Exhibit R-2, RDT&E Budget Item Justification							Date: February 2002	
APPROPRIATION/BUDGET ACTIVITY RESEARCH, DEVELOPMENT, TEST & EVALUATION, DEFENSE-WIDE, BUDGET ACTIVITY 4					R-1 ITEM NOMENCLATURE JOINT ROBOTICS PROGRAM PE 0603709D8Z			
COST ($ in Millions)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete
Total PE Cost	13.667	12.558	11.305	11.714	12.015	12.192	12.452	Continuing
JAUGS	0.600	0.800	0.900	0.900	0.900	1.235	1.508	Continuing
BUGS	0.900	0.900	0.000	0.000	0.000	0.000	0.000	Continuing
JOINT SERVICE EOD ROBOTICS	0.000	0.800	0.760	0.800	0.819	0.807	0.804	Continuing
FTUV	3.167	0.000	0.000	0.000	0.000	0.000	0.000	Continuing
MPRS	0.000	3.458	3.325	3.450	3.540	3.490	3.480	Continuing
MOBILITY ENHANCEMENTS	5.200	1.400	1.340	1.394	1.430	1.420	1.410	Continuing
RACS	3.800	5.200	4.980	5.170	5.326	5.240	5.250	Continuing

A. Mission Description and Budget Item Justification. This program is a budget activity level 4 based on the concept/technology development activities ongoing within the program. This PE was established in response to Congressional guidance to consolidate DoD robotic programs on unmanned ground systems and related robotic technologies in order to increase focus of the Services' robotic programs on operational requirements. The program will demonstrate maturity of robotics technologies for their application to the formal acquisition process of land systems and subsystems. Emphasis is on the development of robotic technologies that: are amenable to multi-service applications; provide capability in high hazard environments; provide improved battlefield efficiency using supervised autonomous operational capability; reduce or enhance force manpower and support; and are affordable. This PE consolidates the DoD robotics program for Unmanned Ground Vehicles (UGV) into two activities: (1) advancement of UGV concepts into Advanced Development (AD) acquisition programs and (2) the enhancement and exploitation of critical robotic technologies for present and future UGV acquisition requirements. Categories under this PE are: (1) the Basic Unexploded Ordnance System (BUGS) – a Joint Service EOD effort to locate and dispose of surface unexploded ordnance; (2) the Robotics for Agile Combat Support (RACS) – a USAF effort to advance the robotic state-of-the-art capability for counter-terrorism and force protection technologies. RACS platforms include the following: All-purpose Remote Transport System (ARTS), Autonomous Mobility Research and Development System (AMRADS), and the Automated Ordnance Excavator (AOE). This technology has been applied to formerly used defense sites and active range clearance for cleanup/disposal. (3) Joint Service EOD Robotics consolidates all EOD robotic activities under one program line to include the BUGS program, improvements to fielded EOD robotic systems and exploration of a smaller man-portable EOD robotic system. (4) The Mobility Enhancements program is a research and development program aimed at improving the mobility of small, man portable unmanned vehicle systems in support of urban warfare, engineering, physical security/force protection missions. (5) The Family of Tactical Unmanned Vehicles (FTUV) is a joint Army/Marine Corps effort to provide commanders a family of reconnaissance, surveillance and target acquisition UGV's that are properly sized to operate in a variety of tactical situations. Requirements are emerging for small and medium unmanned systems that improve warfighters' situational awareness in scout, mechanized and infantry operations in urban terrain. The success and lessons learned from FTUV has led to the decision to create two separate program lines: MPRS and Gladiator. (6) Man Portable Robotic Systems (MPRS) – is an effort to develop smaller (10-40 lb. Class) UGV's to conduct operation in urban terrain and tunnel reconnaissance. Gladiator is an effort to develop a light ($\leq$ 1000 lbs) unmanned system for the USMC to conduct surveillance, reconnaissance and other selected missions. The Office of Naval Research will provide FY 2002 funding for Gladiator to conduct concept development and explore existing technology. The JRP will seek Gladiator funding in the out years. (7) The Joint Architecture for Unmanned Ground Systems (JAUGS) is an approach to standardizing software component interfaces and component behaviors of all anticipated DoD unmanned systems.

