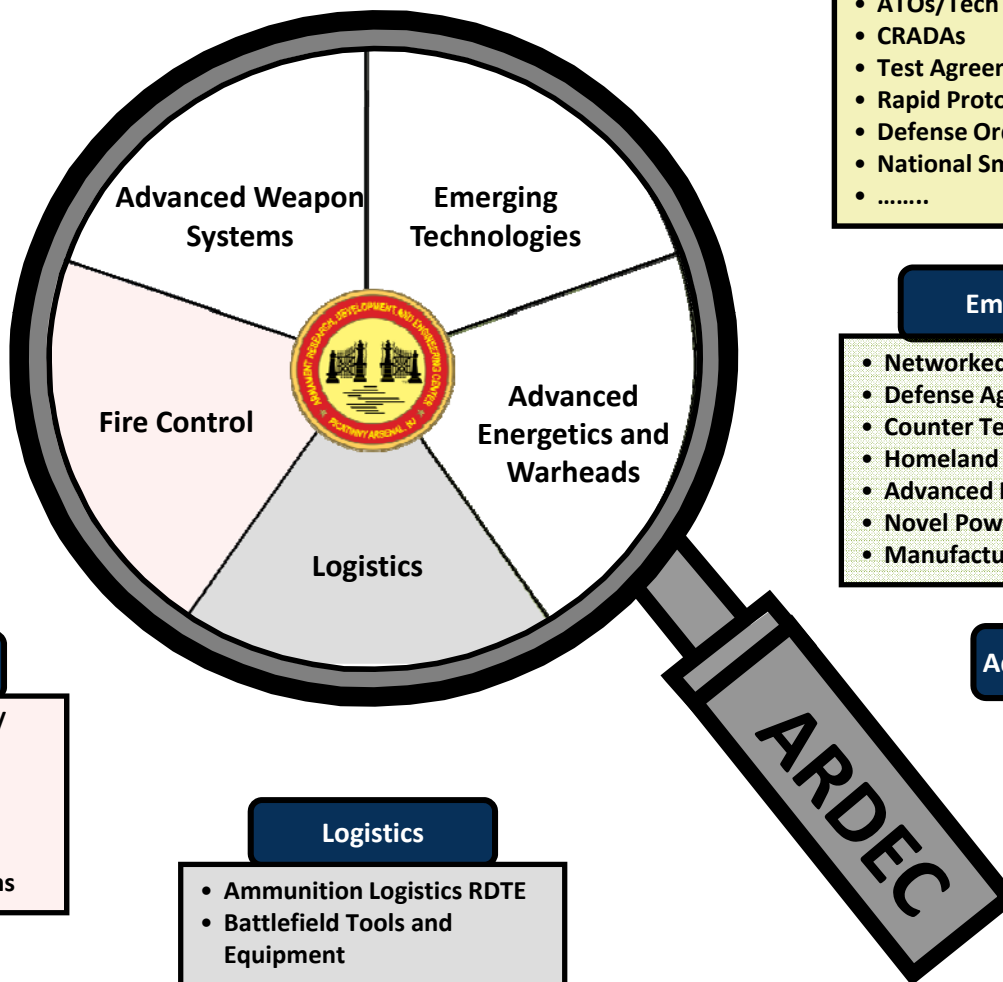


\* As of 30 Apr 09

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## Advanced Weapon Systems

- Direct Fire
- Indirect Fire
- Scalable Effects
- Non-Lethal Systems
- Small/Medium/Large caliber ammunition
- Directed Energy
- Remote Armaments
- Insensitive Munitions
- Fuzes
- Telemetry
- Precision Armaments
- Grenades
- Maneuver Support Munitions
- Demolitions



## Collaboration Mechanisms

- ATOs/Tech Base
- CRADAs
- Test Agreements
- Rapid Prototyping
- Defense Ordnance Technology Consortium
- National Small Arms Consortium
- .....

