

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)									DATE February 1999	
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices						
<i>COST (In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	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	23974	25238	25796	27719	29554	31543	30070	31840	Continuing	Continuing
AH11 Battery/Individual Power Technologies	5439	6515	4338	4042	4501	4569	2682	2810	Continuing	Continuing
AH94 Electronics and Electronic Devices	17130	18723	21458	23677	25053	26974	27388	29030	Continuing	Continuing
AJ04 Thermophotovoltaic Generator	1405	0	0	0	0	0	0	0	0	1405

A. Mission Description and Budget Item Justification: This program consists of research in the physical sciences essential to all land combat systems that contain electronics, chemical/biological sensors, photonics, magnetic materials, ferroelectrics, microwave and millimeter-wave components, batteries, electromechanical systems (engine generator sets) and fuel cells. Supported systems include the Future Soldier System (FSS), autonomous missile systems, advanced land combat vehicles, smart anti-tank munitions, electric weapons, secure jam-resistant communication, automatic target recognition (ATR), foliage-penetrating radar, combat identification, and digitizing of the battlefield. 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 develop low-cost, lightweight, high-energy density power sources of power for communications, target acquisition, miniaturized displays, combat service support applications and microclimate cooling for Future Soldier System. Under Defense Reliance agreements, this program supports the in-house exploratory development 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, Ballistic Missile Defense Organization, and Defense Nuclear Agency. 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), the Army Modernization Plan, and Force XXI.

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)	DATE February 1999
---	------------------------------

BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices
--	---

B. Program Change Summary	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (<u>FY 1999</u> PB)	24464	22329	23680	26506
Appropriated Value	26792	25479		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-828	-241		
b. SBIR / STTR	-359			
c. Omnibus or Other Above Threshold Adjustments	-1619			
d. Below Threshold Reprogramming	-12			
e. Rescissions				
Adjustments to Budget Years Since <u>FY 1999</u> PB			+2116	+1213
Current Budget Submit (<u>FY 2000 / 2001</u> PB)	23974	25238	25796	27719

Change Summary Explanation: Funding: FY 1998 – DoD Internal Reprogramming realigned funds provided by Congress for enzyme-based chemical and biological detection technology from this PE (-1500) to the RDT&E Defense-Wide Appropriation for proper program execution.
 FY 1999 – Congressional increase (+3150).

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)									DATE February 1999	
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices					PROJECT AH11	
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	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	5439	6515	4338	4042	4501	4569	2682	2810	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 develop 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. Technology developments support thrusts aimed at reduced acquisition costs, reduced operation and support costs, and Army modernization.</p> <p>FY 1998 Accomplishments:</p> <ul style="list-style-type: none"> • 910 - Completed development of lithium manganese dioxide batteries for thermal weapon sight (TWS) and Land Warrior. These batteries are more cost effective than the present non-rechargeable lithium sulfur dioxide system for combat missions. <ul style="list-style-type: none"> - Completed specification development for safe, performance-optimized standard family of rechargeable lithium-ion batteries. These batteries provide lighter weight, lower operations and support cost to the present nickel cadmium and nickel metal hydride batteries. • 332 - Completed the fabrication/test of a lightweight, manportable, electronically controlled, signature suppressed 3 kW generator set capable of starting and operating on multiple fuels. This 3 kW system was demonstrated to the User community during the rapid force projection initiative review at Ft. Benning. <ul style="list-style-type: none"> - Awarded contracts for the design and development of state of the art, efficient, lightweight 5 kW alternator/power electronic subsystems. Effort will lead to the modernization and upgrade of existing power systems. • 917 - Designed, constructed and tested improved lightweight 50 and 150 watt fuel cell with 600 watt-hour capacity. • 460 - Performed design analysis and engineering of lithium-ion coin cell batteries to replace obsolete mercury batteries for low power and memory hold applications. • 930 - Demonstrated low cost reusable alkaline manganese battery for low power training applications. <ul style="list-style-type: none"> - Implemented new AA and C cell designs for high current discharge batteries used for military training. Fabricated prototype batteries and battery chargers for test and demonstration. Test resulted in AA cell design providing superior performance. • 500 - Investigated components to develop high rate, large (fat D cell size), non-metallic rechargeable lithium-ion cells optimized for safety and performance for use in BB-X590/U military batteries. • 1390 - Demonstrated feasibility of a high energy zinc-air system suitable for field recharging batteries. <p>Total 5439</p>										
Project AH11			Page 3 of 9 Pages			Exhibit R-2A (PE 0602705A)				