Exhibit R-2, RDT&E Budget Item Justification	Date: February 2002
APPROPRIATION/BUDGET ACTIVITY RESEARCH, DEVELOPMENT, TEST & EVALUATION, DEFENSE-WIDE, BUDGET ACTIVITY 4	R-1 ITEM NOMENCLATURE JOINT ROBOTICS PROGRAM PE 0603709D8Z

(U) FY 2001 Accomplishments

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.600 million)

- Continued to update JAUGS based on technology improvements, Joint Technical Architecture (JTA) standards established by DoD, and mission requirements.
- Coordinated JAUGS activities closely with JRP development activities.
- Continued compliance process on JAUGS.
- Updated and improved documentation that described the UGV domain and set performance specifications.
- Incorporated JAUGS into the Robotic Combat Support System (RCSS) contract package.
- Conducted configuration management functions and activities.
- Revised JAUGS Working Group procedures and processes to initiate a National Standards Body's processes.

BASIC UXO GATHERING SYSTEM (BUGS) (0.900 million)

- Expanded both test systems (random search and direct search) to ten vehicles each.
- Initiated testing of ten vehicle systems.
- In FY 2002, the Joint Service EOD program will consolidate BUGS under Joint Service EOD Robotics which will encompass other EOD Robotic activities.

(U) FY 2002 Plans

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.800 million)

- Evolve, refine, and update to achieve greater autonomous mobility, weapons, recon and manipulation. Inputs will be received primarily from user appraisals, fielded systems feedback, and industry/Tech Base development efforts.
- Implement JAUGS throughout the Joint Robotics Program.
- Begin development of the JAUGS compliance suite.
- Continue to improve JAUGS documentation.

(U) FY 2003 Plans

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.900 million)

- Evolve, refine, and update to achieve greater autonomous capability. Inputs will be received primarily from user appraisals, fielded systems feedback, and industry/Tech Base development efforts.
- Complete development of the JAUGS compliance suite.
- Continue to improve JAUGS documentation.

Exhibit R-2, RDT&E Budget Item Justification	Date: February 2002
APPROPRIATION/BUDGET ACTIVITY RESEARCH, DEVELOPMENT, TEST & EVALUATION, DEFENSE-WIDE, BUDGET ACTIVITY 4	R-1 ITEM NOMENCLATURE JOINT ROBOTICS PROGRAM PE 0603709D8Z

B. Program Change Summary ($ million)

	FY2001	FY2002	FY2003
Previous President's Budget	10.294	11.302	11.305
Appropriated Value	13.974	12.802	
Adjustments to Appropriated Value			
a. Congressionally Directed Appropriation Reduction			
b. Congressionally Directed Undistributed Reduction	(0.096)	(0.244)	
c. OSD Directed Program Reduction/Increase	(0.211)		
Current Budget Submit/President's Budget	13.667	12.558	11.305

Change Summary Explanation:
Funding: N/A
Schedule: N/A
Technical: N/A

C. Other Program Funding Summary
Not Applicable.

D. Execution
Not Applicable.

Exhibit R-2a, RDT&E Project Justification							Date: February 2002	
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z				PROJECT/THRUST NAME AND NUMBER JOINT SERVICE EOD ROBOTICS			
Cost ($ in Millions)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete
JOINT SERVICE EOD ROBOTICS	0.000	0.800	0.760	0.800	0.819	0.807	0.804	Continuing

A. Mission Description and Budget Item Justification. The Joint Service EOD Robotics program is a Joint program under the Joint Service EOD – Program Management Office at Indian Head, Maryland. This program office is responsible for lifecycle management of EOD equipment for all the services. This particular program will conduct Concept and Technology Development efforts to determine maturity of existing technology and exploration of new concepts to meet EOD requirements. This effort will continue work done on the Basic UXO Gathering System (BUGS), a prototype system of small semiautonomous platforms operating as teams that can search large areas and detect, pick-up and carry away multiple UXO's. The EOD community has another requirement for a small Man Transportable Robotic System that can conduct EOD tasks to include the use of a manipulator arm to render safe or neutralize unexploded ordnance in confined areas that current systems having difficulty entering and operating. The program will invest effort in product improvements to its Remote Ordnance Neutralization System (RONS) based on needs identified by EOD technicians in the field.

