

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2004

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602211A - AVIATION 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	39163	39172	41629	40127	40057	44645	38746
47A AERON & ACFT WPNS TECH	35533	34553	37716	35935	35793	40412	34436
47B VEH PROP & STRUCT TECH	3630	3650	3913	4192	4264	4233	4310
47C ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	0	969	0	0	0	0	0

A. Mission Description and Budget Item Justification: The Aviation Applied Research Technology program element (PE) conducts research and expands scientific knowledge in the area of manned and unmanned rotary wing vehicle (RWV) technologies in support of the Future Force and Joint Vision 2020, and, where feasible, exploits opportunities to enhance Current Force capabilities. Based on the Army transformation, this PE is focused to investigate technologies applicable to unmanned systems, while providing opportunities for technology insertion into the Current Force manned systems. Unmanned RWVs bring unprecedented agility, maneuverability, and lethality to the Future Force, while providing improved survivability and reduced logistics costs. Emphasis is on maturing rotary wing platform technologies to support unmanned combat, reconnaissance, and communication relay capabilities. Technologies that enable autonomous flight, higher aerodynamic loads, lower detectability and increased maneuverability are emphasized. These technologies are assessed for their ability to support the long-term sustainability and reduced logistics required of Future Force airframes. This PE supports Phase I and II of the Unmanned Combat Armed Rotorcraft (UCAR) and unmanned technologies for the A-160 Hummingbird, the Organic Air Vehicle (OAV), the Micro Air Vehicle (MAV) and the Unmanned Cargo Lifter. This PE also supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia, and adds a major focus to mature organic air vehicles designs and other unmanned rotorcraft technologies. Efforts under this PE transition to projects supported by PE 0603003A (Aviation - Advanced Technology). Upgrade activities of DoD systems such as the AH-64 Apache, UH-60 Black Hawk, Navy SH-60 Seahawk, CH-47 Chinook and USMC AH-1 Cobra are included in this PE. This PE does not duplicate any efforts within the Military Departments and supports Project Reliance for which the Army is the lead service for the maturation of rotorcraft science and 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 in this PE is performed by the Aviation and Missile Research, Development and Engineering Center, Redstone Arsenal, AL and the Army Research Laboratory, Adelphi, MD with facilities located at Fort Eustis, VA; Ames Research Center, Moffett Field, CA; Glenn Research Center, Cleveland, OH; and Langley Research Center, Hampton, VA.

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<u>B. Program Change Summary</u>	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2004)	39693	39459	41886
Current Budget (FY 2005 PB)	39163	39172	41629
Total Adjustments	-530	-287	-257
Congressional program reductions		-343	
Congressional rescissions			
Congressional increases		1000	
Reprogrammings	-530	-944	
SBIR/STTR Transfer			
Adjustments to Budget Years			-257

FY04 Congressional Adds with no R-2A:

(\$964) Advanced Control Technology, Project 47C. The purpose of this one year Congressional add is to integrate advanced engine controls technology into an engine control for improved engine response and embedded diagnostics. No additional funds are required to complete this project.

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COST (In Thousands)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	
47A AERON & ACFT WPNS TECH	35533	34553	37716	35935	35793	40412	34436	