## Emerging Technologies

- Networked Lethality
- Defense Against Unmanned Systems
- Counter Terrorism Technologies
- Homeland Defense Technologies
- Advanced Materials / Nanotechnologies
- Novel Power & Energy Systems
- Manufacturing Science Technologies

## Fire Control

- Battlefield Digitization / SW Applications
- Embedded Systems SW
- Firing Tables
- Ballistics
- Automated Test Systems

## Logistics

- Ammunition Logistics RDTE
- Battlefield Tools and Equipment

## Advanced Energetics and Warheads

- Propellants
- Explosives
- Pyrotechnics
- Warheads
  - Kinetic Energy
  - Chemical Energy
  - Shaped Charges
  - EFPs
  - Fragmentation







## Advanced Technology and Precision Armaments



- The Future is Now: Warfighter Needs are being actively addressed
  - Increased Precision
  - Force Protection / Survivability Needs
  - Longer Standoff
  - Affordability
  - Reduced Logistics Burden
  - Adaptive Lethality / Reduced Collateral Damage
  - High Reliability
- *Where we are going*
  - *Satisfy the Warfighter's needs thru continuous/Life Cycle investment in S&T, SD&D and O&S*
  - *Focus on Reliability, Cost and Transition to the Warfighter*



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

## Mid Range Munition

- Transitioned in FY07 to PM MAS
- 1<sup>st</sup> BLOS smart munition
- Autonomous and SAL designated
- Raytheon (Technology Base Provider) selected for SDD



## Precision Guidance Kit

- Provides **Affordable** Near-Precision Accuracy
- Fits in standard 155mm High Explosive artillery projectile fuze wells (deep intrusion)
- GPS guidance (incorporates SAASM)
- 20 Year Storage Life (no battery)
- Proximity & Point Detonating Fuzing



## Excalibur & Excalibur 1B

Excalibur Experiencing Tactical Success

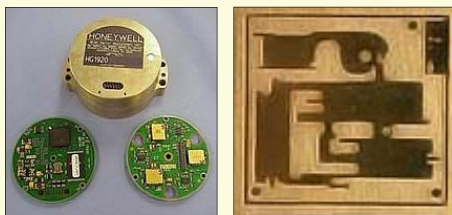
Excalibur 1B in Development

- Improvements Over Baseline
  - **Cost Reduction**
  - **Reliability Improvement**
- Improved Accuracy in CM Environment
- Increased Range



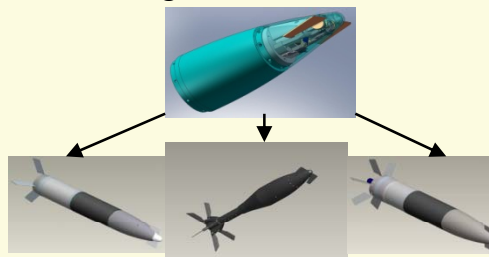
## MEMS IMU

- Transitioned in FY07 to PM CAS
- Co-developed with AMRDEC
- Common munitions / missile IMU
- Used in Excalibur



## Very Affordable Precision Projectile / Very Affordable Precision Mortar

- Precision at \$10,000 / RD
- Government design
- Forthcoming CDD for 105mm



## Affordable Precision Component Technologies

- Demonstration of Industry & Government Concepts for Low Cost Guided Munitions and Associated Technology
- Focus on commonality across mortars and artillery
- Component Technology Evaluation of power source, Guidance Module, GPS receiver/processor (if required)/SAL; and control system (e.g., canards, vents, thrusters)

*APCT will provide low cost precision accuracy in artillery & mortar systems lacking that capability.*

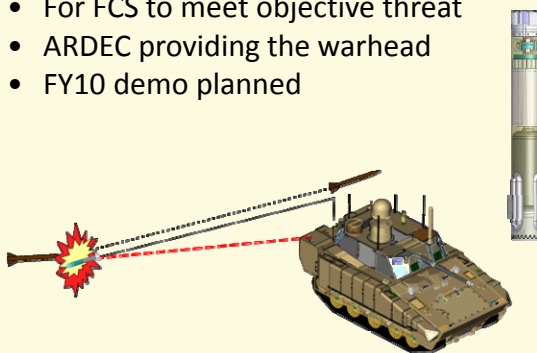
## Extended Area Protection System (EAPS)

- 50mm gun and guided bullet
- Counter rocket artillery and mortar



## KEAPS

- For FCS to meet objective threat
- ARDEC providing the warhead
- FY10 demo planned