(U) FY 2001 Accomplishments
Not Applicable.

(U) FY 2002 Plans
- Complete prototype development of Basic UXO Gathering System (BUGS) for both random search and direct search utilizing ten vehicles each.
- Conclude BUGS testing and experimentation for both systems in user-developed scenarios.
- Collect data for input to the Submunition Clearance Analysis of Alternatives (AoA) study.
- Initiate Submunition Clearance Analysis of Alternatives study for unexploded submunition clearance.
- Initiate program for the EOD Man Transportable Robotic System.

(U) FY 2003 Plans
- Conclude Submunition Clearance Analysis of Alternatives study for unexploded submunition clearance.
- Develop acquisition strategy and initiate BUGS acquisition program if appropriate.
- Test EOD Man Transportable Robotic Systems.
- Develop and test concepts for improved capabilities for the Remote Ordnance Neutralization System.

B. Other Program Funding Summary
Not Applicable.

Exhibit R-3 Cost Analysis (page 1)								Date:	February 2002				
DEFENSE-WIDE		Program Element						JOINT SERVICE EOD ROBOTICS					
BUDGET ACTIVITY 4		PE 0603709D8Z											
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract	
Primary Hardware Development				0.178		0.212		0.295					
Ancilliary Hardware Development													
Systems Engineering				0.089		0.043		0.050					
Licenses													
Tooling													
GFE													
Award Fees													
Subtotal Product Development				0.267		0.255		0.345					
Remarks:													
Development Support						0.050							
Software Development				0.133		0.050		0.085					
Training Development						0.045							
Integrated Logistics Support													
Configuration Management													
Technical Data													
GFE													
Subtotal Support				0.133		0.145		0.085					
Remarks:													

Exhibit R-3 Cost Analysis (page 2)							Date:	February 2002				
DEFENSE-WIDE		Program Element					JOINT SERVICE EOD ROBOTICS					
BUDGET ACTIVITY 4		PE 0603709D8Z										
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
DT												
IOT&E												
DT												
IOT&E												
User Appraisal				0.133		0.090		0.120				
Subtotal T&E				0.133		0.090		0.120				
Remarks:												
Contractor Engineering Support				0.089		0.090		0.050				
Government Engineering Support				0.089		0.090		0.100				
Program Management Support				0.089		0.090		0.100				
Program Management Personnel												
Travel												
Labor (Research Personnel)												
Miscellaneous												
Subtotal Management				0.267		0.270		0.250				
Remarks:												
Total Cost				0.800		0.760		0.800				
Remarks:												

Exhibit R-2a, RDT&E Project Justification							Date: February 2002	
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z				PROJECT/THRUST NAME AND NUMBER FAMILY OF TACTICAL UNMANNED VEHICLES (FTUV)			
Cost ($ in Millions)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete
FTUV	3.167	0.000	0.000	0.000	0.000	0.000	0.000	Continuing
MPRS	0.000	3.458	3.325	3.450	3.540	3.490	3.480	Continuing

A. Mission Description and Budget Item Justification. Man-Portable Robotic Systems (MPRS) is an Army program involving the U.S. Army Maneuver Support Center (MANSCEN), U.S. Army Infantry Center (USAIC), and the U.S. Army Special Operations Command (SOCOM). A Joint Operational Requirements Document (ORD) is being developed to provide small, man-portable, unmanned ground vehicles to support mission needs in the following areas: Building Reconnaissance, Route Reconnaissance, Vehicle Inspection, Forward Observation/Listening Post, Trip Wire/Booby Trap Detection, Remote Resupply, Move/Carry Equipment, Personnel Evacuation, and Door/Wall Breaching. These mission needs will be typical during Military Operations in Urban Terrain (MOUT). MPRS is a low risk acquisition program which leverages existing UGV technologies as an integral part of the development process to mitigate performance risk. Small unmanned ground vehicles have been provided to the National Guard to support the Civil Support Teams (CST) as contingency assets. The CSTs are first responders during weapons of mass destruction threats.