A. Mission Description and Budget Item Justification: The Aeronautical and Aircraft Weapons Technology project develops Rotary Wing Vehicle (RWV) technologies for unmanned and manned Army / DoD rotorcraft to increase strategic and tactical mobility / deployability; improve combat effectiveness; increase aircraft survivability; and improve combat sustainability. This project supports the Future Force and Joint Vision 2020 by providing technology to improve capabilities in Dominant Maneuver, Precision Engagement and Focused Logistics. Areas of research are focused on technology application to unmanned aerial vehicles (UAV) systems, manned and unmanned teaming, and selected opportunities for manned systems. These system technologies will provide enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, and reduced cost of unmanned and manned aerial vehicles. This project supports research for the Unmanned Combat Armed Rotorcraft (UCAR), a lethal, survivable Vertical Takeoff and Landing (VTOL) UAV capable of autonomous operations. UCAR is a joint program with the Defense Advanced Research Projects Agency (DARPA) and is planned to transition to Program Executive Officer Aviation at the completion of its 6.3 funded phases. UCAR will be capable of performing mobile strike operations; reconnaissance; target acquisition and identification; suppression of enemy air defense (SEAD); and teaming with the manned air platforms, and will bring unprecedented lethality to the Army's Future Force. This project supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia, and adds a major focus to mature organic air vehicles designs and other unmanned rotorcraft technologies. The propulsion component technologies investigated in this project will provide improved specific fuel consumption, horsepower to weight ratios, and operation and support (O&S) cost savings for manned and unmanned Future Force systems. These engine component technologies address engine needs for future UAVs, such as the UCAR and A-160 Hummingbird, with up to a 50% endurance increase and 30% payload increase over currently available turbine engines. These component technologies also will enable engine demonstrations for manned systems, providing a 33% increase in payload and a 50% reduction in fuel consumption for CH-47 Chinook; and an 80% payload increase and a 20% combat range increase for future rotorcraft. Advanced active controls, aerodynamics, handling qualities, acoustic signature attenuation and smart materials (materials that respond to specific stimuli) technologies will provide rotors and flight controls capable of increased payload, range, agility, maneuverability and survivability. Unmanned/manned system interface, autonomous collaborative flight control, flight simulation, weapons and sensor integration, and pilot-vehicle interface technologies and advanced mission equipment packages that provide full spectrum engagement, precision and selectable lethality, suitable for the target and engagement scenario are being pursued. This project also supports work accomplished in collaboration with the National Aeronautics and Space Administration (NASA) and work done under the auspices of the NRTC. Technologies researched within this project will transition to advanced development technology demonstration programs with application to future, as well as current, Army / DoD rotorcraft systems. 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 in this project is performed by the Aeroflightdynamics Directorate of the Aviation and Missile Research, Development and Engineering Center (AMRDEC), located at the NASA Ames Research Center, Moffett Field, CA and the Aviation Applied Technology Directorate located at Fort Eustis, VA.

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Accomplishments/Planned Program

	FY 2003	FY 2004	FY 2005
Unmanned Combat Armed Rotorcraft (UCAR)- In FY03, completed Phase I and started Phase II Preliminary Design with two industry teams. Industry teams conducted Preliminary Design of UCAR System to include vehicle systems / subsystems, survivability features, weapons / sensors integration, and system of systems architecture. Advanced Technology Development for the UCAR is funded in FY04 and beyond in PE 0603003A Aviation Advanced Technology.	10000	0	0
National Rotorcraft Technology Center (NRTC) - In FY03, conducted component research in the areas of rotorcraft aerodynamics, limited authority flight control technology, crashworthiness and advanced structures, and advanced low-cost composite manufacturing. Performed NRTC applied research efforts in improved bevel gear design concepts and Health and Usage Monitoring (HUM) smart transducer data bus research. In FY04, conduct component research in the areas of crashworthiness and advanced structures, advanced low-cost composite manufacturing, structural joining technologies, and rotorcraft transmission technologies. Perform NRTC applied research efforts in composite durability and damage tolerance, and integrated helicopter design technology. In FY05, will conduct research and component testing in technologies that enable rotorcraft performance improvement, limited authority flight control, damage tolerance, and rotorcraft transmission advances.	6519	6984	7192
Rotor Technology [Includes Low Cost Active Rotor (LCAR) program.] - In FY03, established loads and affordability baselines for the swashplate-less rotor geometry and design rotor for the swashplate-less concept. In FY04, design and begin fabrication of model rotor to demonstrate 40% vibration reduction and control system weight savings. In FY05, will complete fabrication of a swashplate-less rotor model and will start model scale testing.	3911	4288	3906
Survivability [Includes Manned / Unmanned Rotorcraft Enhanced Survivability program.] - In FY03 fabricated and ground tested prototype reactive engine infrared (IR) suppression system that reduces thermal signatures by 75% over currently suppressed aircraft, while eliminating engine performance penalties during non-threat operations. In FY04, begin the maturing of the real-time Survivability Associate Re-router (SAR) tailored to small unit manned / unmanned team operations. Mature a family of intelligent sentinel agents to monitor threat warning sensors. In FY05, will construct a database of threat sensors, multi-spectral signatures, clutter and jammer effects. Will demonstrate real-time threat lethality predictor, wet & dry, in 3-D terrain environment.	3631	3692	3795

