

S&T Advances

Future Munitions Development

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As the Army's "Center for Lethality," the U.S. Army Armament Research, Development and Engineering Center (ARDEC) located at Picatinny, NJ, provides the U.S. military with fire-power necessary to achieve decisive battlefield victory. To support this effort, ARDEC conducts an aggressive science and technology (S&T) program focusing on the development of state-of-the-art munitions from explosives, propellants and warheads to the lethal power of mortars, artillery, tanks and much more.

A blast from a 155mm, high-explosive round fired from an M109A6 Medium Self-Propelled Howitzer from the 3-16th Field Artillery, 4th Infantry Division (4ID), Fort Hood, TX. The 3-16th Field Artillery deployed last year to Camp Warhorse in the Diyala Province, Iraq, in support of *Operation Iraqi Freedom (OIF)*. (U.S. Army photo by SSG William L. Davis, 982nd Signal Company.)

ARDEC scientists and engineers — working in Picatinny’s laboratories and engineering centers — play a critical role in developing new technologies for the Army’s Future Force. A network of strategic alliances and partnerships with other government laboratories, the private sector and academia contribute to ARDEC’s ability to mature technologies to an adequate technical readiness level (TRL) so the Army can proceed to successful Milestone B system development and demonstration decisions. ARDEC’s S&T strategy also incorporates input from the U.S. Army Training and Doctrine Command (TRADOC) and the program manager (PM)/program executive office (PEO) communities to field mission-critical munition technologies to enhance capabilities within the Current Force.

In keeping with its long history of munitions excellence, ARDEC continues to pursue technology programs that will improve munitions capabilities. Among these are five important S&T objectives (STOs) that reflect Army transformation objectives: Mounted

Combat System (MCS) Ammunition System, Common/Modular Power Sources, Hardened Combined Effects Penetrator Warheads, Common Guidance and Microelectromechanical System (MES) Safe and Arm (S&A). Each offers significant promise, providing Soldiers the required power and lethality to decisively win future battles. In addition, ARDEC’s labs and centers are working on numerous emerging technologies, such as the Liquid Metal Kinetic Energy Penetrator and Photo-Etched S&A.

effort began under the Multi-Role Armament and Ammunition System Advanced Technology Demonstration (ATD), but when the MCS was selected, the ammunition S&T required to support Increment I continued development as part of the LOS/BLOS ATD.

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The MAST STO will also provide enhanced capabilities to the Mid-Range Munition (MRM) and Advanced Kinetic Energy (KE) munitions to increase range and lethality, develop technologies to integrate an advanced multipurpose

MCS Ammunition System Technologies (MAST) STO

The MAST STO is working on technologies that will enhance the capabilities of the Future Combat Systems (FCS) Increment I — line-of-sight/beyond-line-of-sight (LOS/BLOS) — ammunition suite for the MCS. This

munition — the LOS Multipurpose (MP) Munition — and advanced propulsion and multi-effects warhead technologies.

MAST supports the ammunition development for the FCS MCS. The Unit of Action Maneuver Battle Lab, PM Office for Maneuver Ammunition



An M1A1 Abrams tank from Charlie Company, 1st Tank Battalion, fires its 120mm main gun at the Udari Range in Kuwait in support of OIF. (U.S. Marine Corps (USMC) photo by SGT Paul L. Anstine II.)

Systems and the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology are the key customers and the MAST efforts support their priorities. The primary deliverables are:

- TRL 6 demo of an LOS-MP munition by the end of FY05.
- TRL 6 demo of an Enhanced KE munition by the end of FY07.
- TRL 5 demo of an Enhanced MRM munition by the end of FY07.
- TRL 6 demo of an Advanced Propulsion capability by the end of FY07.

Common/Modular Power Sources for Advanced Munitions STO

This STO will develop new power sources for future advanced munitions that will extend range and increase lethality. Thrust areas include thermal batteries with novel insulation and new gas-generating materials,

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This 5-year effort will transition new thermal battery technology at TRL 7 in FY07, new hybrid technology at TRL 7 in FY08 and new liquid reserve battery technology at TRL 7 in FY08. Eventually, the STO will supply new thermal battery and hybrid power technologies for numerous important munitions development efforts including Excalibur, the MRM and the Precision Guided Mortar Munition (PGMM) programs.