(U) FY 2001 Accomplishments
- Conducted radio and electronic upgrade on the MATILDA system to support emerging CST requirements.
- Conducted baseline testing of the URBOT system to include radio range testing and mobility testing.
- Conducted a design upgrade program on the URBOT to include new sprockets, tracks, battery packs, and selected software upgrades.
- Supported the deployment of MATILDA systems to the 4th, 5th, and 6th CSTs.
- Provided URBOT system to Cybernet to support a Phase II SBIR on a Wearable Operator Control Unit.
- Developed a 5th URBOT system with enhanced capabilities, to include GPS, higher speed motors, and radio amplifiers.

(U) FY 2002 Plans
- Conduct characterization of small UGVs at Ft. Benning Characterization Course.
- Support the Cybernet Phase II SBIR on a Wearable Operator Control Unit.
- Continue to support the deployment of MATILDA systems to CSTs.
- Integrate Tactical Mobile Robot (TMR) program technologies in the 5th URBOT system.
- Aid the MANSCEN, USAIC, and SOCOM in developing the Joint ORD.
- Provide acquisition guidance in the ORD development process.
- Finalize the fiber optic dispenser technology for small UGVs.

(U) FY 2003 Plans
- Prepare MPRS Milestone documentation.
- Initiate Request for Proposal to start the Concept and Technology Development phase for MPRS.
- Conduct development testing.

Exhibit R-2a, RDT&E Project Justification	Date: February 2002

- Complete user requirements determination.

B. Other Program Funding Summary
Not Applicable.

Exhibit R-3 Cost Analysis (page 1)													
DEFENSE-WIDE			Program Element								Date:	February 2002	
BUDGET ACTIVITY 4			PE 0603709D8Z								MPRS		
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract	
Primary Hardware Development				1.440		1.480		1.376					
Ancilliary Hardware Development													
Systems Engineering				0.864		0.348		0.375					
Licenses													
Tooling													
GFE													
Award Fees													
Subtotal Product Development			0.000	2.304		1.828		1.751					
Remarks:													
Development Support				0.288		0.150		0.200					
Software Development				0.144		0.150		0.092					
Training Development						0.150		0.310					
Integrated Logistics Support				0.288		0.115		0.100					
Configuration Management				0.144		0.115		0.100					
Technical Data				0.144									
GFE													
Subtotal Support			0.000	1.008		0.680		0.802					
Remarks:													

Exhibit R-3 Cost Analysis (page 2)							Date:	February 2002				
DEFENSE-WIDE BUDGET ACTIVITY 4		Program Element PE 0603709D8Z					MPRS					
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
DT								0.288				
IOT&E												
User Appraisal						0.230						
Subtotal T&E			0.000	0.000		0.230		0.288				
Remarks:												
Contractor Engineering Support				0.146		0.207		0.203				
Government Engineering Support						0.200		0.203				
Program Management Support						0.180		0.203				
Program Management Personnel												
Travel												
Labor (Research Personnel)												
Miscellaneous												
Subtotal Management			0.000	0.146		0.587		0.609				
Remarks:												
Total Cost			0.000	3.458		3.325		3.450				
Remarks:												

Exhibit R-2a, RDT&E Project Justification							Date: February 2002	
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z				PROJECT/THRUST NAME AND NUMBER MOBILITY ENHANCEMENTS			
Cost ($ in Millions)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete
MOBILITY ENHANCEMENTS	5.200	1.400	1.340	1.394	1.430	1.420	1.410	Continuing

A. Mission Description and Budget Item Justification. The Mobility Enhancements program is an effort under the U.S. Army Tank-Automotive Research Development and Engineering Center (TARDEC) Intelligent Mobility (IM) Program. Mobility Enhancement will improve the mobility of small unmanned ground vehicles (UGV's) to operate on both improved surfaces and off-road terrain in support of urban warfare, physical security and force protection missions for military police and engineering operations. The Intelligent Mobility program has worked closely with the Center for Self-Organizing and Intelligent Systems (CSOIS) at Utah State University to develop a family of omni-directional vehicles where steering, speed and height of each wheel can be controlled independently maximizing vehicle stability and negotiation of obstacles.

