ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**

	COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
	Total Program Element (PE) Cost	66141	60935	48174	48194	49097	43327	44247
214	MISSILE TECHNOLOGY	46032	52689	48174	48194	49097	43327	44247
223	AERO-PROPULSION TECHNOLOGY	10749	4768					
G02	Army Hypersonics Applied Research	2000						
G04	AIR DEFENSE TECHNOLOGIES (CA)	1598						
G05	MISSILE TECHNOLOGY INITIATIVES (CA)	4164	3478					
G06	UNMANNED SYSTEMS TECHNOLOGIES (CA)	1598						

A. Mission Description and Budget Item Justification: This applied research program element (PE) designs and develops advanced component technologies for missiles, rockets, and launch systems for use in the Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities. The overall objectives of the PE are to develop technologies which increase the lethality and effectiveness of tactical missiles and guided interceptors under adverse battlefield conditions, enhance the survivability of launch systems, increase kill probabilities against diverse targets, and provide advanced simulation and virtual prototyping analysis tools. A major cross-cutting theme is developing missile technologies that are smaller, lighter weight, and more affordable. Major technology areas include missile guidance systems, multi-spectral seekers, high fidelity simulations, missile aerodynamics and structures, missile propulsion (including efforts to help solve the insensitive munitions requirements for missiles), hypersonic/hypervelocity missile efforts, and the development of a common high-gravitational force (high-G), low cost, Micro Electro-Mechanical System (MEMS) Inertial Measurement Unit (IMU). The major efforts include the high-G MEMS IMU program (which is designing and developing affordable, reliable precision guidance components for missiles and guns at a significantly lower unit cost and smaller size than current systems) and integrating a GPS receiver with the IMU in a deeply-integrated guidance and navigation unit (DIGNU). The performance and small packaging goals enable the components to meet the requirements of 90 percent of Department of Defense guided munitions and missiles. The high-G MEMS IMU/DIGNU program is a collaborative project between the US Army Armament Research, Development, and Engineering Center (ARDEC) and US Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC). Another major thrust in the PE is to investigate and develop small, lightweight force protection technologies needed to cost effectively counter the rocket, artillery, and mortar (RAM) threats to the Current and Future Force. The Extended Area Protection and Survivability (EAPS) program investigates and develops the interceptor and fire control technologies necessary to provide the Future Force with an active defense against RAM. In addition, the Smaller, Lighter, Cheaper (SLC) Tactical Missiles effort explores technologies to reduce the cost and logistics burden of precision munitions. This program's goal is to reduce the cost per kill of precision guided missiles and munitions, through the innovative application of technology in concert with more efficient production and integration processes. An important thrust is developing new approaches to ensure future tactical missiles can meet insensitive munition (IM) requirements. This helps insure the safety of Soldiers from unintentional detonation of munitions and missiles. This project is also funding sensor technologies for integration with ARDEC warhead and fuze technologies for both missile and gun applications. The Army Hypersonics Applied Research program explores and developes the critical technologies required for force protection against Unmanned Aerial Vehciles and rotary wing aircraft. Projects 223 and G05 support Congressional special interest items. This PE contains no duplication with any effort within the Military Departments. The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work is performed at the US Army Aviation and Missile Research, Development, and Engineering Center,

Redstone Arsenal, AL.

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	77276	53038	48324
Current BES/President's Budget (FY 2009)	66141	60935	48174
Total Adjustments	-11135	7897	-150
Congressional Program Reductions		-403	
Congressional Rescissions			
Congressional Increases		8300	
Reprogrammings	-9431		
SBIR/STTR Transfer	-1704		
Adjustments to Budget Years			-150

FY07 funds were reprogrammed to higher priority efforts.

Five FY08 congressional adds totaling $8300 were added to this PE.

