

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2005

BUDGET ACTIVITY
1 - Basic research

PE NUMBER AND TITLE
0601101A - In-House Laboratory Independent Research

COST (In Thousands)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
	Actual	Estimate						
Total Program Element (PE) Cost	23040	23077	20542	21199	21730	22148	21753	21811
91A ILIR-AMC	17676	17531	15268	15715	16070	16527	16144	16145
91C ILIR-MED R&D CMD	4000	3891	3741	3886	4017	3963	4007	4046
91D ILIR-CORPS OF ENGR	1364	1365	1217	1270	1309	1319	1256	1268
91E ILIR-ARI	0	290	316	328	334	339	346	352

A. Mission Description and Budget Item Justification: The goal of the Army's In-House Laboratory Independent Research (ILIR) program is to attract and retain top flight science and engineering PhDs to the Army's research organizations. This basic research lays the foundation for future developmental efforts by identifying the fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge. The ILIR program provides a source of competitive funds to technical directors to stimulate high quality, innovative research with significant opportunity for payoff in Army warfighting capability. The ILIR program serves as a catalyst for major technology breakthroughs by giving laboratory directors flexibility in implementing novel research ideas and nurturing promising young scientists and engineers. Successful ILIR projects are typically transitioned to start-up projects under basic or applied research mission funding within an organization. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). The work in this program is performed by the Army Materiel Command (AMC), Army Medical Research and Materiel Command (MRMC), the Army Corps of Engineers Engineer Research and Development Center (ERDC) and the Army Research Institute for the Behavioral and Social Sciences (ARI).

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<u>B. Program Change Summary</u>	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2005)	23971	25052	25302
Current Budget (FY 2006/2007 PB)	23077	20542	21199
Total Adjustments	-894	-4510	-4103
Net of Program/Database Changes			
Congressional Program Reductions	-344		
Congressional Rescissions			
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer	-550		
Adjustments to Budget Years		-4510	-4103

Change Summary Explanation:

FY06 - Funds realigned (\$4510) to higher priority requirements.

FY07 - Funds realigned (\$4103) to higher priority requirements.

Projects with no R-2A:

(FY05:\$290; FY06: \$316; FY07: \$328) Army Research Institute, Project 91E: The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) provides the Army's basic research in personnel, training, and leader development to ensure that the human component of warfighting keeps pace with the equipment, weapons, and system changes envisioned for transformation to the Future Force. In FY05 focus on the ability of people to detect and react to changes in the digital environment, evaluate theories of situational judgment tests, and develop theory of consensus based measurement. In FY06, focus on conditional reasoning and performance in the context of decision-making. In FY07, focus on cognitive models of the emotional regulation of behavior.

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BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601101A - In-House Laboratory Independent Research					PROJECT 91A			
COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	
91A ILIR-AMC	17676	17531	15268	15715	16070	16527	16144	16145	

A. Mission Description and Budget Item Justification: This project provides funding for In-house Laboratory Independent Research (ILIR) in the Army Materiel Command's six Research, Development and Engineering Centers (RDECs). This basic research lays the foundation for future developmental efforts by identifying the fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge. The cited work is consistent with Strategic Planning Guidance, the DoD Research Plan (BRP), the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan. Work in this project is performed by the Army Materiel Command and the Army Research Institute.

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Accomplishments/Planned Program

- Edgewood Chemical Biological Center - In FY04, conducted basic research in chemistry and biology having potential application to meet Army requirements in chemical and biological defense (CBD) as well as biotechnology. Specific accomplishments having potential for CBD applications include the construction of antibody-based nanosensors used with nuclear magnetic resonance (NMR) to detect ricin, and the use of metabonomics (measurement of the metabolic response of an organism to a stimulus) in combination with NMR as a means to identify a brain biomarker for chemical agent exposure. Accomplishments in biotechnology include the innovative construction of hybridoma cells (hybrid cells formed from cancerous and normal cells) having enhanced antibody production capacities and the scale-up of a recombinant protein production and downstream processing capability for the production of bacteriorhodopsin, a light absorbing protein having potential application in biologically-derived electronic and photonic materials. In FY05, solicit new and continuing basic research proposals and make awards based on scientific merit, innovation, and military relevance. Expected efforts include: continue investigation on metabonomics to further enhance antibody production; conduct principal component analysis to better identify biomarkers of chemical agent exposure. In FY06, will solicit new and continuing basic research efforts focused on fundamental questions pertaining to CBD and applied biotechnology that address Army requirements. Anticipated efforts: will investigate and establish molecular fingerprints for detection and forensic sub-typing of protein toxins; characterize protein toxin interactions with ligand molecules by NMR to develop better detection of and countermeasures for these threats. In FY07, will solicit new and continuing basic research efforts focused on fundamental questions pertaining to CBD and applied biotechnology that address Army requirements.