(V) FY 2002 Plans

- Participate in the Engineer school (Ft. Leonard Wood) Concept Experimentation Program.
- Begin Omni-Directional Inspection System (ODIS) function outline and concept of use for physical security and anti-terrorism scenario's and/or applications.
- Conduct baseline testing of the ODIS prototype vehicles, and demonstrate the system to DOJ, CDC, and other agencies for physical security applications.

(U) FY 2003 Plans

- Test ODIS systems.
- Produce Tele-operated ODIS vehicles for User evaluation.
- Marsupial Deployment of ODIS from an MDARS system.
- Deliver a Teleoperated ODIS system to PM-PSE for evaluation in counter-terrorism activities.

(U) FY 2004 Plans

- Further work on Marsupial deployment.
- Enhance sensor and supervised Tele-operation of ODIS, and work on semi-autonomy.
- Continue producing limited quantities of current ODIS version as demand requires.

B. Other Program Funding Summary

Not Applicable.

Exhibit R-3 Cost Analysis (page 1)							Date:	February 2002				
DEFENSE-WIDE		Program Element					MOBILITY ENHANCEMENTS					
BUDGET ACTIVITY 4		PE 0603709D8Z										
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Primary Hardware Development			1.600	0.420		0.315		0.147				
Ancilliary Hardware Development			0.300	0.047		0.063		0.049				
Systems Engineering			0.400	0.070		0.063		0.033				
Licenses												
Tooling								0.033				
GFE												
Award Fees												
Subtotal Product Development			2.300	0.537		0.441		0.262				
Remarks:												
Development Support			0.500	0.140		0.063		0.065				
Software Development			0.700	0.187		0.189		0.196				
Training Development			0.100	0.047		0.062		0.033				
Integrated Logistics Support			0.100	0.033		0.032		0.033				
Configuration Management			0.100	0.033		0.032		0.065				
Technical Data			0.150			0.032		0.131				
GFE												
Subtotal Support			1.650	0.440		0.409		0.523				
Remarks:												

Exhibit R-3 Cost Analysis (page 2)							Date:	February 2002				
DEFENSE-WIDE		Program Element					MOBILITY ENHANCEMENTS					
BUDGET ACTIVITY 4		PE 0603709D8Z										
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
DT												
IOT&E												
User Appraisal			0.350	0.150		0.094		0.194				
Subtotal T&E			0.350	0.150		0.094		0.194				
Remarks:												
Contractor Engineering Support			0.200	0.070		0.063		0.065				
Government Engineering Support			0.100	0.045		0.052		0.053				
Program Management Support			0.100	0.045		0.052		0.053				
Program Management Personnel			0.100	0.045		0.052		0.053				
Travel			0.200	0.023		0.052		0.053				
Labor (Research Personnel)			0.100	0.045		0.063		0.069				
Miscellaneous			0.100			0.061		0.069				
Subtotal Management			0.900	0.273		0.395		0.415				
Remarks:												
Total Cost			5.200	1.400		1.340		1.394				
Remarks:												

Exhibit R-2a, RDT&E Project Justification							Date: February 2002	
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z				PROJECT/THRUST NAME AND NUMBER ROBOTICS FOR AGILE COMBAT SUPPORT (RACS)			
Cost ($ in Millions)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete
RACS	3.800	5.200	4.980	5.170	5.326	5.240	5.250	Continuing

A. Mission Description and Budget Item Justification. The Robotics for Agile Combat Support (RACS) currently addresses (1) urgent and compelling requirements from Air Combat Command (ACC) for a remote platform capable employing a variety of techniques to diagnose and render safe large vehicle bombs (LVBs) and improvised explosive devices (IEDs); (2) needs outlined in the Air Force Agile Combat Support (ACS) Mission Area Plan (MAP) for infrastructure support and force protection; and (3) needs and requirements for remotely detecting, identifying, and safely clearing surface and buried Unexploded Ordnance (UXO). Requirements Documentation is as follows:

a. Agile Combat Support (ACS) Mission Area Plan for FY01
b. Operational Requirements Document for All-purpose Remote Transport System [ORD CAF(USN) 014-93 I/II-A]
c. Mission Need Statement for Active Range Clearance [MNS CAF 306-98]
d. Mission Need Statement for Enhanced Force Protection Capabilities [MNS CAF 314-97]
e. Mission Need Statement for Explosive Ordnance Disposal Capabilities [MNS CAF(USN) 001-97]
f. Mission Need Statement for Autonomous Firefighting Capabilities [MNS CAF 311-90]