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PROJECT
47A

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
Structures and Airframe [Includes Survivable, Affordable, Repairable Airframe Program (SARAP).] - In FY03, conducted hardware testing to substantiate a 5% reduction in airframe weight for multi-mission rotary-wing UAV with adaptive payload vibration control. Evaluated the design and certification standards and methods specific to rotary-wing UAVs. In FY04, design and fabricate smart re-configurable airframe and rotors structures for bench tests. Design and evaluate multifunctional structures for reduced signature, weight, and enhanced survivability. Investigate technologies for affordable, low weight, repairable structures that enhance ballistic and crash survivability. In FY05, will validate and disseminate improved loads determination tools that are 25% more accurate. Will conduct bench tests on smart re-configurable airframe and rotors structures. Will standardize (Joint Service) test methods for durability and damage tolerance certification / qualification of composite structures. Will demonstrate field and depot level advanced composite airframe inspection and repairs. Will evaluate conceptual reconfigurable panels, blades and self-healing structures.	2316	2624	2446
Propulsion [Includes the Integrated High Performance Turbine Engine Technology (IHPTET) program.] - In FY03, fabricated and rig tested advanced inlet particle separator providing increased separation efficiency and reduced engine losses and operations and support (O&S) costs. Designed 700 horsepower class ceramic turbine providing increased cycle efficiency and reduced engine weight and production cost. In FY04, conduct initial rig test and aero redesign of advanced power turbine providing increased cycle efficiency and reduced engine weight. Complete fabrication of 700 horsepower class compressor for improved full- and part-power performance. Complete fabrication of 700 horsepower class ceramic turbine. In FY05, will conduct final rig test of advanced power turbine providing increased cycle efficiency and reduced engine weight. Will conduct rig test of 700 horsepower compressor for improved performance. Will conduct rig test of 700 horsepower class ceramic turbine.	1641	1379	1431

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PROJECT
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Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
<p>Networked Operations and System Integration [Includes the Precision Automated Landing Adaptive Control Experiment and the Unmanned Aerial Vehicle (UAV) Autonomous Collaborative Operations program.] - In FY03, researched autonomous control laws and operator interface for small scale UAV rotorcraft. Researched control system/handling qualities criteria for Future Force rotorcraft, to include tilt-rotor. Defined display research / evaluation methodology for associated unmanned aerial vehicle aeronautical design guide. Defined control law architecture, performance criteria, and simulated precision autonomous landing of UAVs. Conducted research for candidate autonomous modes of operation for UAV. In FY04, conduct requirements analysis and concept definition studies for multi-UAV control to handle multiple integrated mission operations. Evaluate control law and sensor optimization in simulation for precision autonomous landing of UAVs. Modify RMAX rotorcraft surrogate UAV for precision autonomous landing experiments. Produce UAV aeronautical design guide. In FY05, will conduct preliminary design of UAV "swarm" control for vehicle, mission equipment, and flight management architectures. Will evaluate system performance, effectiveness, and risk. Will prepare specification for control law and sensor optimization for precision autonomous landing of UAVs. Will conduct precision autonomous landing experiment with RMAX rotorcraft surrogate UAV. Will research autonomous control laws and operator interface for UAV cargo rotorcraft/sling load handling qualities. Will develop prototype UAV operator control station that can be worn by the soldier.</p>	7515	15072	18946
Small Business Innovative Research/Small Business Technology Transfer Programs	0	514	0
Totals	35533	34553	37716