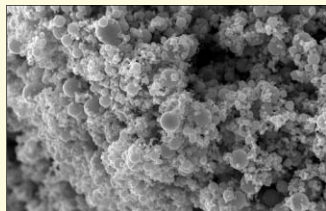
## Gunfire Detection & Location

- Enhanced acoustic, UV, IR, narrow-band, and/or optical augmentation sensors to detect/locate/ID shooters
- Provide combat forces with actionable understanding of hostile shooters & gunfire in real-time & enhance TTPs to defeat threats



## Novel/Nano Structured Energetics

- High performance extremely insensitive fills
- Structural Energetics



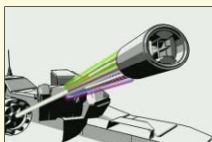
## Insensitive Munitions (IM)

- HPC institute, ARL and ARDEC teamed to develop the next generation of M&S for Insensitive Munitions application
- New M&S capability: Faster design and implementation
- Improved tactical and combat survivability
- IM efforts for HE Munition and new IM Fills



## EM Gun

- Eliminate use of energetics with increased lethality
- Enhanced Survivability with reduced launch signature
- 20MJ Railgun Launcher, Integrated Launch Package, & 20MJ Pulsed Power supply



## Projectile

- XM1113 Extended Range Artillery redesigned to achieve 1200m/s muzzle velocity with a 20m CEP
- Velocity Augmented solution leverages ERGM design to achieve ranges with larger payloads



## HPM Conceptual Payload

Ability to neutralize targets outside the range of vehicle based DE with minimal collateral damage



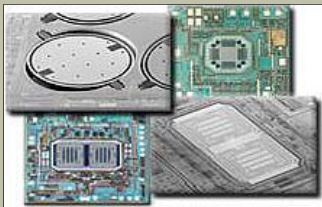
## Weapon Improvements

- Extended Length
- Composite Barrel
- High Efficiency Muzzle Break
- Laser Ignition
- Modular Recoil
- Increased Muzzle Velocities



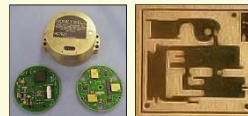
## MEM S&A

- S&T and MTO
- Proven at TRL 6 and MRL 7 for 20mm and 155mm
- Saves space for more lethality



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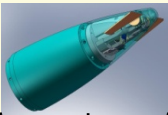


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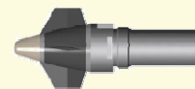
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## Joint Modular Intermodal Distribution System (JMIDS)

- JMID+JMIP transition in FY09 to PM-FSS
- Critical supplies delivered faster - 45% fewer C17 missions
- Reduces exposure to IEDs - 40% fewer vehicle trips



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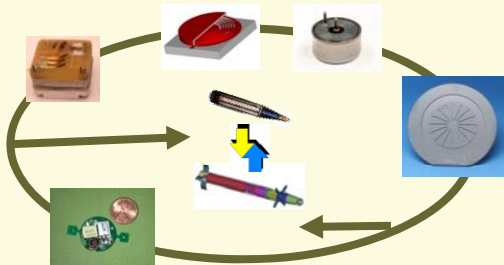
## Breech Mounted Laser Ignition

- Being developed for 155mm artillery
- Replacement for primer based ignition
- Provides logistics and operational benefits
- Improves mission readiness
- Supports continuous high rates of fire



## Fuze and Power

- High Voltage Fireset
- MEMS Impact Sensor
- Thermal/Reserve Batteries
- Shaped Charge Array for MP ESAD



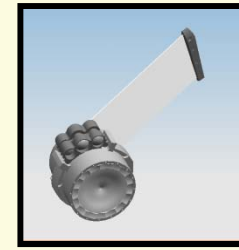
## Multi-Mode Warheads

- Target Selectable (e.g. armor or bunkers)
- Scalable (Full or mitigated effect)
- Tunable (non-lethal to highly lethal)



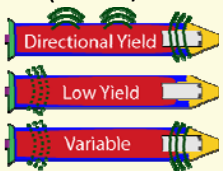
## Common Smart Submunition

- Increased lethality sensor fuzed munition
- Combined effects warhead
- Multi platform 128mm



## Scalable Technology for Adaptive Response (STAR)

- Scalable, selectable & adaptive lethal effects
- Demonstrators: 250mm (GMLRS), 155mm (Excalibur), 30mm (M789/Mk238)