(U) FY 2001 Accomplishments

- Developed and applied teleoperated technologies in support of the US Army Corps of Engineers' program for UXO cleanup at Formerly Used Defense Sites (FUDS)
  - Conducted field demonstration at a former military reservation known as Camp Croft in Spartanburg, SC. The US Army Corps of Engineers (Huntsville) demonstrated a robotic alternative to manually conducted clearances within an impact zone. The following remote controlled systems were demonstrated concurrently over a three month period at Ordnance Operable Unit 6 (OOU 6), an area inside Camp Croft.
    - D-8 bulldozer – A jointly developed AFRL/USMC bulldozer pushed the surface contaminated soil down steep terrain to a centralized location for processing.
    - Automated Ordnance Excavator (AOE) – A jointly developed AFRL/NAVEODTECHDIV/AEC excavator transferred the stockpiled material from the D-8 and processed the soil through a sifter/shaker unit.
    - All-purpose Remote Transport System (ARTS) – An OSD/JRP developed system transferred the clean sifted material to a stockpile location for later transport back over the impact zone.
  - Collected data for evaluation of the feasibility of using remote systems.
    - Two previous attempts to clear the impact zone had only cleared a small section of land (10' x 600' to a one foot depth). Our demonstration cleared the entire site (5 acres) to depths of 1-4 feet minimizing the number of anomalies a UXO contractor would have to investigate.
    - Reducing the clearance time from several years to days and saving the Army Corps of Engineers hundreds of thousands of dollars on this site alone.
- Developed and applied advanced robotic technologies for integration onto existing and future unmanned systems platforms.
  - Integrated and demonstrated an articulated fire fighting nozzle mounted and controlled on the ARTS to aid fire fighter in crash/rescue

mission for large aircraft fires.

- Developed an ARTS charge setting tool capability to pickup, place and initiate explosive charge for active range clearance and Base Recovery After Attack (BRAT) missions.
  - Designed and prototyped a tray compartment to house 30 explosive charges along with the ability to drop entire tray.
  - Developed two methods of initiating timer cord (hot igniter coil and electro-magnetic cap).
  - Deployed charge setting unit to 75th CEG/CED (EOD unit) at Hill AFB for user evaluation during Aug – Nov 01.

- Designed and integrated a commercial water cutting tool as an ARTS deployable asset to aid EOD troops ability to access and attack an improvised explosive device.
  - Cooperative effort with the Office of Special Technology who provided two water cutting systems that were designed for integration onto the ARTS platform.
  - Integrated water cutting systems onto the ARTS platform. Developed a cutting head control mechanism to aid in attacking suspect articles.
  - Finalized test plans and scheduled for delivery to the 99th CEG/CED (EOD unit) at Nellis AFB NV in Nov 01.

- Developed 1-mile fiber optic system for deployment to Pacific Air Forces (PACAF) ARTS fleet to answer urgent and compelling need to operate the ARTS with a non-radio frequency communication package.
  - Completed prototype reel assembly and conducted field trials for dispensing and retracting fiber cabling.
  - Completed drawing package and fabrication of six units.
  - Transferring technology package to operate ARTS with fiber optic system to AAC/WMO as part of their Alternate Control System strategy.
  - Deployed six units directly to Air Force bases in Kunsan and Osan, Korea and Misawa and Kadena, Japan .
- Developed an ARTS flail based on previous UGV/S JPO mini-flail project. Two ARTS flails have been deployed to SouthWest Asia to aid in mine clearing/proofing operations.