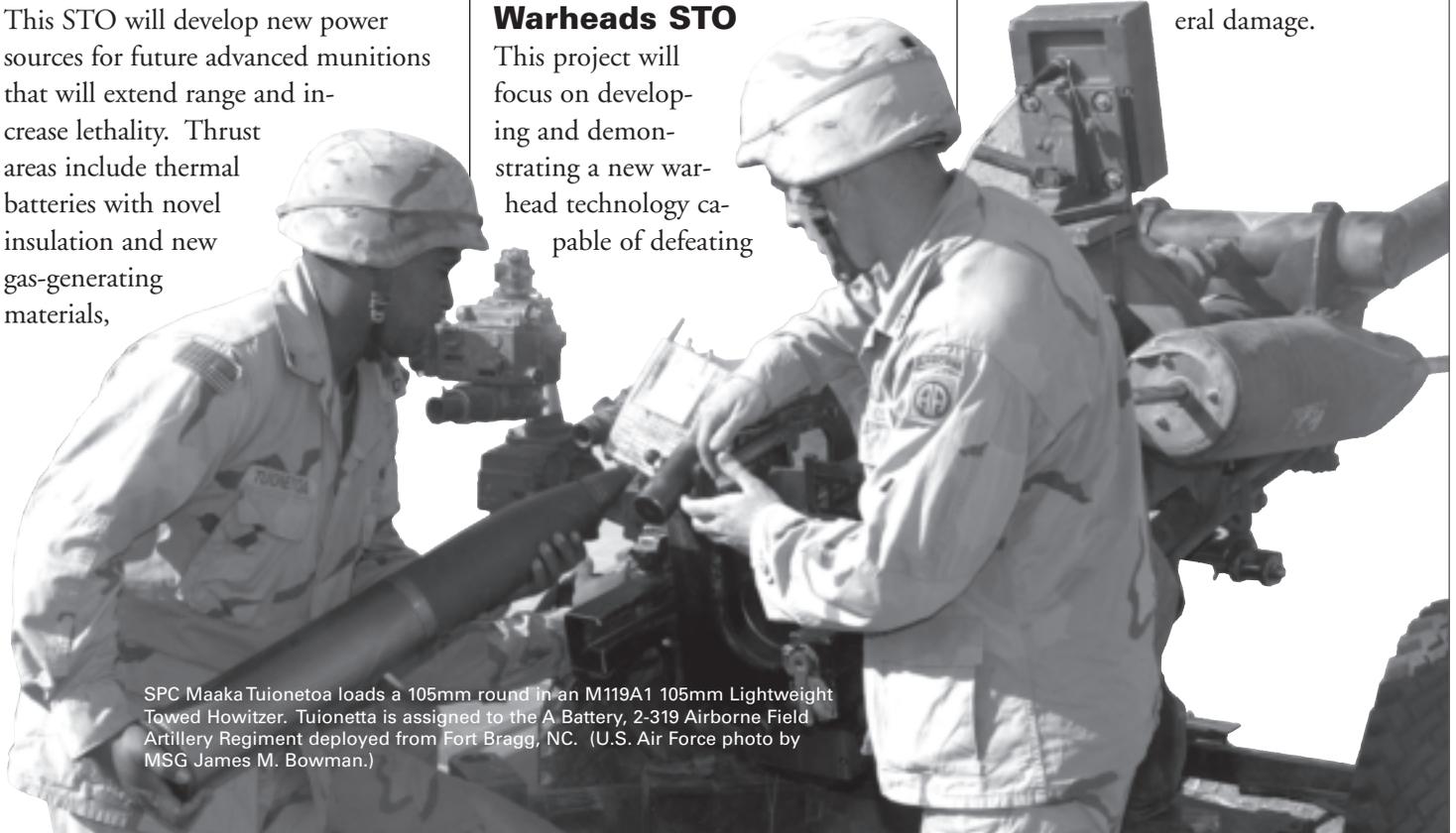
Hardened Combined Effects Penetrator Warheads STO

This project will focus on developing and demonstrating a new warhead technology capable of defeating

structures, bunkers, armored targets and personnel, fortified positions and urban and aerial targets using the same warhead. Thus, instead of needing a family of munitions to defeat disparate targets, Soldiers will be able to use a single munition for a large range of targets. This new warhead technology will provide increased effectiveness against armor systems equipped with Explosive Reactive Armor and increase the number of stowed kills by an estimated 150 percent. It will also simplify battlefield engagement requirements, add flexibility, increase firepower and produce substantial logistical savings for the Future Force. When mature, the technology will be applied to the Joint Common Missile, PGMM and MRM.

