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

February 2003

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Total Program Element (PE) Cost		31635	21820	22765	25510	33882	37172	37928	31864
140	HI-POWER MICROWAVE TEC	2691	2766	2898	2954	3656	3721	3773	3864
142	PASSIVE MMW CAMERA	2015	0	0	0	0	0	0	0
H15	GROUND COMBAT ID TECH	7492	3477	4836	4970	6064	6142	6247	8304
H16	S3I TECHNOLOGY	17039	15577	15031	17586	24162	27309	27908	19696
SA1	ADVANCED SENSORS AND OBSCURANTS	2398	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The objective of this program is to enhance the capabilities of the Future Combat Systems (FCS) and the Objective Force by: providing sensor, signal, and information processing technology for advanced reconnaissance, surveillance, and target acquisition (RSTA), ground-to-ground and air-to-ground combat identification (ID), and fire control systems, as well as the fuzing and guidance-integrated fuzing functions in future munitions; and significantly improving the survivability, lethality, deployability, and sustainability of FCS by devising high-power electronic components and technologies for compact, light-weight power and energy storage, conversion and conditioning, and radio frequency (RF)/microwave directed energy (RF-DE) weapons. Critical technologies to be addressed to increase the combat effectiveness of tactical Army forces include: high power, solid-state/vacuum, power/RF component technology; combat identification technology; and sensors, signatures, signal and information processing (S3I) technology. Work in this PE is related to and fully coordinated with efforts in PE 0602307 (Advanced Weapons Technology), PE 0602705 (Electronics and Electronic Devices), PE 0602709 (Night Vision Technology), PE 0602782 (Command, Control, Communications Technology), PE 0603772 (Advanced Tactical Computer Science and Sensor Technology), and PE 0603008 (Command, Control, Communications Advanced Technology).The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this program.

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B. Program Change Summary	FY 2002	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2003)	31934	24305	24624	25834
Current Budget (FY 2004/2005 PB)	31635	21820	22765	25510
Total Adjustments	-299	-2485	-1859	-324
Congressional program reductions				
Congressional rescissions		-2174		
Congressional increases				
Reprogrammings	148	-125		
SBIR/STTR Transfer	-447	-186		
Adjustments to Budget Years			-1859	-324

Change Summary Explantion:

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**140**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
140	HI-POWER MICROWAVE TEC	2691	2766	2898	2954	3656	3721	3773	3864

A. Mission Description and Budget Item Justification: This project focuses on efforts to significantly improve the survivability, lethality, deployability, and sustainability of Future Combat Systems (FCS) and the Army's Objective Force by devising high-power electronic components and technologies for compact, lightweight power and energy storage, conversion and conditioning. Current technical barriers result in excessive size and weight requirements for these components and systems. Matching of potential FCS radio frequency (RF)/microwave directed energy (RF-DE) and high energy laser (HEL) weapons and other electric power loads such as electromagnetic gun, electromagnetic (EM) active protection armor and electric drive to the FCS electric power sources will be improved with the advances in this project. This program is coordinated and, when appropriate, leveraged with directed energy (both RF and laser) and power programs in the Air Force, Navy, Defense Special Weapons Agency, National Labs, university consortia and relevant industry and foreign partners. This work is done in coordination with the Tank and Automotive Research, Development and Engineering Center (TARDEC), the Armaments Research, Development and Engineering Center, and the Communications and Electronics Command Research, Development and Engineering Center (CERDEC). The emphasis of this project is being focused to more effectively support the Army Transformation, by concentrating on the critical path technology of power components common to all Directed Energy Weapons (DEW) and hybrid electric propulsion systems. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Perform technology -base R&D in power converter design and high-temperature devices to achieve high-power and high-temperature operation of power converters with enhanced performance while significantly reducing size and weight to meet the stringent weight/volume requirements of the Future Combat Systems and ultimately the Objective Force. In FY02: characterized silicon-based 100 kW matrix converter in relevant environment for motor control. Evaluated 4 kW silicon carbide (SiC) high-temperature bi-directional switch module. In FY03, evaluate a brassboard 10 kW SiC module and 100 kW Si matrix converter. In FY04, install and evaluate SiC power devices in a high temperature 10kW matrix converter. In FY05, fabricate, install and evaluate SiC power devices in the world's first high-temperature matrix converter at 100 kW power level in a relevant environment controlling an electric drive traction motor such as those needed for FCS applications. This is in support of work done in TARDEC on power generation, conditioning and control.	1300	1328	1442	1900
- Design of RF-Agile Target Effect System (ATES) breadboard. Investigate and mature components and sub-systems such as antennas and microwave sources to support the non-lethal and directed energy program. Conduct susceptibility experiments on targets of interest to the ATES STO program. In FY02, completed first round of laser/RF synergy tests on items selected by ARDEC. In FY03, expanded 2nd generation synergy experiments will be conducted on ARDEC-selected targets and microwave (MW) components will be investigated. In FY04, MW component designs will be matured for inclusion in system designs. In FY05, complete design for ATES breadboard system with state-of-the-art components suitable for integration onto hybrid-electric platforms.	1015	1041	1057	558