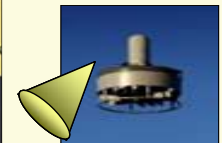
## Hardened Combined Effects

- Bash through structures
- Transitioned already to NLOS-LS PGMM and MRM



## High Power Microwave

- Weapon and a payload technologies
- Multi-effects across multiple targets





## Recent Activity – Affordable Reliability



- To Achieve **Affordable Reliability** we Need...
  - Infrastructure (Teams, M&S, Process)
  - Reliability Toolkit
    - Tools (Like Relentless Root Cause Process/**Probabilistic Technology**)
    - Training
    - IT Resources
  - **Culture to Apply Reliability Tools**
    - **Support for Reliability-Driven Design**
    - **Focal Point for early Demos**
    - **Significance in Acquisition Approach & Source Selection**
  - Broadly Applied Method to Qualify Materials (Potting, Adhesives, Elastomers) & Components
  - Process to Increase Component Reliability
  - **Do It Early!**



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# Increased use of Modeling and Simulation



## *Change ARDEC's Product Development Culture to Model-Test-Model*

- **Focus on enhancing these M&S areas initially:**
  - Design & Testing: Structural, Software, Energetics
  - Operational and System Analysis
  - Systems Integration
  - Manufacturing
- **Key Initiatives:**
  - **Training/Certification** – *M&S Modules in APO training (once a month)*
    - Management
    - Workforce
  - **Infrastructure**
  - **Test Community acceptance**

Emphasis on Rapid Prototyping and Speed of Technology Transition



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# High Performance Computing (HPC) Resource Utilization



- **Increasing available High Performance Computing**
  - **Acquired a Local HPC Resources for ARDEC Engineers**
    - ✓ **Dell HPC Cluster (Supercomputer) on-line and available for use**
    - ✓ **192 CPUs 96 Nodes; ~2.5TFlops; 768GB RAM**
    - ✓ **Connectivity to ARDEC enterprise storage - Secure Area Network (SAN)**

**Significantly Increases ARDEC Capabilities to Solve  
Complex Armament Systems Design Challenges**



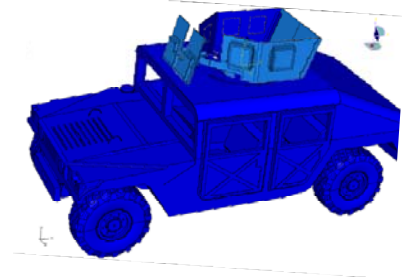
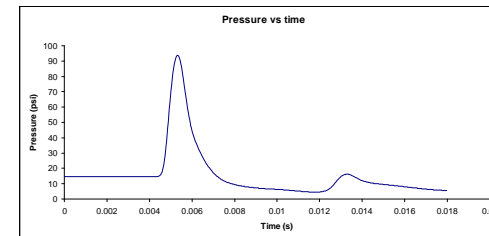
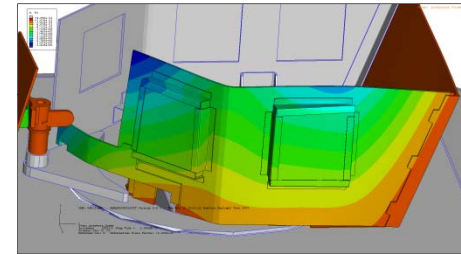
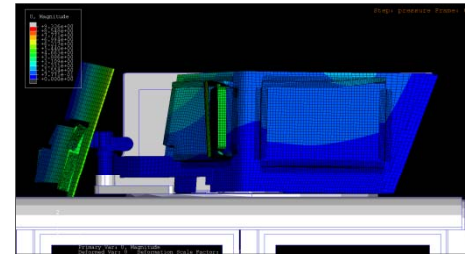
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# M&S Value Added- Example Objective Gunners Protection Kit (OGPK)



- Issue
  - Soldiers requested more visibility on Gunners protection kit (GPK)
  - Concern over excessive deflection of armor when subjected to blast
- Modeling Effort
  - Modeled Blast effects on structure
  - Developed larger glass panels
  - Effort completed in 2 weeks
- Benefits
  - Saved 4 months of testing
  - Saved \$1.0 M
  - Could not have met fielding schedule