($800) LENS XX Hypervelocity Ground Testing
($1000) Materials Application Research Center
($1000) Novel Lgtwt Armor Material f/Insensitive Munitions
($1500) Jam Resistant Technology for INS/GPS Precision
($4000) MARIAH II Hypersonic Wind Tunnel Develpment Program

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**	**214**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
214 MISSILE TECHNOLOGY	46032	52689	48174	48194	49097	43327	44247

A. Mission Description and Budget Item Justification: This project focuses on missile and rocket technologies that support lightweight, highly lethal weapons concepts with greatly reduced logistics requirements for Future Modular Force and, where feasible, exploits opportunities to enhance Current Force capabilities. Major technology areas investigated are missile guidance systems; air defense target acquisition systems; multi-spectral seekers; high-fidelity simulations; missile aerodynamics and structures; and missile propulsion including research to help solve the insensitive-munitions requirements. A theme embedded throughout the efforts in this project is developing smaller, lighter, and cheaper (SLC) missile technology to reduce the cost and logistics burden of precision munitions. Program objectives are to develop enabling technology that enhances the survivability of launch systems, provides greater effectiveness under adverse battlefield conditions, increases kill probabilities against diverse targets, and provides advanced simulation and virtual prototyping analysis tools. A major effort in this project is to design and develop the high-gravitational force (high-G), low cost Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU), and to design, develop, and integrate a GPS receiver with the IMU in a deeply-integrated guidance and navigation unit (DIGNU). The Army is the service lead in the development of low-cost MEMS IMUs capable of supporting precision guidance requirements of Department of Defense's missile and gun launched precision munitions programs. This is a collaborative effort with the US Army Armament Research, Development, and Engineering Center at Picatinny Arsenal. The DIGNU effort is to develop and demonstrate an Inertial Sensor Assembly (ISA) with the same 1.0 deg/hr, and greater than 20,000G survivability requirements of the initial IMU program with an additional "deeply-integrated" or "deeply-coupled" Selective Availability and Anti-Spoofing Module (SAASM)-based GPS military receiver. The goal of the DIGNU incorporates a single microprocessor architecture and integrated hardware and software anti-jam (AJ) capability. The Smaller, Lighter, Cheaper (SLC) Tactical Missile effort focuses on component technology to reduce the cost and logistics burden of precision munitions. This effort's goal is to reduce the cost per kill of precision guided missiles and munitions, through the innovative application of technology in concert with more efficient production and integration processes. The SLC effort includes a partnership with the Defense Advanced Research Projects Agency (DARPA) on the design and proof of principle of the Close Combat Lethal Recon (CCLR) system, a 5 lb, Soldier-launched, loitering munition (two minute duration/two km radius) for use over and around buildings and other obstructions in non-line-of-sight environments. The DARPA portion of the CCLR effort is funded under PE 0603766E. Guidance Electronics Miniaturization (GEMS), is working to significantly reduce the size, weight, and cost of guidance electronics. GEMS incorporates commercial electronics miniaturization (die stacking, wafer thinning, etc.) and seeks to develop technologies to use the electronics substrate as the chassis, wiring harness, and printed wiring board for the electronics. Each of these elements is being incorporated into a series of Integrated Guidance Units (IGU) which consist of a guidance computer and an IMU. An important thrust is developing new approaches to ensure future tactical missiles can meet insensitive munition (IM) requirements. This helps insure the safety of Soldiers from unintentional detonation of munitions and missiles. Solid propellant formulations along with improved, high performance rocket case materials, and rupture mechanisms are being investigated. Also included in this project is the Extended Area Protection and Survivability (EAPS) program, which develops the component technology necessary to provide the Future Force with an active defense capability against rockets, artillery, and mortars (RAM). Major products of this PE generally transition to PE 0603313A (Missile and Rocket Advanced Technology). The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work is performed at the US Army Aviation and Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
High-G Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU): In FY07, continued to investigate methods to	4475	3100	