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices	PROJECT AH11
FY 1999 Planned Program:		
<ul style="list-style-type: none"> • 942 • 1224 • 528 • 643 • 850 • 850 • 700 • 650 • 128 Total 	<ul style="list-style-type: none"> - Develop 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. - Develop and demonstrate 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. - Develop and demonstrate vehicle-mounted chargers that utilizes vehicle power to recharge family of C4I2W batteries. - Perform design analysis and demonstrate 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. - Investigate low power and power management technologies for applicability to Army C4I2W equipment. - Design and develop a 350 pound portable, electronically controlled 5000 Watt engine driven generator set capable of operating on multiple fuels for tactically mobile use. The design shall integrate state-of-the-art commercially available engines with R&D alternator and power electronics technologies. - Design liquid fueled 50 to 150 watt fuel cell with 2000 watt-hour per kilogram of fuel. - Develop very high energy density, compact zinc-air coin cells for special mission requirements. - Develop low cost, high rate rechargeable alkaline manganese batteries for training and garrison environments. - Develop low cost, high rate non-rechargeable alkaline batteries for portable military communications applications. - Develop low cost, rechargeable lithium-ion coin cells for low rate and memory hold applications for communications and COMSEC devices. - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs 	
FY 2000 Planned Program:		
<ul style="list-style-type: none"> • 976 • 2488 	<ul style="list-style-type: none"> - Develop lithium-ion polymer electrolyte (dry cell) rechargeable battery that provides higher safety and higher capacity than wet cell batteries for C4I2W training applications. - Develop and demonstrate prototype universal smart charging cables for charging complete family of military rechargeable batteries used for C4I2W applications. - Demonstrate proof-of-concept rechargeable vest battery for the multiple integrated laser engagement simulation (MILES) 2000. - Develop, fabricate and demonstrate components for cost-effective 5-150 Watt man-portable hybrid power sources for land warrior and forward field charging applications. - Develop and evaluate fueled energy sources (direct methanol/logistic fueled fuel cells, generators, thermophotovoltaics (TPV)) and mechanical energy converters (flywheels, coiled springs, etc.) for applicability in 300-500 watt and 5-10 kilowatt hybrid power sources for lightweight Tactical Operations Centers (TOCs) and future command posts. - Leverage appropriate DARPA low power electronics programs; develop and demonstrate a 1 volt dc-dc converter for future Army radio upgrade. 	
Project AH11	Page 4 of 9 Pages	Exhibit R-2A (PE 0602705A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices	PROJECT AH11
FY 2000 Planned Program: (Continued)		
•	454 - Fabricate the 350 pound portable, electronically controlled 5000 Watt engine driven generator set capable of operating on multiple fuels for tactically mobile use. Investigate and use latest advances in composite materials and signature suppression techniques.	
•	420 - Fabricate and test liquid fueled 50 to 150 watt fuel cell with 2000 watt-hour per kilogram of fuel.	
Total	4338	
FY 2001 Planned Program:		
•	910 - Develop, fabricate and demonstrate high energy rechargeable lithium-ion polymer electrolyte battery for the mini eyesafe laser infrared observation set (MELIOS).	
	- Complete development and field test of manpack metal-air/universal smart charging cable recharging system for light infantry C4I2W equipment.	
•	2318 - Complete evaluation of batteries, capacitors, fueled energy sources, and mechanical energy converters in the 5-150 W range for land warrior application and identify most promising, highest payback candidates for final development and field testing.	
	- Complete evaluations of batteries, capacitors, fueled energy sources, and mechanical energy converters in the 300 W-10kW range for TOCs and identify most promising, highest payback candidates for final development and field testing.	
	- Develop and integrate a low power efficient subsystem for Force XXI land warrior.	
•	400 - Test and evaluate the 350 pound, 5000 Watt generator set prototype. Leverage design and test results and use them to establish operational and performance criteria for general power system designs for the 21 st Century Family of generator sets (10 – 60 kW).	
•	414 - Optimize the design of the liquid fueled 50 to 150 watt fuel cell with 2000 watt-hour per kilogram of fuel for field use.	
Total	4042	
Project AH11	Page 5 of 9 Pages	Exhibit R-2A (PE 0602705A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices				PROJECT AH94		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	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	17130	18723	21458	23677	25053	26974	27388	29030	Continuing	Continuing
<p>Mission Description and Justification: This project supports applied research in the application of the physical sciences of physics, electrochemistry, biotechnology, electronics, and process science, as they apply to improving existing systems and enabling newer, more advanced systems. Technology developments support thrusts aimed at reduced acquisition cost, reduced operations and support costs, Army modernization, Advanced Technology Demonstrations (ATDs) and Advanced Technology Transition Demonstrations, as described in the Army Science and Technology Master Plan.</p> <p>FY 1998 Accomplishments:</p> <ul style="list-style-type: none"> • 6517 - Evaluated ferroelectric thin-film millimeter wave scanning antenna to demonstrate electronic scanning. <ul style="list-style-type: none"> - Demonstrated MW/MMW/terahertz devices for communications/navigation/surveillance systems. - Developed predictive physics-based and circuit-based modeling and simulation tools for circuits, leveraging high performance computing assets. - Assessed application of digital receiver technology and Microelectromechanical Systems (MEMS) for application to low cost MMW radar. - Demonstrated performance Ku band rotman escan antenna with an octave of bandwidth. - Developed 5W 35 GHz power amplifier module design concept. - Established SiC thyristor process to support high power switching requirements of all electric vehicle program. • 1800 - Executed DoD-mandated program to maintain industrial base in oscillator and clock technology. <ul style="list-style-type: none"> - Developed low-noise, acceleration-insensitive oscillator technology for air-borne navigation and communication systems such as Joint Surveillance and Target Acquisition Radar System (JSTARS). - Developed low-power, high-accuracy clock technology to support direct P-code acquisition of global positioning system (GPS) as well as a high-shock version for GPS guided munitions. • 3248 - Demonstrated laboratory prototype rechargeable lithium-ion battery with new low temperature electrolyte (joint with CECOM). This helps enable wider rechargeable battery use to reduce battery cost and logistic burden. <ul style="list-style-type: none"> - Developed laboratory prototype capacitor demonstrating new electrolyte. - Developed prototype monopolar cell stacks for small fuel cell for individual soldier applications. • 5565 - Fabricated mercury cadmium telluride detector array on Si substrates. <ul style="list-style-type: none"> - Completed preliminary field demonstration of active and passive Multi Domain Smart Sensor (MDSS) concepts. - Completed literature survey of emerging magnetic sensor technologies and components and determined which are suitable for magnetic microsensors. - Demonstrated .8 micrometer quantum well modulator for laser radar (ladar). - Demonstrated remote temperature sensing using a two-color C-QWIP. 										
Project AH94	Page 6 of 9 Pages					Exhibit R-2A (PE 0602705A)				