Common Guidance STO and Manufacturing Technology Objective (MTO)

Currently, the maneuver commander does not have a capability to defeat high-value targets from a distance and still minimize collateral damage.



SPC Maaka Tuionetoa loads a 105mm round in an M119A1 105mm Lightweight Towed Howitzer. Tuionettoa is assigned to the A Battery, 2-319 Airborne Field Artillery Regiment deployed from Fort Bragg, NC. (U.S. Air Force photo by MSG James M. Bowman.)

This project brings together a team to achieve the Common Guidance STO and MTO goals to find affordable, Gun-Hard Inertial Measurement Units (IMUs).

Gun-Hard IMUs do not exist for precision munitions (optical IMUs are expensive and not gun-hardened). The team is looking at MEMS technology, which will provide inherent cost savings and size reduction, and is ideal for application to navigation and control systems for small missiles and munitions. Using MEMS technology, gyroscopes, accelerometers and control electronics can readily be integrated to form a tightly packaged, low-cost, extremely small, high-performance IMU suitable for munition and missile guidance and other applications.

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Munitions and missiles equipped with MEMS IMUs will significantly reduce the cost of precision-delivered missiles and munitions, as well as expand precision delivery capability to artillery ammunition, thereby reducing the number of required rounds by more than 30 percent. In addition to the inherent cost savings provided by MEMS technology, a 1-degree-per-hour MEMS IMU, which meets the navigation requirement for more than 90 percent of the tactical weapons fleet, will provide major cost savings to the military via expanded production by using cross-system commonality and industrial-base production. While there is little commercial support for military applications, an active military program for MEMS IMUs

would make it economically feasible for commercial plants to commit to producing the military devices that could survive and function after a 20,000 g-force launch.

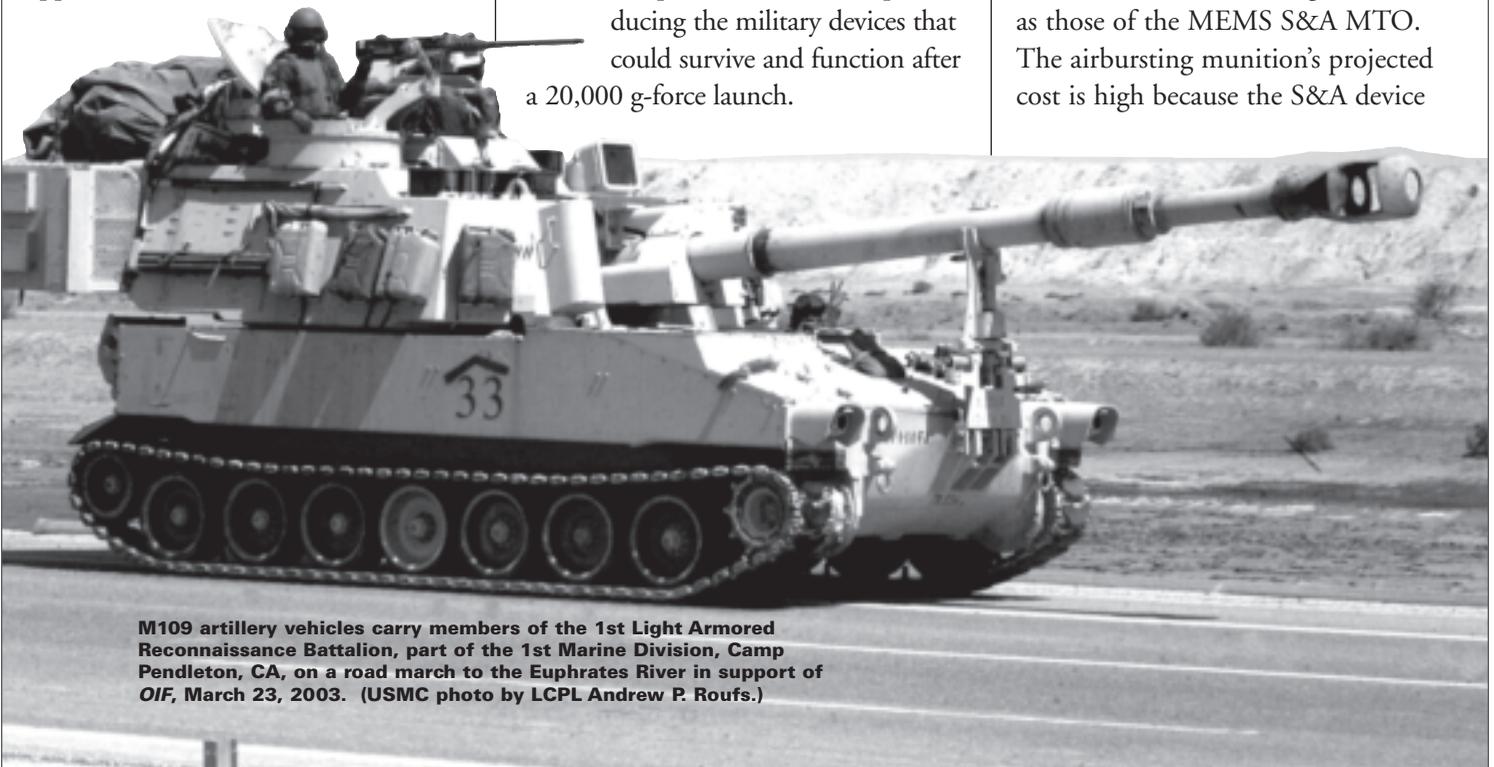
Current planning for program implementation is for a 5-year effort spanning FY01 through FY06. The design and manufacturing technologies concurrently developed and pursued in Phases 1 and 2 will directly evolve into the ultimate Phase 3 IMU product.

