ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2004

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

	COST (In Thousands)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
	Total Program Element (PE) Cost	52793	91560	51993	59900	46443	36549	38221
214	MISSILE TECHNOLOGY	46217	39571	35154	43072	35347	36549	38221
223	AERO-PROPULSION TECHNOLOGY	4574	24301	0	0	0	0	0
340	SWORD	2002	2905	0	0	0	0	0
G02	NATIONAL AEROSPACE INITIATIVE APPLIED RESEARCH	0	8130	16839	16828	11096	0	0
G04	AIR DEFENSE TECHNOLOGIES (CA)	0	4454	0	0	0	0	0
G05	MISSILE TECHNOLOGY INITIATIVES (CA)	0	3292	0	0	0	0	0
G06	UNMANNED SYSTEMS TECHNOLOGIES (CA)	0	8907	0	0	0	0	0

A. Mission Description and Budget Item Justification: This applied research program element investigates advanced 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 increase the survivability of launch systems; provide greater lethality and effectiveness under adverse battlefield conditions; increase kill probabilities against diverse targets; and provide powerful new simulation and virtual prototyping analysis tools. Major technology areas include missile guidance systems, air defense systems, multi-spectral seekers, high fidelity simulations, missile aerodynamics and structures, missile propulsion, hypersonic missile efforts and the maturation of a common high-gravitational force (high-g), low cost, Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU). The high-g MEMS IMU program will provide affordability and precision to missile and munitions guidance. The high-g MEMS IMU program is a joint project between the Armament Research, Development and Engineering Center, and Aviation and Missile Research, Development and Engineering Center. The MEMS IMU effort is funded by a combination of applied research funding, in this PE, and manufacturing technology funding, in PE 0708045A (Industrial Preparedness). The National Aerospace Initiative applied research program explores and matures the critical technologies required for expendable hypersonic missiles. Primary technology focus areas are those deemed critical by National Aerospace Initiative to advance the national goals in hypersonic weapon maturation and access to space. This program element contains no duplication with any effort within the Military Departments. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

B. Program Change Summary	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2004)	53308	43269	50407
Current Budget (FY 2005 PB)	52793	91560	51993
Total Adjustments	-515	48291	1586
Congressional program reductions		-4302	
Congressional rescissions			
Congressional increases		54800	
Reprogrammings	-515	-2207	
SBIR/STTR Transfer			
Adjustments to Budget Years			1586

Significant Change Explanation:
FY04 - Ten FY04 Congressional Adds totaling $54800 were added to this PE.

FY04 Congressional Adds with no R-2As:
($9394) Hypersonic Army Missile Technology, Project 223: The purpose of this one year Congressional add is to advance distributed processing for hypersonic computational fluid dynamics. No additional funding is required to complete this project.

($470) Large Energy National Shock Tunnel (LENS), Project 223: The purpose of this one year Congressional add is to improve the Large Energy National Shock facility to extend capabilities to address lower Mach numbers at higher altitudes for hypersonic flight. No additional funding is required to complete this project.

($11273) MARIAH II Hypersonic Wind Tunnel Development Program, Project 223: The purpose of this one year Congressional add is to develop component technologies required for pilot scale test facility to produce actual flight conditions for timeframes orders of magnitude greater than currently available. No additional funding is required to complete this project.

($2442) Multiple component flight test, Project 223: The purpose of this one year Congressional add is to fabricate prototype divert altitude control system to validate wind tunnel model predictions for the low-cost flight testing of hypersonic vehicles.

No additional funding is required to complete this project.

($2819) E-STRIKE Short Range Radar, Project 340: The purpose of this one year Congressional add is to perform comprehensive systems engineering analysis establishing future radar requirements and underlying critical technology needs required to engage aerial threats such as rockets, artillery and mortars. No additional funding is required to complete this project.

($4322) Maneuver air defense system, Project G04: The purpose of this one year Congressional add is to perform force-level trade studies and mission requirements analysis, establish a best technical approach and begin demonstrating critical technologies in support of the Extended Area Air Defense System (EAADS). No additional funding is required to complete this project.

($3195) Red Rain, Project G05: The purpose of this one year Congressional add is to perform technology assessments. No additional funding is required to complete this project.