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Investigate electronic warfare (EW) survivability, lethality, EW tools technology, and methodology research. In FY 02, completed analysis of unmanned aerial vehicle (UAV) countermeasure runs for anti-radiation missile (ARM) survivability model development and finished statistical analysis of secondary modulation signal used to develop electric countermeasures. In FY03, complete theoretical design analysis of a narrow band filter (Faraday Anomalous Dispersion Optical Filter (FADOF)) that provides a multi-spectral approach in identification of extremely low signature missile propellants. Conduct theoretical studies and develop algorithms for atmospheric propagation of this phenomenology. These technology efforts support the Full Spectrum Active Protection (FSAP) effort for TACOM in support of the Future Combat Systems (FCS). In FY04, investigate integration of the FADOF onto FCS platforms, design concepts for fiber optic bundles, and develop Electronic Warfare/Electro Optic (EW/EO) models/simulations of atmospheric/background clutter processes impacting hit avoidance mechanisms. In FY05, investigate a methodology, tool set, generic radar sensor, and EW models for EW survivability analysis of missile defense and sensor systems.	376	397	399	496
Totals	2691	2766	2898	2954

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February 2003

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**H15**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H15	GROUND COMBAT ID TECH	7492	3477	4836	4970	6064	6142	6247	8304

A. Mission Description and Budget Item Justification: US and Allied Forces lack a comprehensive combat identification (CID) system to prevent fratricide. The objective of this project, the Coalition Combat Identification ACTD, is to mature and demonstrate emergent CID systems for joint, allied and coalition air-to-ground and ground-to-ground mounted, dismounted, forward observer and forward air controller mission for the Objective Force. This program provides the technologies necessary for US, UK, French, German, Canadian and Australian Coalition Combat Identification Advanced Concept Technology Demonstrations (ACTD). The program provides maturation of the enabling technologies to demonstrate common identification (ID) standard agreements (STANAGs), reduce weight and cost, and evaluate radio frequency (RF) tags, such as those under development by DARPA as a CID enabler. This program will set the baseline for the Objective Force to enable fratricide reductions through CID concepts to include blue force tracking via RF Tags scanned by synthetic aperture radar/moving target indicator (SAR/MTI) radar. This program increases the survivability and lethality of Coalition Forces by providing a matured capability to identify friend from foe, thereby, reducing fratricide incidents across the battlefield. CID must be software functional, portable across a family of platforms, tied to the future tactical internet, over-the-horizon capable and highly resistant to countermeasures. The system must operate successfully in all weather environments and must not be impacted by smoke, fog, dirt and other obscurants. The Objective Force CID capability will fuse situational awareness (SA) and Point-of-Engagement Target Identification into a common "through sight" picture. The future CID architecture will necessitate the integration of a network composed of diverse reconnaissance, surveillance and target acquisition (RSTA) sensors that include non-cooperative capabilities in the sensor suites and a cooperative ID capability that will be realized as part of the future network centric, real-time, red and blue SA for both combat vehicles and unit of action/unit of employment (UA/UE) Commander. Coordination will be accomplished with other services, allies and coalition partners. MANPRINT will be addressed in all activities. Future CID will operate with the Objective Warrior System providing a seamless boundary with vehicle CID. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) were provided to the program/project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02, completed radio based study to investigate the possibility of migrating the Radio Based Combat Identification (RBCI) from the Ground System Improvement Program (SIP+) SINCGARS to the Advanced SIP (ASIP+) SINCGARS radio and the potential for use on exportable ASIP radios for multinational CID. In FY03, coordinate allied participation in ACTD (GE, UK, FR, CA, AUS). Share technical approaches to develop hardware and implement the Battlefield Target ID (BTID) and Dismounted Soldier CID (DSCID) STANAGs. Develop RBCID using the ASIP SINCGARS . IN FY04, develop a smaller, lighter, more efficient and less costly version of the Battlefield Combat Identification System Millimeter Wave system with a NATO STANAG approved waveform. Coordinate development of a NATO standard for DSCID for a US/NATO common system to increase protection to the dismounted soldier. Plan/Conduct a CID Military Operation in an Urban Terrain exercise. In FY05, develop modeling and simulation capability to conduct international virtual operational exercise to evaluate technologies and test or establish new tactics, techniques and procedures. Conduct technical, operational, and simulated test and evaluation.	7492	3477	3878	4056