FY 2004	FY 2005	FY 2006	FY 2007
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2176	1920	1635	1704
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PROJECT
91A

Accomplishments/Planned Program (continued)

- Armaments RDEC - In FY04 conducted basic research in: synthesis of new energetic formulations for higher output with lower vulnerability; multi-sensor fusion for smart munitions; nanotechnology enhanced energy density capacitance; and synergistic directed energy effects. In FY05, conduct basic research in nano-scale materials and carbon nano-tubes, novel uses of acoustic sensors, new methods for synthesis of high energy materials, E-field sensors for area denial munitions, angular and position measurement systems, advanced target acquisition techniques, and advanced insensitive munitions. In FY06, will conduct basic research in advanced warheads, micro-electrical mechanical system technology, insensitive munition technology, lightweight composite materials, advanced propellants, more powerful energetic formulations and advanced fuzing technology. In FY07, will conduct basic research in nanoparticle explosives, advanced projectile guidance and control, new advanced smart munitions, high power microwave technology, non-lethal effects, and high energy composite materials.

FY 2004	FY 2005	FY 2006	FY 2007
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3093	3152	2745	2812
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- Tank-automotive RDEC - In FY04, tested and evaluated fuzzy logic and neural net control strategies and terrain models for unmanned ground vehicle perception; continued maturation and testing of engine combustion models and materials for laser eye protection; modeled and tested mechanisms for cooling vehicle electronics; and performed investigations into high speed ballistic impact imaging and modeling. In FY05, fabricate and test real-time four-Stokes parameter optical apparatus for robotic vehicle perception and signature measurement; formulate mathematical models of diesel engine flame propagation in terms of multi-fuel performance parameters; compare theoretical and experimental liquid heat capillary tube thermal transfer performance characteristics for passive, low signature cooling of military electronics; formulate intelligent agent architectures for swarming ground robot behaviors. In FY06 will formulate evolutionary computing algorithms for adaptive path planning and navigation; develop in-situ combustion chamber temperature and pressure sensors to validate high performance engine thermodynamic combustion models; solve multi-body equations of motion for forward and inverse ground vehicle dynamic models. In FY07, will develop reinforcement learning algorithms and compare performance with bio-inspired robot behaviors; compute liquid heat pipe (LHP) heat transfer coefficients for ground vehicle environments and compare with NASA zero-gravity spacecraft data; model advanced ground propulsion phenomena in support of Army's Future Combat Systems (FCS) requirements.

2011	2214	1928	1974
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91A

Accomplishments/Planned Program (continued)

- Natick Soldier Center – In FY04, modeled new nanocomposites for use in improved ballistic/optical materials; examined layered nanomaterials for potential soldier applications; determined kinetics of microbial inactivation using high pressure in model foods; researched influence of optical properties of textiles on thermal/signature management; modeled bluff body motion and measured unsteady aerodynamic characteristics; and quantified nanoparticle-polymer interaction in nanocomposites using electron spin resonance. In FY05, extend model on inactivation of pressure resistant bacterial spores; research behavioral strategies for overcoming claustro-intolerance in warfighters; investigate interaction between movement in complex environments and cognitive processing of information; and examine self-assembled phage based fibers (collaboration with Institute for Collaborative Biotechnologies). In FY06, will confirm essential features of mathematical representation of permeation kinetics in model foods; explore novel structures and biological templates for textile-based, soldier-borne sensors; and examine new approaches to materials for soldier personal protection via self-assembled nanostructures. In FY07, will examine means for coupling biorecognition elements to polymers for advanced sensing; and examine fundamental mechanisms that can interrupt degradation mechanisms in model foods for shelf-stable rations.