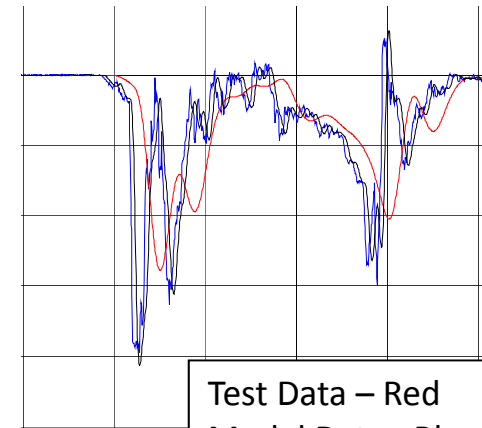
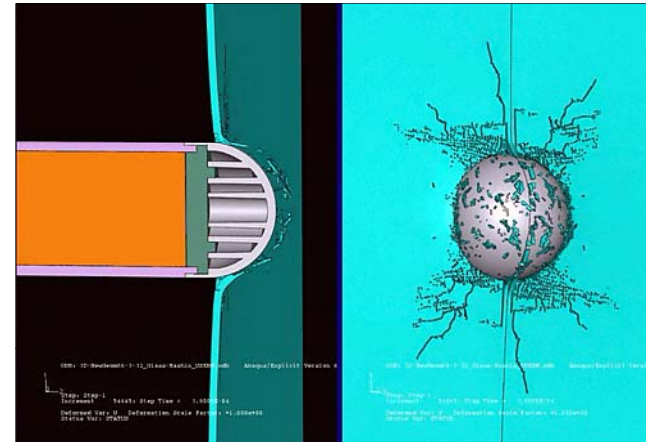


Test cost and schedule prohibitive

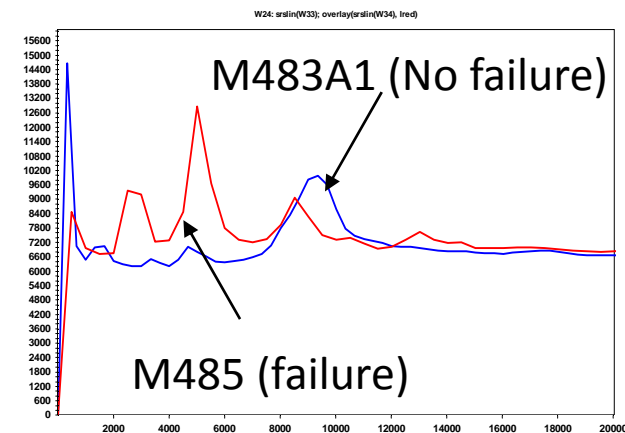
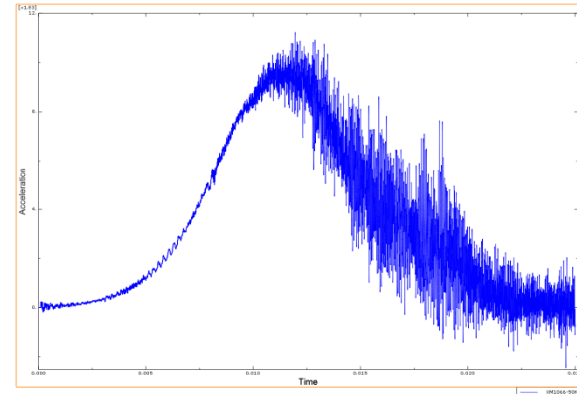
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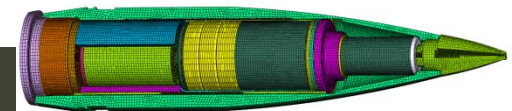
- Issue
  - Surveillance grenade design (SmADSNet) requires transmitter to survive impact into concrete after passing through a window
- Modeling Effort
  - Modeled multiple designs for front end of grenade to absorb impact
  - Each iteration can be run at various impact angles
  - Effort is ongoing
- Benefits
  - Saved 2-3 years of trial and error testing
  - Saved an estimated \$1M to date