- In FY05, evaluate the use of RF Tags in conjunction with a SAR/MTI radar to provide passive CID. Develop ground integrated target identification system for ground-to-ground CID for the Objective Force. This will integrate CID data from cooperative and non-cooperative target identifiers (FLIR, EPLRS, RF Tags, Radar, tactical internet, etc.) and situational awareness sensors to display CID results through the sight. Mitigates engagement latency and provides beyond line-of-sight capability.	0	0	958	914
Totals	7492	3477	4836	4970

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

February 2003

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**H16**

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H16	S3I TECHNOLOGY	17039	15577	15031	17586	24162	27309	27908	19696

A. Mission Description and Budget Item Justification: This project is focused on advanced sensor, signal processing and information technologies to provide the Future Combat Systems (FCS), Objective Force Warrior (OFW) and other emerging thrusts with decisive new capabilities to locate, identify, and engage battlefield targets. The ultimate utility of this work will be to protect our soldiers and to greatly increase their lethality and range and speed of engagement. Emphasis is on solving critical Army-specific battlefield sensing and information management problems such as dealing with false targets, complex terrain, movement of sensors on military vehicles, etc. Cost reduction is a key focus. Work is coordinated with outside organizations, particularly the Night Vision Electronic Sensors Directorate, other Research and Development Engineering Centers (RDECs) and the Defense Advanced Research Projects Agency (DARPA). Significant areas of research include: 1) Low cost sensors designed to be employed in large numbers as unattended ground sensors (UGS) for force protection, homeland defense, minefield replacements, counter terrorism operations, and munitions. Research is conducted in fusion of diverse sensors such as acoustic, seismic, magnetic, radar, IR, visible imagers, etc. Technical barriers are: diverse, low-power sensors, autonomous networks, and sensor fusion. Algorithms and concepts transitioning to Communications and Electronics Command (CECOM) Disposable Sensors Program. 2) Low cost acoustic, seismic and magnetic sensors that can passively detect and track battlefield targets such as tanks, helicopters, etc. and locate gun fire. 3) Sensor technologies for the detection and tracking of humans, especially in urban terrain. Technical barriers: effective fusion of many diverse sensor types and innovation of high reliability, low cost approaches. 4) High performance multi-function radio frequency (RF) systems which allow target acquisition, combat identification, active protection, surveillance, and communications systems consolidated into a single system, reducing system cost and size. Technical barrier: maintaining performance of each function in the combined system. 5) Passive and active RF sensors capable of high-resolution imaging to detect targets hidden in foliage, smoke and fog. Ultra wideband radar work will enable buried mine detection and target imaging through dense foliage and will greatly enhance robotic mobility. Technical barriers include real-time signal processing and false alarm rate. 6) Aided/automatic target recognition (ATR) to allow sensors to autonomously locate and identify targets. Algorithms will minimize the workload on the soldier in combat to find and identify targets using laser radar (LADAR), multi-band infrared cameras, and hyperspectral imagers. 7) Opto-Electronic (OE) interconnects and processors are being built to greatly speed the movement of information within and between electronic digital processing units to facilitate smart sensors, adaptive sensors, and sensor fusion. Sensor processing, analysis, and displays will provide soldiers with clearer, higher resolution images from their targeting systems. 8) Advanced battlefield sensor and information processing to conduct a dynamic and real time situation assessment to present a common picture of the battlespace. Technical barriers: fusion of data from dissimilar sensors, coherent display of complex information, and human factors. 9) Advanced information processing methods to provide automatic information technologies which utilize widely dispersed sensor and legacy information sources. Technical barrier: development of autonomous networks. This work supports the following Army Programs: FCS, OFW, Networked Sensors for the Objective Force (NSfOF)ATD, Multi-Function Starting Sensors Suite (MFS3), Warrior Extended Battlespace Sensors (WEBS), Anti-Personnel Landmine Alternatives (APLA), 3rd Generation forward-looking infrared (FLIR), Full Spectrum Active Protection, and Quicklook. Work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance.

