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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)							DATE February 2000		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices					
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	25004	36812	23869	27504	31257	30984	31952	Continuing	Continuing
AH11 Battery/Individual Power Technologies	6355	12446	4025	4475	4532	4410	4689	Continuing	Continuing
AH94 Electronics and Electronic Devices	18649	24366	19844	23029	26725	26574	27263	Continuing	Continuing

A. Mission Description and Budget Item Justification: The work under this program element provides enabling capability to perform precision deep fires against critical mobile and fixed targets, to provide exceptional all-weather, day or night, theater air defense against advanced enemy missiles and aircraft, and to provide electronic components, power components, and low-cost, lightweight, high-energy density power sources for communications, target acquisition, and miniaturized displays, for applications such as the Future Combat Systems (FCS) and soldier systems. This program consists of research in the physical sciences essential to all land combat systems that contain electronics, photonics, magnetic materials, ferroelectrics, microwave and millimeter-wave components, batteries, electromechanical systems (engine generator sets) and fuel cells. Supported systems include FCS, soldier systems, autonomous missile systems, advanced land combat vehicles, smart anti-tank munitions, electric weapons, secure jam-resistant communications, automatic target recognition (ATR), foliage-penetrating radar, combat identification, and digitizing of the battlefield. This program supports the in-house applied research effort at a single Army site which serves as both the center for display technology development and the center for frequency control and timing for the Army, Navy, Air Force, and Ballistic Missile Defense Organization. It supports all of the science and technology thrust areas that employ electronic and portable power-source technology. Work in this program element is consistent with the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan.

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B. Program Change Summary	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (<u>FY 2000/2001</u> PB)	25238	25796	27719
Appropriated Value	25479	37096	
Adjustments to Appropriated Value			
a. Congressional General Reductions	-241		
b. SBIR / STTR	-128		
c. Omnibus or Other Above Threshold Adjustments		-83	
d. Below Threshold Reprogramming	-6		
e. Rescissions		-201	
Adjustments to Budget Years Since (<u>FY 2000/2001</u> PB)	-100		-1850
New Army Transformation Adjustments		TBD	-2000
Current Budget Submit (<u>FY 2001</u> PB)	25004	36812	23869

Change Summary Explanation: Funding – FY 01: Project AH94 was adjusted to reflect the new Army Transformation.

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COST (In Thousands)				FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH11 Battery/Individual Power Technologies				6355	12446	4025	4475	4532	4410	4689	Continuing	Continuing
<p>Mission Description and Justification: This project provides applied research in the application of the physical sciences of energy conversion, electrochemistry, electronics, signature suppression, etc. as they apply to improving existing systems and enabling newer, more advanced battery, fuel cell, thermoelectric, hybrid, and electromechanical (including engines and permanent magnet alternators) technologies. The goal is to investigate small, low-cost, environmentally compatible, light weight, high energy density sources of power for communications, target acquisition, miniaturized displays, combat service support applications, and future soldier systems. These technologies support thrusts aimed at reduced acquisition costs, reduced operation and support costs, and Army modernization.</p> <p>FY 1999 Accomplishments:</p> <ul style="list-style-type: none"> • 936 - Designed a rechargeable lithium-ion liquid electrolyte (wet cell) battery and non-rechargeable metal-air battery, both with ultra high energy density and low operations and support costs. <ul style="list-style-type: none"> - Generated and exhibited prototype smart charging cables for forward field charging of rechargeable batteries for light infantry forces Command, Control, Communications, Computers, Intelligence and Information Warfare (C4I2W) equipment. - Generated and showed vehicle-mounted chargers that utilize vehicle power to recharge family of C4I2W batteries. • 1216 - Performed design analysis and demonstrated proton exchange membrane (PEM) fuel cell/lithium-ion rechargeable battery hybrid power source components to provide smaller, lighter and more cost effective man-portable power systems for C4I2W equipment. <ul style="list-style-type: none"> - Investigated low power and power management technologies for applicability to Army C4I2W equipment, including an uncooled IR sensor. • 525 - Designed and implemented a 350 pound portable, electronically controlled 5000 Watt engine driven generator set capable of operating on multiple fuels for tactically mobile use. The design integrated state-of-the-art commercially available engines with R&D alternator and power electronics technologies. • 643 - Designed hydrogen cartridge with 1000 watt-hours per kilogram of fuel for 50 – 150 watt fuel cells. • 845 - Generated very high energy density, compact zinc-air coin cells for special mission requirements. • 845 - Generated low cost, high rate rechargeable alkaline manganese batteries for training and garrison environments. • 697 - Generated low cost, high rate non-rechargeable alkaline batteries for portable military communications applications. • 648 - Generated low cost, rechargeable lithium-ion coin cells for low rate and memory hold applications for communications and COMSEC devices. <p>Total 6355</p>												
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<p>FY 2000 Planned Program:</p> <ul style="list-style-type: none"> • 935 - Design lithium-ion polymer electrolyte (dry cell) rechargeable battery that provides higher safety and higher capacity than wet cell batteries for C4I2W training applications. <ul style="list-style-type: none"> - Design and test universal smart charging cables for charging complete family of military rechargeable batteries used for C4I2W applications. - Show proof-of-concept rechargeable vest battery for the multiple integrated laser engagement simulation (MILES) 2000. • 682 - Complete power electronics design for the next generation family of engine driven generator power systems <ul style="list-style-type: none"> - Install power-on-the-move system in the drive train of a tactical vehicle and perform tests to characterize electrical performance. • 1342 - Integrate and exhibit battery/capacitor, fuel cell, or battery hybrid. <ul style="list-style-type: none"> - Assess approaches to kinetic active and passive power generation. - Test components researched by ARL/DARPA for system design of a thermophotovoltaic (TPV) power source and upgrade design. - Design a hybrid fuel cell for