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices	PROJECT AH94
Total	17130	
FY 1999 Planned Program:		
•	7220 - Design and fabricate high frequency electronic components including antennas, ferroelectric materials/devices, transmit/receive modules, and MW/MMW devices to improve soldier situational awareness by enhancing the senses through communications, radar, electronic warfare (EW), surveillance, and target acquisition systems. - Demonstrate simulation models and new materials for power semiconductors and electromagnetic solvers for high frequency circuit design to reduce costs of high frequency electronic components. - Demonstrate technical performance of Ka Band Rotman lens with 34 element linear horn array with better than 3° azimuth beam width. - Demonstrate 5W Ka Band power amplifier module.	
•	2975 - Execute DoD-mandated program to support industrial base for research on low-noise, acceleration-insensitive oscillator technology and low-power, high-accuracy, high-shock clocks for communication/navigation systems.	
•	2901 - Develop laboratory prototype capacitor with low equivalent series resistance (ESR) (new high conductivity electrolyte, improved electrode binder technology). - Develop prototype thermal battery with reduced thermal losses with 2x improvement in active life for smart munitions applications. - Demonstrate prototype hydrogen-PEM (proton exchange membrane) fuel cell with "strip-cell" design.	
•	5627 - Demonstrate long wavelength infrared (LWIR) mercury cadmium detector array on Si substrates. - Demonstrate dual color quantum grid detector array for improved quantum efficiency and operating temperature. - Complete testing and analysis of ladar to demonstrate applicability to ARDEC submunition. - Demonstrate and deliver monolithic integrated semiconductor optical circuit to AMCOM for fiber gyro.	
Total	18723	
FY 2000 Planned Program:		
•	3100 - Evaluate new acceleration insensitive clocks and oscillators using langasite and opto-electronic feedback.	
•	8181 - Investigate novel resonator structures and electronic materials to improve filtering and control of RF signals to reduce Co-site interference. - Evaluate novel device structures, through modeling, that will provide improved low power operation for communications, high temperature operation for power conditioning, and sub-MMW performance for chemical agent classification. - Evaluate and select rf switch technology for multi beam switching Ka Band Rotman e-scan antenna. - Demonstrate performance of polarimetric W-Band active e-scan antenna.	
•	6583 - Demonstrate dual color infrared focal plane array (IRFPA) grown directly on Si. - Complete scannerless eye-safe ladar and two color passive sensor and demonstrate as part of MDSS system. - Develop magnetometer-based sensor system for Army application.	
•	3594 - Demonstrate lab prototype lithium-ion battery cell with new, more energetic anode & cathode materials, and more conductive electrolyte. - Demonstrate lab prototype methanol fuel cells with improved cathodic electrocatalyst and membrane electrolyte.	
Project AH94	Page 7 of 9 Pages	Exhibit R-2A (PE 0602705A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices	PROJECT AH94
Total	21458	- Demonstrate lab prototype capacitors with new high voltage, low temperature electrolytes.
FY 2001 Planned Program:		
•	5200	- Demonstrate factor of 5 improvement in acceleration insensitivity and phase noise through application of new materials and clock architectures.
•	8189	- Demonstrate cross bar switching control for Escan antennas to promote integration of target acquisition, combat ID, and communications in a common aperture.
•	3671	- Demonstrate new device structures for high power/efficiency and temperature operation through exploitation of novel semiconductors.
•	3671	- Develop laboratory prototype rechargeable lithium battery with all solid-state components for 3X improvement in energy density, enhanced safety for individual soldier applications.
•	3671	- Demonstrate prototype methanol fuel cell for system energy density 5X greater than batteries for long missions.
•	3671	- Develop miniature reserve batteries for smart munitions requiring long shelf life/long active life.
•	3671	- Develop prototype capacitors for battery/capacitor hybrids capable of full charge/discharge in minutes with energy densities >2X that of batteries.
•	6617	- Demonstrate large area dual color IRFPA with smart ROIC, improved storage capacity and optical readout.
•	6617	- Demonstrate feasibility of high temperature quantum grid or quantum dot detector array.
•	6617	- Develop reflection modulator that will conform to total ladar system design requirements.
Total	23677	