- Issue
  - M485 illumination projectile is suffering from fuze failures in lot acceptance testing
  - Previous testing showed no issue
- Modeling Effort
  - Modeled M485 projectile as well as M483 projectile which did not exhibit failure
  - Testing and model are showing dynamic structural issues
  - Effort is ongoing
- Benefits
  - Saved 6 months of trial and error testing
  - Saved an estimated \$1M to date



Failure analysis ongoing and strongly leveraging modeling

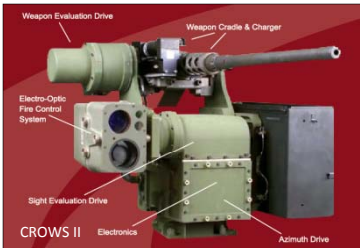




# Accomplishments Weapons and Ammunition Fielded Since 9/11



- Armor (9)
- Artillery (26)
- Aviation (6)
- Engineer (24)
- Infantry (56)
- Log (1)
- Mil Police (13)
- SF (4)






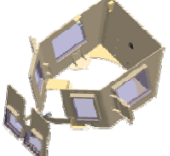






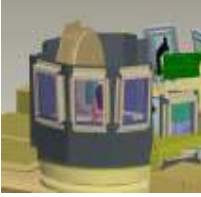

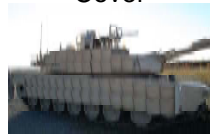












Additionally, ARDEC has provided numerous materiel changes and improvements to fielded items



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# Recent- Rapid Fielding in Support of Overseas Contingency Operations



FY06	FY07	FY08	FY09
 <p>PBS</p>  <p>PBS Coalition LAV</p>	 <p>SWORDS</p>  <p>O-GPK PHII</p>  <p>CROWS Lightning/PDCue</p>	 <p>O-GPK Overhead Cover</p>  <p>M2 Cal 50 Extender</p>	 <p>Objective Weapon Elevation Kit</p>
 <p>Rapid Entry Veh (REV)</p>  <p>Shape Charge Assembly</p>	 <p>RG31 Air Line/Tank Protection Kit</p>  <p>M110 SASS</p>	 <p>XM32 Abrams Reactive Armor Tile II</p>  <p>Picatinny Weapon Elevation Kit</p>	<p>Watchdog</p>  <p>Non-standard Vehicle Armor</p>
 <p>Army's Greatest Inventions</p>	 <p>Excaltibur 1a-1</p>  <p>Sparrow</p>  <p>Bloodhound (OIF)</p>  <p>O-GPK (RG31 Variant)</p>	 <p>Titanium Gunner Protection Kit (SOCOM)</p>  <p>Schonsted</p>  <p>Rattlesnake</p>  <p>Bloodhound (OEF)</p>  <p>Small/Med Machine Gun Weapon Cradle</p>	

134 Successful fieldings since 09/11/2001



## Davidson Advanced Warhead Development Facility



Opened 2000, \$11.7M  
Maximum 50 TNT equivalent capability  
100m indoor warhead test range

## Armament Software Engineering Center



Opened 2005, \$15.5M  
Integrated S/W & H/W development/integration  
Multi-platform SOSI highbay capability  
**CMMI Level 5 Certified**

## Armament Technology Facility



Opened 1996, \$8.4M  
100 and 300m indoor ranges  
Environmental chambers  
Addition—Opening FY09  
100m indoor range

**\$10M  
Expansion  
Underway**

## Precision Armaments Lab



Opened 2003, \$8.8M  
2 Lab grade elevators for sensor development  
3 Target locations; 150m, 400m, and 1500m

## High Energy Propellant Formulation Facility



Opening FY10, \$17.7M  
45,000 ft<sup>2</sup> Propellant Pilot Plant  
Characterization Laboratories  
Magazine Storage / Offices

## Pyrotechnic Research & Technology Complex



Opening FY10, \$9.9M  
33,000 ft<sup>2</sup> Engineering Offices and Laboratories  
Pilot manufacturing facility  
Energetic stowage

## Soft Recovery System (SRS)



Opened 2008, \$9.0M  
High-g test Munition/Components to 20K g's  
155mm capability (current); Only one in existence  
Navy 5", 120mm mortar, and EM Gun planned

## Explosives R&D Loading Facility



Opening FY10, \$8.0M  
28,000 ft<sup>2</sup> Melt Pour Operations and Engineering  
Climate Controlling Machining  
Explosive Pressing, Cast Cure, and X-Ray