the Soldier System. • 1054 - Generate system level design tools for integration to provide a common low power and power management design environment. • 144 - Establish power source(s) and identify power savings technologies for an uncooled infrared (IR) sensor. • 958 - The objective of this one year congressional special interest effort is to evaluate low cost, improved rate capable alkaline cells for use in sensor, surveillance, and monitoring applications. • 384 - The objective of this one year congressional special interest effort is to deliver, test, and evaluate prototype reusable alkaline manganese-zinc batteries with improved power capability and cycle life for C4IEWS equipment. • 575 - The objective of this one year congressional special interest effort is to design, develop, fabricate, and deliver prototype rechargeable lithium ion coin cells for safety and performance evaluations. • 384 - The objective of this one year congressional special interest effort is to design, develop, and fabricate initial prototype lithium carbon monofluoride cells to characterize performance, safety, and feasibility for use in batteries. • 1341 - The objective of this one year congressional special interest effort is to demonstrate improved rate capability, high energy "AA" zinc-air cells for use in Forward Area charger applications. • 2875 - The objective of this one year congressional special interest effort is to evolve the micro-channel reactor and engineered catalyst technology required to reform diesel fuel/JP8 into Hydrogen suitable for use in small (soldier portable) and medium sized fuel cell systems. Laboratory prototypes of critical reformer components will be developed, fabricated, and tested. • 1437 - The objective of this one year congressional special interest effort is to provide advanced research on hybrid power source technologies. Model, develop and fabricate prototype hybrid power systems and components. • 335 - Small Business Innovative Research/Small Business Technology Transfer Programs (SBIR/STTR) <p>Total 12446</p>		
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<p>FY 2001 Planned Program:</p> <ul style="list-style-type: none"> • 906 - Establish the most cost effective, safe, high performance primary battery with greater than 300 watt-hours per kilogram. <ul style="list-style-type: none"> - Complete applied research of a high energy rechargeable lithium-ion battery with non-flammable electrolyte for C4I2W applications. - Complete research and test of manpack metal-air/universal smart charging cable recharging system for light infantry C4I2W equipment. • 847 - Complete integration of power components/subassemblies in a 5 kilowatt engine driven generator system design. <ul style="list-style-type: none"> - Implement system tests to ensure proper operation of power electronics subsystems in a system configuration. - Integrate the power electronics subsystem into a power-on-the-move tactical vehicle. • 1262 - Optimize battery/battery hybrid for size, weight, and cost. <ul style="list-style-type: none"> - Design and build kinetic system, as a charge capacity for soldier system. - Design efficient 500 watt TPV system for a recharger and soldier support applications. - Test and show fuel cell hydride model for soldier system. • 861 - Evolve design tools to support low power/power management, system design and system improvement for Land Warrior. • 149 - Integrate model power source for an uncooled infrared sensor into a 3 pound weapon sight prototype. <p>Total 4025</p>		
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BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices				PROJECT AH94				
COST (In Thousands)				FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH94 Electronics and Electronic Devices				18649	24366	19844	23029	26725	26574	27263	Continuing	Continuing
<p>Mission Description and Justification: This project supports applied research in the application of the physical sciences of physics, electrochemistry, biotechnology, and electronics for the future combat systems (FCS). These technologies support thrusts aimed at reduced acquisition cost, reduced operations and support costs, increased vehicle mobility, Army modernization, Advanced Technology Demonstrations (ATDs) and Advanced Technology Transition Demonstrations, as described in the Army Science and Technology Master Plan. This research is designed to obtain significantly improved detection and identification probabilities at extended range and for low observable targets. These capabilities in conjunction with active electro-optical protection mechanisms are essential for effective combat operation and survival of FCS.</p> <p>FY 1999 Accomplishments:</p> <ul style="list-style-type: none"> • 4347 - Designed high frequency electronic components including antennas, ferroelectric materials/devices, transmit/receive modules, and microwave/millimeter wave (MW/MMW) devices to improve soldier situational awareness by enhancing the senses through communications, radar, electronic warfare (EW), surveillance, and target acquisition systems. <ul style="list-style-type: none"> - Established simulation models and new materials for power semiconductors and electromagnetic solvers for high frequency circuit design to reduce costs of high frequency electronic components. - Improved technical performance of Ka Band Rotman lens with 34 element linear horn array with 3.1° azimuth beam width or better. - Designed 5W Ka Band power amplifier in a single module < 1 cubic inch in volume for smart munitions. • 3873 - Integrated piezoelectric microelectromechanical systems (MEMS) magnetometer, pressure sensor and resonators for guidance, sensor and radio frequency (RF) applications. <ul style="list-style-type: none"> - Designed SiC thyristors for high temperature/high power applications in Army vehicles. - Designed TI-doped GaAs for device applications and innovative device types for W-band radar applications. • 2550 - Designed an operational microprocessor (temperature) compensated digital clock circuit, produced a new type of very low phase noise microwave source, successfully grew reproducible high quality langanite boules leading to new high quality piezoelectric resonators for sensors, filters and oscillators capable of operating at higher frequencies than quartz. • 2528 - Designed capacitor with low equivalent series resistance (ESR) (new high conductivity electrolyte, improved electrode binder technology). <ul style="list-style-type: none"> - Established thermal battery with reduced thermal losses with 2x improvement in active life for smart munitions applications. - Established hydrogen-PEM (proton exchange membrane) fuel cell with "strip-cell" design. • 5351 - Investigated mid wavelength infrared (MWIR) mercury cadmium detector array on Si substrates for more affordable Forward Looking Infrared (FLIR). <ul style="list-style-type: none"> - Established dual color quantum focal plane array for improved quantum efficiency and operating temperature. - Performed laboratory demonstrations to show feasibility of applying ARL's ladar architecture to ARDEC submunition. 												