get tactical grade performance across all environments. Increased built-in-test capabilities, iterated IMU design to get improved performance under vibration, iterate gyro, and accelerometer design to handle canard shock, improved processes to increase sensor yields, and increased automation of test and calibration capabilities. In FY08, perform bench testing and a missile and munition flight test of the final Phase 3 IMUs and analyze and evaluate their performance.			
Embedded Deeply Integrated Guidance & Navigation Unit (eDIGNU) Technology Advancements: The DIGNU is being developed in phases with performance being increased and size being decreased for each successive phase. In FY07, designed and developed a partial system-on-a-chip (SOC) to give DIGNU Phase 3 the smallest volume. Miniaturized GPS receiver and AJ hardware, added frequency excision AJ, miniaturized SAASM, and migrated to an improved microprocessor. In FY08, perform field tests and laboratory characterization on DIGNU Phase 3s including anti-jam capability; further miniaturize the anti-jam module. The DIGNU Phase 3s test against the following parameters: gyro bias less than one deg/hr, volume less than six cubic inches, acceleration bias less than one milli-G, greater than 90 db J-to-S and gun-hardened to 20,000G. In FY09, Will test different platforms, dynamics, and mission envelopes. Will test flight scenarios with hardware-in-the-loop. Will conduct government test and evaluation on inertial sensor, deep integration algorithms, DIGNU anti-jam capability, GPS receiver, and interaction of all these pieces. Phase A deliveries include twelve IMUs and two DIGNUs.	5104	5731	6630
Smaller, Lighter, Cheaper (SLC) Tactical Missiles: SLC reduces precision missile cost per kill and logistics burden via innovative technology application. In FY07, completed Multi-Purpose Warhead (MPW) design and began testing against each target type. Initiated design of miniaturized electronics for automated fuze timing to maximize lethality against different target sets without launcher system modifications. Completed architecture studies for miniaturized Guidance Electronic Unit (GEU) initial designs for Close Combat Lethal Recon (CCLR), Javelin Block II GEU, and Command Launch Unit (CLU). Supported and evaluated DARPA_s development of the CCLR system (5 lb Soldier-launched, loitering munition) including initial warhead, safe and arm (S&A) design, and performed trade studies for adding an uncooled non-gimbaled IR seeker, and assessment of handheld viewer functionality. In FY08, complete component sled testing of the MPW designs support system tandem testing, Finalize design, fabricate, and test miniaturized GEU and seeker technologies for application and insertion into future precision weapon systems. Identify requirements, conduct COTS trade studies, and complete a rate sensor design package for a form, fit and function upgrade to the TOW Gyro. Complete design of uncooled non-gimbaled IR seeker, if trades show feasibility. Finalize design, develop, and fabricate CCLR warhead and S&A, continue to demonstrate and evaluate technologies and system concepts for CCLR requirements. In FY09, will leverage latest in nanotechnology and electronics packaging to achieve small, light, missile form factors to meet urban and emerging threats. Will conduct trades, build prototype designs and test SLC components in relevant environments. Will mature SLC technologies to transition PM Close Combat Weapon System (CCWS) family of missile systems. Will Test small, low cost, ungimbaled see	5900	7000	5500
Missile Guidance Systems and Seeker Technology: In FY07, evaluated uncooled IR concepts and demonstrated prototype configurations. Fabricated and tested passive phased sub-array from optical phase shifters and initiated transition to provide lower cost IR seekers. Integrated countermeasure algorithms and optics in a seeker and performed hardware-in-the-loop testing. Spiraled in die stacking/thinning into Block 2 Inertial Guidance Unit (IGU); built, tested, and compared to IGU baseline performance. Transitioned new vehicle target algorithm to Non-Line-of-Sight Launch System prime contractor for Precision Attack Missile (PAM) target tracker. In FY08, spiral upgrade vehicle target algorithm and initiate Human Tracking Technology (HTT) development for anti-personnel weapon systems. Transition initial HTT to the Close Combat Lethal Recon (CCLR) system. Build and test Phased Arrays for Tactical Seekers (PATS) sub-arrays. In FY09, will transition upgraded HTT to CCLR. Will incorporate physics-based versatile/accurate models of threat targets and environments simulation scenes for enhanced algorithm development, tracker, and Automatic Target Acquisition/Recognition (ATA/R) optimization. Will fabricate an IR seeker with strap-down electronically stabilized imager. Will transition quantitative determination of	12984	13404	12332