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602705A Electronics and Electronic Devices				PROJECT AJ04		
COST <i>(In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AJ04 Thermophotovoltaic Generator	1405	0	0	0	0	0	0	0	0	1405
<p><u>Mission Description and Justification:</u> This Congressional special interest project conducted applied research to enable newer, more advanced thermophotovoltaic (TPV) power sources. Prototypes of TPV power sources were developed and engineered as portable battery chargers operating on logistic fuels.</p> <p>FY 1998 Accomplishments:</p> <ul style="list-style-type: none"> • 1405 - Completed investigation/identification of technology components (i.e. burners, filters, controls) enhancements to increase system efficiency and power output of a 500 Watt TPV power system prototype. - Completed testing/evaluation of a 200 W TPV power system prototype capable of operating on logistic fuels and recharging batteries for C4I2W applications. - Completed demonstration of a hydrocarbon fueled flash light for the individual soldier. <p>Total 1405</p> <p>FY 1999 Planned Program: Project not funded in FY 1999.</p> <p>FY 2000 Planned Program: Project not funded in FY 2000.</p> <p>FY 2001 Planned Program: Project not funded in FY 2001.</p>										
Project AJ04			<i>Page 9 of 9 Pages</i>			Exhibit R-2A (PE 0602705A)				

THIS PAGE INTENTIONALLY LEFT BLANK