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PROJECT
47B

COST (In Thousands)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
47B VEH PROP & STRUCT TECH	3630	3650	3913	4192	4264	4233	4310

A. Mission Description and Budget Item Justification: The Vehicle Propulsion and Structure Technology project investigates engine, drivetrain and airframe technologies for Army / DoD rotorcraft specific to the Future Force. The intent is to significantly increase strategic and tactical mobility/deployability, increase reliability, reduce maintenance costs and increase combat sustainability – all focused on a large reduction in the vehicles’ logistics footprint for unmanned and manned rotorcraft. The problems being addressed in propulsion technology include increased fuel efficiency and reduced propulsion systems weight. Technical barriers include temperature limitations for materials, accurate modeling for flow physics, and accurate prediction of propulsion system mechanical behavior. The problem being addressed in structures is the inability to design for acceptable reliability and durability with current tools, which leads to heavier, more costly designs and poor life cycle management. Technical barriers include inadequate structural analysis design tools, inadequate structural dynamics modeling methods for the rotating and fixed system components, incomplete loads/usage data, and inaccurate inspection and tracking methodologies. Technical solutions are pursued through propulsion and structures research – with a focus on applications towards UAV technologies while supporting manned vehicle requirements. The propulsion research is focused on fluid mechanics, high temperature materials, and mechanical behavior for significantly improved small airflow turbine engines, transmissions, and gears, bearings, and shaft components for advanced drivetrains at significantly reduced weight and cost. This propulsion research supports the goals of the DoD integrated high performance turbine engine technology (IHPTET) / Joint Turbine Advanced Gas Generator (JTAGG) program. The structures research is focused on the effects of aerodynamic loads; aeroelastic interactions, integrated composites, structural integrity, low cost manufacturing and crashworthiness that will provide improved rotor and airframe structure subsystems. 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 in this project is performed by the Army Research Laboratory (ARL), located at facilities at the NASA Glenn Research Center, Cleveland, OH and the NASA Langley Research Center, Hampton, VA.

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PROJECT
47B

Accomplishments/Planned Program

	FY 2003	FY 2004	FY 2005
Rotor & Structure Technology - In FY03, investigated reliability-based design methods, durability and damage tolerance analysis techniques and non-contacting nondestructive evaluation (NDE) methods for UAV rotorcraft structures. Investigated advanced comprehensive design concepts for "Full Authority" on-blade active control rotor system. Acquired smart actuator materials for advanced ATR in support of the Low Cost Active Rotor program. In FY04, conduct experiments and validate reliability-based design methods, durability and damage tolerance analysis methods, crashworthy concepts, and NDE methods on selected airframe and rotor hub UAV components. In FY05, will conduct wind tunnel experiments on advanced "smart rotor" concept. Will conduct analytical study of tiltrotor concept applicability to UAV applications. Will evaluate soft-inplane hub for application to large rotorcraft design advanced tiltrotor UAV concept.	1745	1849	1850
Propulsion & Drive Train Technology - In FY03, conducted experiments on a compact high performance two-stage engine compressor to reduce engine weight. Evaluated cooled monolithic ceramic and ceramic matrix composite turbine nozzles to achieve more fuel-efficient high temperature engine operation. In FY04, analyze the performance of a compact high performance two-stage engine compressor and cooled monolithic ceramic and ceramic matrix composite turbine nozzles. Research full 3-dimensional distributed propulsion simulation. In FY05, will conduct experiments and computer simulations of active stall control technologies to extend stable engine operation. Will investigate autonomous propulsion system technology for future UAV propulsion control and operation.	1885	1800	2063
Small Business Innovative Research/Small Business Technology Transfer Programs	0	1	0
Totals	3630	3650	3913