# Picatinny Arsenal BRAC Overview



- BRAC 05 recommendation created an Integrated Weapons & Armaments Specialty Site for Guns and Ammunition Research, Development and Acquisition (RDA) at Picatinny Arsenal. Functions being realigned:
  - Army – ARDEC Fuze Detachment currently located at Adelphi, MD; group has 44 positions and performs Fuze Technology, Development and Production
  - Navy – functions will be realigned into the Picatinny Navy Detachment; reporting to Indian Head Division, NSWC, MD :
    - ❖ Naval Surface Warfare Center (NSWC) Earle Detachment - Group located at Earle, NJ; has approx 67 positions that perform Packaging, Handling, Storage and Transportation (PHS&T) RDAT&E
    - ❖ NSWC Louisville Detachment - Group located at Louisville, Ky; has approx 106 positions realigning to Picatinny that perform acquisition, production and operational support for in-service engineering and emerging Naval gun systems
    - ❖ NSWC Crane Division – Group located at Crane, IN; has approx 57 positions that perform acquisition and sustainment of Navy and Marine Corps guns and ammunition
    - ❖ Naval Air Surface Warfare Center China Lake – Group located at China Lake, CA has approx 4 positions the perform research, development and acquisition of aircraft guns
- Personnel status:
  - Navy Transition Manager on-site
  - Currently 16 Navy employees on-site (performing Crane, IN functions). No personnel expected to move from Crane; Navy hiring as vacancies occur.
    - Anticipate hiring additional 15 employees in FY09
  - Two Army (Adelphi) employees on-site
  - Remainder of Army and Navy personnel moves scheduled in mid to late FY11 as construction projects completed





## *BRAC Military Construction*



- Military Construction Projects:
  - 3 Navy projects, 1 Army project
  - Total cost of \$76 M
  - Total of 168,000 Sq Ft – 2/3<sup>rd</sup> renovation of existing buildings; 1/3<sup>rd</sup> new construction
  - Solicitations issued for 1 Navy project and the Army project
    - ❖ Groundbreaking ceremonies will be scheduled; likely in late Aug 09
  - Two remaining Navy projects still in design phase; solicitations expected to be issued in late FY09
  - Construction scheduled for all projects during 2009-2011 timeframe
  - Permanent occupancy scheduled in mid to late FY11





# ARDEC Recent Awards



- **5 Army R&D Achievement Team Awards** with 18 individual recipients in FY07; 8 Teams with 33 individual awards in FY08
- **Top 5 DoD Environmental Award:** On 21 April 2008, Secretary of the Army awarded ARDEC 2007 Environmental Award for Environmentally friendly pyrotechnic work
- **Zernow Best Paper Award:** The winning paper entitled "Combined Effects Aluminized Explosives" by Dr. E. L. Baker, (ARDEC's Energetics and Warhead Division) provides new understanding of the physics of combined effects explosives, and demonstrates the extraordinary technical abilities of the authors.
- **Richard Goodman Strategic Planning Award:** ARDEC is the first DOD organization to be recipient in the category of government. The association bases the award on organization strategic planning process.
- **Army Large Research and Development Lab of the Year:** ARDEC is the recipient for 2008.
- **Popular Science Magazine 2009 Invention Award:** RIPSAN unmanned tracked vehicle selected for 2009 Invention Award.
- **2009 National Federal Laboratory Consortium (FLC) Award for Excellence in Technology Transfer:** MINDS has been developed with investment from the U.S. Army's Armament Research, and Development Engineering Center ("ARDEC") at Picatinny Arsenal, NJ, and is being commercialized by InSitech (Partnership Intermediary) the exclusive licensee of Princeton University. MINDS is a practical, cost effective, software-based, nuclide identifier that monitors the environment for the presence of radionuclides in real time.



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- ARDEC has technology programs in place to support a broad range of emerging requirements
- Precision Munitions are becoming integral to most Gun-Fired inventories
  - Advantages of Precision Fire Accepted and Reflected in Acquisition Programs
  - Broad Base of Production and R&D
- Affordable, High Reliability Design is Key and will be accomplished with the right Tools, Process, and Culture