($8643) Unmanned Systems Initiative (USI) at the Aviation and Missile Research Development and Engineering Center (AMRDEC), Project G06: The purpose of this one year Congressional add is to focus on immediate efforts to support the development of unmanned systems through interoperability and the delivery of lethal payloads to better position the military for situations in homeland defense and urban scenarios. No additional funding is required to complete this project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

February 2004

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

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
214	MISSILE TECHNOLOGY	46217	39571	35154	43072	35347	36549	38221

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 the FCS and Future 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. Research objectives are to enhance the survivability of launch systems, provide greater effectiveness under adverse battlefield conditions, increase kill probabilities against diverse targets, and provide powerful new simulation and virtual prototyping analysis tools. The major effort in this project is the high-g, low cost MEMS IMU program. The Army is the Service lead in the investigation of low cost MEMS IMUs capable of supporting precision guidance requirements of DoD's missile and gun launched precision munitions programs. The MEMS IMU effort is funded by a combination of applied research funding, in this PE, and manufacturing technology funding, in PE 0708045A (Industrial Preparedness). The High-g MEMS IMU will also be transitioned to Excalibur, Extended Range Gun Munition (ERGM), and 120-mm Line-of-Sight / Beyond Line-of-Sight (LOS / BLOS) Advanced Technology Demonstration (ATD). This is a joint program with the Armament Research, Development and Engineering at Picatinny Arsenal. Another effort in this project is the Advanced Multi-Mission Precision Guided Munition (AMMPGM) program, which transitions its 6.2 work in FY04 to PE 0603313A (Missile and Rocket Advanced Technology). The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- High-G MEMS IMU - In FY03, matured and live-fire tested IMUs to meet the following parameters: Gyro Bias <75 degrees/hour, Volume <8 cu. in., Acceleration <9mg, Gun-Hardened to 10,000g. In FY04, mature and live-fire test IMUs to meet the following parameters: Gyro Bias <20 degrees/hour, Volume <4 cu. in., Acceleration <4mg, Gun-Hardened to 20,000g. electronic miniaturization will be necessary to fit on the two inch diameter electronics board. In addition, the vibration isolation system will be redesigned for the modified mass and diameter. The 20,000 g launch challenge will require board stiffness redesign with emphasis on high yield and low cost. Test and evaluation will be performed on the Phase 2 IMU devices. In FY05, additional electronics miniaturization will be required to reduce the volume to 2 cubic inches. Assembly, test, and calibration will be increasing automated. Manufacturing and process improvements to get high yields on sensors will be incorporated. Digital electronics design will be improved.	10000	8900	14000
- High-g MEMS/IMU Technology Development Acceleration– This Congressional add in FY03 completed the preliminary design for integration of deeply integrated GPS prototypes into first generation hardware for testing and research and tested Global Positioning System (GPS) anti-jam hardware. In FY04, this add develops and substantiates an IMU "deeply integrated" with a Selective Availability Anti-Spoofing Module (SAASM) GPS military receiver incorporating a single microprocessor architecture and incorporating integrated hardware and software anti-jam capability. Additionally, this add will make manufacturing and process improvements to reduce cost, and reduce process, manufacturing, and testing variability to facilitate the production of the final MEMS IMU and deeply integrated GPS navigational unit design.	12250	8196	0
- MEMS IMU/M-Code GPS – This Congressional add accelerated the development of MEMS IMU/M-Code GPS. No additional funding is required to complete this project.	1681	0	0
- Low Cost Guidance Navigational Unit - This Congressional interest add enhances an existing guidance navigations unit design that will lower cost and power. In addition, it will prototype, test, and evaluate the anti-jam technology.	0	964	0

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Missile Guidance Systems and Seeker Technology - In FY03, integrated and tested MEMS-based angular rate sensors and roll rate sensor into a three-axis rate package for transition to FCS and industry. In FY04, perform laboratory tests of infrared counter-countermeasures (CCM) guidance algorithms in a seeker; devise hardening techniques and algorithms for infrared (IR) seekers to defeat laser counter-countermeasures; and enhance MEMS angular rate sensors with vibration feedback for signal stabilization in high-vibration environments. In FY05, will mature controlled arrays of MEMS sensors to provide full dynamic performance ranges for miniature sensing systems, focusing on inertial applications; design geometry transformations for rapid retraining of automatic target recognition (ATR) systems that will allow precision strike of a target from a different direction than it was originally detected. Will perform field tests of IR CCM guidance algorithms in a seeker; mature concepts of advanced uncooled IR seeker and sensor hardware. Will design, mature, and test advanced optics, signal processing, and guidance and control techniques utilized in uncooled imaging IR seeker and sensor packages. Will conduct captive carry tests of prototype uncooled seeker and sensor systems.	6238	8202	8594
- High Fidelity System Level Simulations and Aerodynamics - In FY03, developed and improved target signature and background scenario modeling and simulation techniques for real-time hardware-in-the-loop system simulations and perform wind tunnel tests and missile aerodynamic predictions. Completed the investigation of an improved method of Radio Frequency (RF) millimeter wave scatter extraction from measurements and validated "spinning tail" and "bent nose" aerodynamic predictions. In FY04, complete the design for a method of rapid infrared passive signature prediction using the MuSES code and investigate techniques for modeling target signatures as perceived by Laser Detection and Ranging (LADAR) sensors; characterize supersonic/hypersonic aerodynamic missile controls and power-on base drag; investigate FCS missile geometry and thrust level prediction methodologies. In FY05, will continue development of techniques for modeling target signatures as perceived by LADAR sensors. Will complete FCS missile geometries and thrust levels characterization.	1000	2083	1720