A second effort will look at developing and producing the IMU deeply integrated within a Global Positioning System military receiver, using a single microprocessor architecture, and incorporating integrated hardware and software antijam capability in less than 3 cubic inches.

These technologies, when matured, will be transitioned to the Joint Direct Attack Munition, Excalibur, Joint Common Missile, PGMM, Extended Range Guided Munition and Advanced Gun System.

MEMS-Based S&A Development Project

This team will work on a program to successfully achieve the Objective Individual Combat Weapon (OICW) System Enhancements STO goals as well as those of the MEMS S&A MTO. The airbursting munition's projected cost is high because the S&A device



M109 artillery vehicles carry members of the 1st Light Armored Reconnaissance Battalion, part of the 1st Marine Division, Camp Pendleton, CA, on a road march to the Euphrates River in support of OIF, March 23, 2003. (USMC photo by LCPL Andrew P. Roufs.)

Soldiers from A Battery, 3rd Battalion, 29th Field Artillery Regiment, 3rd Brigade Combat Team, 4ID, Fort Carson, CO, fire an M109A6 Howitzer (Paladin) during a routine drill Nov. 6, 2003, at Samarra Southeast Airfield, Iraq. The 4ID is deployed in support of OIF. (U.S. Army photo by SGT Jack Morse, 982nd Signal Company.)



contributes significantly to the cost. The fuzing system for OICW includes a power supply, S&A and electronics and occupies approximately half the available payload. A reduced payload limits terminal effects.

The MEMS S&A development project is geared toward overcoming three current challenges:

- Traditionally expensive and labor intensive S&As in production.
- S&A miniaturization limitations.
- Existing energetic materials that require large interfaces.

The approved STO's goal is to rapidly develop, demonstrate and transition lethality-enhancing and weight-/cost-reducing technologies into the XM29 Integrated Airburst Weapon System (formerly OICW). Specifically, the effort is to reduce munition fuzing costs and increase payload volume by reducing the overall S&A fuzing size. Once

again, MEMS was selected as a high-payoff enabling technology that will facilitate XM29 fielding and the XM307 Advanced Crew Served Weapon System. System effectiveness may be boosted by an increase in lethality.

The Army's S&T focus must be responsive to the current war effort by selectively fielding capabilities that directly support the Current Force, and must also continue to drive transformation capabilities for the Future Force. Working closely with key stakeholders in TRADOC and the PM/PEO community, DOD agencies, the private sector and academia, ARDEC continues to provide the most advanced armaments and munitions for peace and war.



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