FY 2004	FY 2005	FY 2006	FY 2007
1442	1570	1407	1484

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PROJECT
91A

Accomplishments/Planned Program (continued)

- Aviation and Missile RDEC Missile Efforts - In FY04, transitioned secure communications link based on chaotic waveform to Unmanned Ground Vehicle Project Office. Transitioned advanced Computational Fluid Dynamics models and designs into future hypersonic missile programs. Transitioned protective coatings based on Photonic Band-Gap materials to applied technology programs for missile sensor protection from laser threats. Constructed, tested, and evaluated a prototype field demonstrator of a cost-effective three dimensional display. Established a laboratory for the evaluation of ultra-short (femtosecond) pulsed laser radiation. In FY05, evaluate the propagation characteristics of ultra-short pulsed laser radiation in realistic atmosphere. Analyze and quantify the damage characteristics of ultra-short pulse laser radiation to materials common to missile, aircraft, and Unmanned Aerial Vehicles (UAV) structure and components. Investigate techniques to predict and engineer the optical properties of materials to be used for laser-based optical communications and optical information technology. Test and evaluate flat panel display technology capable of providing full frame rate, full resolution stereo viewing to the user and transfer this technology to advanced research programs. In FY06, will test and evaluate at the laboratory breadboard level the fundamental operations of a quantum computer. Will perform the necessary experiments and/or analysis to allow the transition of ultra-short pulse laser technology to appropriate applied technology programs. In FY07, will demonstrate new concepts in specific focus areas of ultra-short pulsed lasers, nano technology, complex chaotic systems, quantum computing and photonic bandgap structures for applications in RF devices, sensor protection and other missile systems.

FY 2004	FY 2005	FY 2006	FY 2007
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3447	3055	2661	2728
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- Aviation and Missile RDEC Aviation Efforts - In FY04, completed the investigation of active on-blade control for a swashplate-less rotor concept. Conducted the synthetic jet test to reduce adverse fuselage aerodynamics allowing for increased speed and range. In FY05, perform research to achieve robust control architecture for UAV missions. Conduct research to measure boundary layer properties in separated-flow regions to construct new turbulence models. Generate new high order dissipation schemes to reduce the spurious vortex dissipation in the OVERFLOW code. In FY 06, will analyze the particle image velocimetry (PIV) measured data, and develop new turbulence model based on the PIV measurement of boundary layer properties in separated-flow regions. Will generate the background oriented stereo Schlieren technique. In FY07, will generate unstructured grid algorithms for rotorcraft/UAV aerodynamics. Will investigate the modeling and suppression of rotorcraft disturbance response.

2836	2895	2519	2582
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PROJECT
91A

Accomplishments/Planned Program (continued)

Communications-Electronics RDEC - In FY04, studied and monitored Explosive Related Chemicals (ERC) levels in surface soils over time and correlated air flux to surface soil ERC concentrations. Studied the basic solvent/ion interactions to determine optimum composition for new Lithium Ion Batteries. Investigated a software approach to convert natural language to eXtensible Mark-up Language (XML) for C2 applications. Investigated an improved encryption algorithm for communications networks. In FY05, investigate models for fused sensors and improved automatic/aided target recognition algorithms. Characterize membrane-based oxygen-enriched combustion of liquid hydrocarbon fuels. Investigate an entropy based network architecture for improved communication, conduct basic research in highly efficient small antennas. Investigate the enhancement of electromagnetic signals utilizing surface plasmonic properties. In FY06, will complete analysis of ultraviolet-C band muzzle flash intensity and detection range for counter sniper applications. Will perform research enabling high bandwidth, high-efficiency small antennas at lower frequencies with reduced co-site interference. Will formulate and investigate new high-energy cathode materials for advanced lithium batteries. In FY07, will investigate new radio frequency absorption material for warfighters body-wearable vest. Will explore techniques for more reliable (terahertz band) communication and for improving information encoding in noisy channels. Will investigate polymer and polymer blends with high breakdown voltage characteristics for electrochemical systems. Will investigate the feasibility of using modified Bayesian Belief Networks to express essential knowledge in order to perform selected core data fusion tasks for Level 2 data fusion.