- Continued development of a Laser Ordnance Neutralization System (LONS) to utilize a directed energy technology integrated on an unmanned platform to "burn" unexploded ordnance (UXO) and improvised explosive devices (IEDs).
  - Investigating the use of a Commercial-Off-The-Shelf (COTS) CO_2 laser applicability to perform at long ranges.
  - Continued design parameters for integration of a laser onto an unmanned system.

- Designed 2nd generation Articulated Remote Manipulator System (ARMS II), a pair of dual arm force-feedback manipulators for transition to a co-sponsored joint project with the Bureau of Alcohol, Tobacco, and Firearms (BATF).

(U) FY 2002 Plans

- Research and develop robotic systems to support of Agile Combat Support/Force Protection missions (i.e., Weapons of Mass Destruction (WMD) threat reduction, UXO disposal, structural protection, physical security).
  - Autonomous Mobility Research and Development Systems (AMRADS).
  - All-purpose Remote Transport System (ARTS).

- Next-Generation EOD Robot Remote Control Vehicle (RCV).
- P-19 Fire Fighting Vehicle.
- Automated Ordnance Excavation (AOE).

- Develop and apply advanced robotic technologies for integration onto existing and future unmanned system platforms in support of Agile Combat Support/Force Protection missions (i.e. WMD threat reduction, structural protection, physical security, mobility).
  - **(Mobility)** Examine existing Commercial-Off-The-Shelf (COTS) units, build custom components for specialized mission requirement, and test these mobility platforms in various mission scenarios.
    - Assessment of commercial and existing platforms for Next Generation EOD Remote Control Vehicle (RCV).
    - High speed vehicle.
    - Light weight platforms.
  - **(Navigation and Sensor Integration)** Investigate acquisition of vehicle system specific parameters for intelligent operations and integrate environmental data acquisition units to detect, classify and characterize environmental features for mission operations.
    - Global Positioning Systems (GPS) combined with Inertial Navigation Systems (INS).
    - Obstacle detection and avoidance.
    - Stereo Vision (depth perception).
    - Forward looking infrared (FLIR) and Night vision for teleoperation.
  - **(Communication)** Determine communications requirements for a network of mobile systems performing a mission.
    - Utilize communication relays, such as marsupial robots.
    - System awareness of location to maintain communications.
    - Non-line-of-sight communication.
  - **(Man/Machine Interface and Control)** Determine requirement for user interface to mobile systems and mission specific tools. Implement both high and low-end user interfaces for multiple mobile systems.
    - Robot-to-robot control (marsupial communication).
    - Multiple vehicle control.
    - Alternate control input (fiber optics).
  - **(Intelligence)** Determine the requirements for intelligent behaviors and implement an expanding intelligence system in the mobile system for mission success. This area includes path-planning, navigation, and intelligent behavior implements.
    - Three dimensional (3D) path planning.
    - Active high speed control.
  - **(Payload Development and Integration)** Develop and integrate the tools needed to perform the mission once the mobility platform reaches the destination. Tools range from an articulated robotic manipulator arm to a simple device to gain entry into a building.
    - Intelligent manipulation.
    - Laser Ordnance Neutralization System (LONS).

(U) FY 2003 Plans

- Research and develop robotic systems to support Agile Combat Support/Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security).
  - Autonomous Mobility Research and Development System (AMRADS).

- Next Generation EOD RCV.
- Robots Support Environmental Security (ROSES).
- Next Generation Small Robotic System (Mark VI replacement).