The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds were provided to this program.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Mature underpinning technologies for low-cost unattended ground sensors (UGS) for homeland defense, counter-terrorism, FCS and OFW. Implement and mature advanced passive acoustic/seismic algorithms to detect, track and ID targets for UGS. In FY02, completed and evaluated 2nd generation processor for UGS; implemented 3-axis seismic sensors for direction finding and fused output with acoustic sensors and implemented algorithm on testbed; and studied key underpinning technology needs for sensors for position / orientation. In FY03, conduct field experimentation and evaluation of new passive sensors technologies and capabilities for multi-target detection, classification and tracking; characterize robust beam forming algorithm for multi-target vehicle tracking; and conduct field exercises for experimentation, technology characterization, and capability determination. In FY04 implement acoustic / seismic sensor fusion algorithm for multi-target tracking and ID in support of Networked Sensors for the Objective Force ATD; and design low-cost magnetic sensor for CECOM Disposable Sensors Program. In FY05, provide mature sensor nodes and algorithms along with RF, magnetic, electric field, and acoustic technology required for providing baseline personnel detection capability to CECOM for use in Networked Sensors for the Objective Force ATD and transition to CECOM Disposable Sensors Program.	4856	5397	5188	5599

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Implement new target recognition and image understanding techniques to detect and ID targets in clutter for implementation on manned and unmanned systems. Mature low cost LADAR and target recognition techniques for 3rd Generation FLIR in support of CECOM program for FCS sensors. In FY02, matured and transitioned a technique for recognizing moving targets to the Long Range Advanced Scout Sensor System (LRAS3) CECOM/CRDEC program; conducted LADAR data collection experiments, analysis and evaluation of targets under camouflage and targets for robotic perception obstacle avoidance applications; and implemented ATR algorithm for dual color FLIR systems. In FY03, investigate FLIR and multi/hyperspectral imagery for target recognition applications; evaluate improvement in performance of dual color FLIR algorithm over single band FLIR algorithms; and conduct field experiments using line array LADAR. In FY04, expand moving target techniques to include sensor effects and multiple sensors. In FY05, implement new target recognition algorithms in multi-sensor experiments, mature eye-safe staring array LADAR and conduct extensive field experiments.	1787	1851	2054	2252
- Using models and measurements, determine effectiveness of ultra wideband (UWB) radar for detecting complex obstacles for robotic perception. Assess and remediate image formation artifacts that may limit the potential of UWB SAR to detect buried mines. In FY02, completed major field experiment to collect UWB radar data on various types of obstacles effecting mobility of robotic vehicles. In FY03, demonstrate ability of UWB radar to detect obstacles. In FY04 develop radar imaging techniques to assess the value of 3D resolution for detecting negative obstables. In FY05, develop and evaluate physics-based mine detection algorithm.	1123	1219	866	968
- Complete enhanced RF signature measurement and hybrid electromagnetic (EM) modeling capabilities to enable prediction of tactical vehicle signatures through millimeter wave (MMW) frequencies for integrated survivability. Building on results from other work units, use enhanced models and measurements on tactical vehicles and clutter to produce improved target detection, tracking and classification algorithms for FCS tactical radars. In FY02, compared EM model outputs to turntable measurements on a tactical vehicle through MMW frequencies and identified technical issues associated with signature modeling of ground vehicles. In FY03, develop metrics to assess the signature prediction performance of x-patch; characterize issues such as the vehicle CAD accuracy, geometry complexity and material composition. In FY04, using facet files generated from CAD, model an FCS-like vehicle at X-band and Ka-band and assess accuracy of prediction. In FY05, evaluate hybrid approaches to model complex targets. Compare hybrid approaches to x-patch.	776	849	1944	2111