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<p>FY 1999 Accomplishments: (continued)</p> <ul style="list-style-type: none"> - Designed electrically pumped interband quantum cascade laser. <p>Total 18649</p> <p>FY 2000 Planned Program:</p> <ul style="list-style-type: none"> • 3000 - Evaluate new acceleration insensitive clocks and oscillators using langasite and opto-electronic feedback to provide highly stable high data rate communications and global positioning system (GPS) to meet FCS requirements, e.g., the network centric force. • 8766 - Investigate novel resonator structures and electronic materials to improve filtering and control of RF signals to reduce co-site interference. <ul style="list-style-type: none"> - Evaluate novel device structures, through modeling, that will provide improved low power operation for communications, high temperature operation for power conditioning, and subMMW performance for chemical agent classification and evaluate and select RF switch technology for multi beam switching Ka Band Rotman e-scan antenna for increased lethality and survivability of FCS. - Build drive circuit for all-electric future ground combat system to provide increased mobility. • 6343 - Design interband quantum cascade laser with .5W/facet and 250⁰K operating temperature at 3.5μm. <ul style="list-style-type: none"> - Design acousto-optic tunable filter (AOTF) hyperspectral imaging in the 3-5μm and 8-12μm bauds. - Design 8-12 μm and 3-5 μm HgCdTe detector array grown on Si substrate to lower cost of IRFPA allowing a more wide-spread utilization in FCS. - Grow and characterize InAs/GaSb/AlSb based type II LWIR superlattice detector for near-room-temperature operations, reducing logistic burdens of FCS. • 3055 - Design and establish lithium-ion battery cell with new, more energetic anode & cathode materials, and more conductive electrolyte. <ul style="list-style-type: none"> - Design and establish methanol fuel cells with improved cathodic electrocatalyst and membrane electrolyte. - Design and establish capacitors with new high voltage, low temperature electrolytes. • 3000 - Establish a Center for Display Technology Evaluation. <ul style="list-style-type: none"> - Define metrics for the evaluation of systems that include both hardware displays and operator performance. - Define standards for display products to meet unique Army system performance requirements and to minimize life-cycle costs. • 202 - Small Business Innovative Research/Small Business Technology Transfer Programs (SBIR/STTR) <p>Total 24366</p> <p>FY 2001 Planned Program:</p> <ul style="list-style-type: none"> • 3000 - Show factor of 5 improvement in acceleration insensitivity and phase noise through application of new materials and clock architectures to provide highly stable high data rate communications and GPS to meet FCS requirements, e.g., the network centric force. • 8299 - Incorporate cross bar switching control for electronically scanned antennas to promote integration of target acquisition, combat ID, and communications in a common aperture and investigate new device structures for high power/efficiency and temperature operation through exploitation of novel semiconductors for increased lethality and survivability of FCS. <ul style="list-style-type: none"> - Optimize drive circuit all-electric vehicle drive circuit for operation at 400° C to provide increase mobility. 		
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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	0602705A Electronics and Electronic Devices	AH94
FY 2001 Planned Program: (continued)		
•	2703	- Design rechargeable lithium battery with all solid-state components for 3X improvement in energy density, enhanced safety for individual soldier applications. - Design methanol fuel cell for system energy density 5X greater than batteries for long missions. - Investigate capacitors for battery/capacitor hybrids capable of full charge/discharge in minutes with energy densities >2X that of batteries.
•	5842	- Design AOTF hyperspectral imager with 70% transmission. - Establish feasibility of higher operating temperature for IR photon detectors for near-room-temperature operations, reducing logistic burden of FCS. - Design long range flash ladar at eye safe laser wavelength. - Establish feasibility of EO active protection concept for FCS.
Total	19844	