- Develop and apply advanced robotic technologies for integration onto existing and future unmanned system platforms in support of Agile Combat Support/Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security).
  - **(Mobility)** Examine existing Commercial-Off-The-Shelf (COTS) units, build custom components for specialized mission requirements, and test these mobility platforms in various mission scenarios.
    - Specialized/optimized platforms for Next Generation force protection robotic systems.
    - High speed vehicles.
    - Light weight platforms.
    - Low cost mobility.
  - **(Navigation and Sensor Integration)** Investigate acquisition of vehicle system specific parameters for intelligent operations and integrate environmental data acquisition units to detect, classify and characterize environmental features for mission operations.
    - Global Position Systems (GPS) combined with Inertial Navigation Systems (INS).
    - Scene-based/Visual Navigation.
    - Obstacle detection and recognition (ultrasonic sensors, line scanners).
    - Stereo Vision (depth perception).
    - Forward looking infrared (FLIR) and Night vision for teleoperation.
    - Auto-mapping and database mapping/modeling.
  - **(Communication)** Determine communications requirements for a network of mobile systems performing a mission.
    - Utilize communication relays, such as marsupial robots.
    - System awareness of location to maintain communications.
    - Non-line-of-sight communication.
    - Secure communication schemes.
  - **(Man/Machine Interface and Control)** Determine requirement for user interface to mobile systems and mission specific tools. Implement both high and low-end user interfaced for multiple mobile systems.
    - Robot-to-robot control (marsupial communication).
    - Multiple vehicle control.
    - Augmented Reality Interfaces.
  - **(Intelligence)** Determine the requirements for intelligent behaviors and implement an expanding intelligence system in the mobile system for mission success. This area includes path-planning, navigation, and intelligent behavior implementation.
    - Three dimensional (3D) path planning.
    - Active high speed control.
    - Robotic cooperative behavior.
  - **(Payload Development and Integration)** Develop and integrate the tools needed to perform the mission once the mobility platform reaches the destination. Tools range from an articularted robotic manipulator arm to a simple device to gain entry into a building.
    - Manipulation.
    - Inspection sensors.
    - LONS.

- Projectile Neutralization.

B. Other Program Funding Summary

The United States Air Force (USAF), Headquarters Air Combat Command (ACC) has programmed 3600 funding to support Advanced Research and Development (R&D) and Engineering, Manufacturing, and Development (EMD) for advanced force protection robotic systems designed under the RACS Program. In addition, ACC has programmed 3080 funding for the procurement, fielding, and sustainment of advanced force protection robotic systems/technologies developed under the RACS program.

		FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007
Cost								
	3600 (64617)	0.2	1.7	1.5	1.3	1.2	0.4	0.4
	3080 (28028)	3.8	6.2	4.5	2.4	8.7	5.6	2.1

($ in Millions)

Exhibit R-3 Cost Analysis (page 1)							Date:	February 2002				
DEFENSE-WIDE		Program Element					RACS					
BUDGET ACTIVITY 4		PE 0603709D8Z										
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Primary Hardware Development			0.600	0.867		0.819		1.270				
Ancilliary Hardware Development			0.100	0.371		0.351		0.250				
Systems Engineering			0.050	0.371		0.351		0.250				
Licenses												
Tooling												
GFE												
Award Fees			0.150	0.186		0.117						
Subtotal Product Development			0.900	1.795		1.638		1.770				
Remarks:												
Development Support			0.350	0.433		0.410		0.500				
Software Development			0.300	0.433		0.410		0.500				
Training Development			0.100	0.124		0.059		0.064				
Integrated Logistics Support												
Configuration Management												
Technical Data			0.100	0.124		0.117						
GFE												
Subtotal Support			0.850	1.114		0.996		1.064				
Remarks:												

Exhibit R-3 Cost Analysis (page 2)							Date:	February 2002				
DEFENSE-WIDE		Program Element					RACS					
BUDGET ACTIVITY 4		PE 0603709D8Z										
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2001 Cost	2002 Cost	2002 Award Date	2003 Cost	2003 Award Date	2004 Cost	2004 Award Date	Cost To Complete	Total Cost	Target Value of Contract
DT			0.300	0.681		0.451		0.389				
IOT&E												
Subtotal T&E			0.300	0.681		0.451		0.389				
Remarks:												
Contractor Engineering Support			0.700	0.866		0.720		0.766				
Government Engineering Support			0.100	0.124		0.234		0.258				
Program Management Support			0.150	0.186		0.293		0.319				
Program Management Personnel			0.100	0.124		0.234		0.228				
Travel			0.100	0.124		0.214		0.228				
Labor (Research Personnel)			0.500	0.124		0.100		0.074				
Miscellaneous			0.100	0.062		0.100		0.074				
Subtotal Management			1.750	1.610		1.895		1.947				
Remarks:												
Total Cost			3.800	5.200		4.980		5.170				
Remarks:												