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Smart, Stealthy, Smokeless Missile Propulsion and Smart Structures - In FY03, designed, fabricated, and static tested an integrated deep throttling booster that extends the capabilities of controllable thrust technology to increase range and provide multi-mission capability for a family of FCS and Future Force weapon systems. Matured controllable thrust components applicable to the 2.75-inch and smaller diameter family of rockets and delivered a validated Computational Fluid Dynamics (CFD) tool for designing compact thrusters. Matured system level concepts, select one propulsion option and one pressurization option for brassboard evaluation, evaluate designs using CFD model, and begin design of component hardware (TRL 3). In FY04, complete design and fabricate hardware, conduct functional demonstration of critical components, and begin CFD model validation (TRL 4). In FY05, will test components in brassboard hardware.	3720	3420	3670
- Focused Technology Integration - In FY03, established the best technical approach for the component technologies for AMMPGM and transitioned AMMPGM to 0603313 Missile and Rocket Advanced Technology. In FY04, perform concept development and subsystem/component level development of supporting technologies of an air defense capability for the Unit of Action. In FY05, will mature system concepts and complete initial system and component design of an air defense capability for the Unit of Action.	7532	7062	7170
- Multiple Component Army Flight Test - This one year Congressional add designed alternative test processes to verify advanced missile components in a ground test facility under duplicated flight conditions to avoid performing the actual expensive and difficult flight tests. No additional funding is required to complete this project.	2451	0	0
- Advanced Composite Chassis - This one year Congressional add investigated the feasibility of using advanced, novel, lightweight composites for hypervelocity missile airframe and support structures. No additional funding is required to complete this project.	1345	0	0
Small Business Innovative Research/Small Business Technology Transfer Programs	0	744	0
Totals	46217	39571	35154

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**	**G02**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
G02	NATIONAL AEROSPACE INITIATIVE APPLIED RESEARCH	0	8130	16839	16828	11096	0	0

A. Mission Description and Budget Item Justification: This project funds applied research to explore and mature the critical technologies required to mature expendable hypersonic missiles. Primary technology focus areas are those deemed critical by the National Aerospace Initiative (NAI) to the advancement of national goals in hypersonic weapon maturation and access to space. These focus areas include scramjet engines, active and passive cooling mechanisms, turbulent mixing enhancement at low Reynolds numbers, computational fluid dynamics, high yield storable fuel grains. Initial effort will focus on concept maturation of Scramjet enabled missiles to enhance Army operational missions. Efforts will be conducted through detailed system and subcomponent simulation, design, maturation and test in laboratory and operational settings. Funding for this effort is provided in coordination with other DOD and government elements participating in NAI. As a result, numerous leveraging and technology insertion opportunities are available. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- Hypersonic System Trade Studies: In FY04, perform trade studies at both system and component level to determine the system and subsystem technical requirements required for future design efforts and to assess the operational enhancement expected from a hypersonic enabled system. Use computational fluid dynamic and high fidelity simulation analysis to identify airframe components under critical aero thermal stress at worst-case operational conditions. In FY05, will complete design trade studies culminating in preliminary subcomponent designs. Will initiate constructive simulations based on preliminary design trades to further explore operational advantages of the proposed systems.	0	1000	2700
- NAI Engine: In FY04, perform computational fluid dynamic analysis to develop initial engine flow path design. Formulate design concepts for inlet, combustor, fuel injector, and mixing enhancement methodologies. In FY05, will be complete design concepts for engine flow path subcomponents . Will conduct lab and ground testing of preliminary engine component designs.	0	6888	14139

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
Small Business Innovative Research/Small Business Technology Transfer Programs	0	242	0
Totals	0	8130	16839