FY 2004	FY 2005	FY 2006	FY 2007	
2671	2725	2373	2431	
Totals	17676	17531	15268	15715

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PROJECT
91C

COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
91C ILIR-MED R&D CMD	4000	3891	3741	3886	4017	3963	4007	4046

A. Mission Description and Budget Item Justification: This project addresses medical and force protection research needs at the six Medical Research and Materiel Command laboratories: the U.S. Army Aeromedical Research Laboratory (USAARL), the U.S. Army Institute of Surgical Research (USAISR), the U.S. Army Research Institute of Environmental Medicine (USARIEM), the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), and the Walter Reed Army Institute of Research (WRAIR). Research areas address countermeasures against infectious diseases, defense against environmental extremes and operational hazards to health, and mechanisms of combat trauma and innovative treatment and surgical procedures. The cited work is consistent with Strategic Planning Guidance, the DoD Basic Research Plan (BRP), the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan. Work in this project is performed by the WRAIR, Silver Spring, MD; USAMRICD, Aberdeen Proving Ground, MD; USAMRIID, Fort Detrick, MD; USARIEM, Natick, MA; USAISR, Fort Sam Houston, TX; and USAARL Fort Rucker, AL.

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PROJECT
91C

Accomplishments/Planned Program

In FY04, published study showing soldiers experiencing exertional heat injury (EHI) had high levels of expression of interferon (IFN)-inducible genes in their peripheral blood mononuclear cells, suggesting that (IFN)-gamma may play a role. Produced human and animal microarrays for analysis of gene expression, emphasizing transcriptome in circulating white blood cells, which may predict success of appropriate resuscitation following traumatic injury. Identified steps that vaccine-induced antibodies must block to prevent malaria parasite invasion into new red blood cells. Validated a method to measure the adverse effects of glare on soldier visual performance under low light conditions. Established analytical methods for diagnosing sulfur mustard and nerve agent soman exposure. In FY05, conduct gene chip studies to characterize the human gene expression response to dehydration. Research the genetic response to hemorrhagic shock and screen for cytoprotective agents for use in resuscitation. Assess acute sensorineural hearing loss and vestibular pathology in deployed soldiers. Investigate the suppression of Ebola virus by ribonucleic acid interference. Evaluate the role of inflammation in sulfur mustard toxicity. In FY06, will determine whether IFN-gamma is associated with incidence/severity of EHI; evaluate blood dilution and lower core body temperature in clotting dysfunction during hemorrhage; research novel infectious disease and bio/chem threat treatments, diagnostics, and delivery systems; study visuomotor markers of cognitive impairment in UAV operators; construct/analyze genetic footprints of Alphaviruses and Filoviruses; and compare phosgene induced respiratory and inhaled chemical warfare agent injury. In FY07, will conduct studies on the human cellular response to environmental stress; explore new concepts for hemorrhage control and treatments; and identify potential biomarkers of bio-agent infection.

FY 2004	FY 2005	FY 2006	FY 2007	
4000	3891	3741	3886	
Totals	4000	3891	3741	3886

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PROJECT
91D

COST (In Thousands)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
	Actual	Estimate						
91D ILIR-CORPS OF ENGR	1364	1365	1217	1270	1309	1319	1256	1268

A. Mission Description and Budget Item Justification: This project supports In-House Laboratory Independent Research (ILIR) in the areas of Battlespace Environments, Military Engineering, and Environmental Quality/Installations. Past and current ILIR efforts have had, and are having, significant impacts on technology development efforts supporting the Army Transformation to the Future Force. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

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91D

Accomplishments/Planned Program

Battlespace Environment/Military Engineering/Environmental Quality and Installations - In FY04, investigated response of human cells to environmental contamination using novel bio-chemical chemistry procedures to potentially develop cell-based analyses for on-site sensing of environmental contamination. Evaluated electrokinetics as a means for rapidly strengthening soils. Explored applications of laws of electromagnetic energy transfer for use in characterizing media reflections. Investigated neural nets as a tool for predicting geologic fracture properties from imagery to enhance weapons effects and penetrability. In FY05, study differential temperature effects on the thermophysical properties of bulk and vicinal water in soils. Conduct research on soil electromagnetic models to be incorporated into state-of-ground models supporting terrain reasoning and awareness. In FY06, will investigate radar signal reflectance to remotely map soil moisture and strength for mobility and landing site assessments for aircraft. Will investigate new, innovative acoustic processing methods that will allow soldiers to locate targets in urban areas. In FY07, will investigate hydrogels for innovative applications in environmental monitoring and engineering, and nanomaterials synthesis. Will study and validate a discrete element model for simulating the mechanical properties of dry soil.

FY 2004	FY 2005	FY 2006	FY 2007	
1364	1365	1217	1270	
Totals	1364	1365	1217	1270