Automatic Target Detection (ATD)/Automatic Target Recognition (ATR) performance versus Synthetic Aperture Radar (SAR) image resolution to UAS and tactical missile developers.			
High Fidelity System Level Simulations and Aerodynamics: The use of advanced simulation and aerodynamics tools promises to reduce size, lighten the weight, and reduce cost in missile systems. In FY07, completed a hybrid patch approach for clutter statistics in order to progress simulation technology toward a fully predictive scene generation capability that provides accurate and high fidelity simulated scenes for missile seeker simulations. Extended aerodynamic predictive techniques by validation of Navier-Stokes equation solvers with detailed measurements of supersonic, reacting airflows. In FY08, complete infrared solar spectrum requirements analysis and feasibility studies to fill the gap that exists in missile solar exposure simulation and testing. Install and test HWIL simulation control software in a range of simulation capabilities and will extend aerodynamic prediction techniques for evaluating novel aerodynamic shapes. In FY09, will complete initial spectral and optics/platform designs and begin IR radiation component development for solar exposure simulation and test. Will extend HWIL simulation control software to improve user capabilities and extend aerodynamic prediction techniques to address fully turbulent, short correlation length, unsteady flows.	2780	3431	3334
Smart, Stealthy, Smokeless Missile Propulsion, Smart Structures and Enhanced Lethality: In FY07, completed testing of Variable Area Nozzle (VAN) motors and updated design concepts and subsystem integration test to demonstrate projected increase in performance and decrease in sensitivity of the motor. Demonstrated a compact combined effects warhead which has been integrated into a tandem warhead missile system against a state-of-the-art target set. Investigated and evaluated the integration of warhead concepts into tactical missile systems. In FY08, investigate new propellant formulations that operate efficiently over extreme temperature ranges. Demonstrate a fully integrated dynamic Hardened Combined Effects Warhead with enhanced blast and fragmentation characteristics against heavy armor and MOUT targets. Design, fabricate, and test distributed thermal ignition concept and grain surface energetic coating schemes in order to improve engagement timeline and accuracy through prompt and repeatable rocket motor ignition with reasonable cost, weight, and volume in support of Active Protection Systems (APS). In FY09, will formulate propellant candidates designed to operate efficiently in extreme temperature ranges in coordination with PE 602624 (Scalable Technologies for Adaptive Response). Will evaluate multi-mode warhead characteristics using multi-point initiation concepts to control the energy deposited on the target in order to determine/characterize optimum fuzing scheme against specific classes of threats. Will perform initial investigation and analysis of variable yield warhead/explosive technologies to vary the effects on target and minimize collateral damage.	6226	8240	7278
Insensitive Munitions (IM) Research: In FY07, evaluated existing and new energetic ingredients for beneficial insensitive munition characteristics. Conducted formulations studies for emerging oxidizers, thermal additives, and nitramine replacements. Applied emerging materials/concepts to canister/case design. In FY08, conduct ballistic/aging evaluation on new formulations. Develop integrated passive venting designs and characterize performance of lightweight barrier concept to impact and thermal threats. In FY09, will demonstrate mitigation of IM response to impact threats of a high performance motor through the use of lightweight barrier. Will demonstrate improved IM response of a minimum smoke motor with new propellant formulation and integrated venting to bullet impact, fragment impact, fast cook off, and slow cook off environments. Will demonstrate improved IM response to thermal threats of high performance motor with new propellant formulation and integrated venting.	1300	1100	1100
Defense Against Rockets, Artillery and Mortars (RAM) - Interceptor Development: In FY07, completed designs and fabrication and test propulsion subsystem. Completed fabrication, and testing of the interceptor sensors and control systems. Updated system simulations and developed interceptor performance specification. In FY08, complete testing of sensors and control systems, update system simulations, develop integrated interceptor design, and begin integrating prototype component technologies. In FY09, will fully integrate component technologies into prototype interceptors and perform hardware-in-the-loop testing. Will incorporate the results of all testing into update-error budgets and system level simulations. Will exercise the simulations to evaluate interceptor performance in expected operational	4000	9700	7000

scenarios. This project transitions into Defense Against RAM efforts in PE 0603313A Project 263.			
Defense Against Rockets, Artillery and Mortars (RAM) - Fire Control and Systems Architecture: In FY07, began fabrication and bench and field testing of critical short range surveillance and fire control sensor technologies. Transitioned these technologies to PE 0603313A (Missile and Rocket Advanced Technology), Project D704.	3263		
Multi-Role Missile Engine and Missile Component Design - In FY09, will design and develop new ground and air defense missile concepts based on the integration of breakthrough component tests. Will demonstrate critical underlying component technologies (e.g. seeker, propulsion, and lethal mechanisms) in laboratory and field environments.			5000
Small Business Innovative Research/Small Business Technology Transfer Programs		983	
Total	46032	52689	48174