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Multifunction RF and optical interconnects for use on small ground and air vehicles and Objective Force Warrior (OFW). Mature understanding of phenomenology for an integrated RF sensor that performs radio, radar, and control functions to allow communications, combat-ID, target acquisition and track, active protection, and munition command guidance for use on small ground and air vehicles. Mature optical data links and optical data processing architectures to accept massive raw data streams from multiple FCS sensors and efficiently produce real-time battlespace information for commanders and the OFW. Mature models and evaluate networked sensor concepts in support of netted fires to allow dynamic updating of weapons in-flight. In FY02, collected and analyzed radar signatures of vehicles in clutter and successfully tracked, in range and velocity high-speed kinetic energy penetrators in flight, to support full spectrum active protection (FSAP); delivered real-time optical data link to Aviation and Missile Research, Development and Engineering Center (AMRDEC) for demonstration in missile testbed; and produced a simulation of distributed sensor concept to provide targeting information for beyond line of sight weapons. In FY03, characterize RF multi-function and communication waveforms in a testbed and generate location errors for various sensor types and mixes. In FY04 develop refined multi-sensor tracking techniques, assess monopulse tracking errors of KE penetrators, and develop beam scheduling techniques and complementary detection algorithms for a multi-function tactical radar. In FY05, determine the utility of polarimetric MMW imaging for aircraft navigation, landing, and obstacle avoidance in limited visibility conditions. Establish improvement in munition lethality available through dynamic updating. Provide and characterize a breadboard optical datalink subsystem with increased data rates beyond 1 Tb/s.	4189	4042	2839	3228
- Improve Commander's situational understanding in complex/urban terrain by maturing infrastructure and validating algorithms, filters and agent technologies to reduce cognitive load by fusing information. In FY02, transitioned to CECOM a diverse suite of software components that significantly improved information access and operator focus of attention so that important battlefield events are rapidly perceived and understood. In FY03, provide agent architecture to enable information fusion from diverse databases. In FY04, develop analytical and computing techniques to present information to soldiers and commanders in an easily understood and perceived form. In FY05, transition Web enabled enhanced service based tools with integrated organizational capability from autonomous asset management and tactical decision aids that reduce both cognitive load and uncertainty to CECOM Network Centric Warfare C2 Program (follow on to CECOM Agile Commander Advanced Technology Demonstration).	2547	2219	2140	2528

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
-S3I Technology: The objective of this one-year congressional add was to enhance the S3I core technology. No additional funding is required.	1761	0	0	0
Exploit breakthroughs in biotechnology basic research transitioning from the Army Biotechnology Research Center, a University Affiliated Research Center, to enable revolutionary Objective Force capabilities in sensors, electronics and photonics. In FY05 mature emerging opportunities in areas such as biomolecular based detector arrays for new sensors, biocomputing leading to advanced computing capability, biological photovoltaic power sources for reduced logistics demand, and biomimetics and biomimetics processing leading to new electro-optic materials, chemical detectors and structural multifunctional smart materials. Applied reseach will be conducted by ARL in collaboration with Center industry partners.	0	0	0	900
Totals	17039	15577	15031	17586