Exhibit R-2, PB 2010 Army RDT&E Budget Item Justification									DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)					R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	242.286	263.879	89.586						Continuing	Continuing
C66: DC66	5.157	.672	2.444						Continuing	Continuing
221: COMBAT VEH SURVIVABLTY	44.207	37.401	22.437						Continuing	Continuing
441: COMBAT VEHICLE MOBILTY	42.452	40.027	47.041						Continuing	Continuing
497: COMBAT VEHICLE ELECTRO	12.686	7.435	7.513						Continuing	Continuing
515: ROBOTIC GROUND SYSTEMS	9.164	10.149	10.151						Continuing	Continuing
53D: NAC Demonstration Initiatives (CA)	37.873	52.227	.000						Continuing	Continuing
53G: FUTURE COMBAT SYSTEMS (FCS)	5.509	11.952	.000						Continuing	Continuing
533: Ground Vehicle Demonstrations	85.238	104.016	.000						Continuing	Continuing

A. Mission Description and Budget Item Justification

The objective of this Program Element (PE) is to develop components and subsystems for ground combat and tactical vehicles in the areas of survivability (project C05), advanced automotive technology (project H77), and tank and automotive technology (project H91). Projects T26 and T31 fund congressional special interest items.

Work in this PE is related to, and fully coordinated with, PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0602618A (Ballistics Technology), PE 06020105A (Materials), and PE 0602705A (Electronics and Electronic Devices). Work in this PE is coordinated with the U.S. Marine Corps , the Naval Surface Warfare Center, and other ground vehicle developers within the Defense Advanced Research Projects Agency (DARPA) and the Departments of Energy, Commerce, and Transportation.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Exhibit R-2, PB 2010 Army RDT&E Budget Item Justification	DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)	**R-1 ITEM NOMENCLATURE** PE 0603005A Combat Vehicle and Automotive Advanced Technology

Work in this PE is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI.

B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	245.629	107.992	87.947	
Current BES/President's Budget	242.286	263.879	89.586	
Total Adjustments	-3.343	155.887	1.639	
Congressional Program Reductions	.000	-.873		
Congressional Rescissions	.000	.000		
Total Congressional Increases	.000	156.760		
Total Reprogrammings	3.119	.000		
SBIR/STTR Transfer	-6.462	.000		

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER C66	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
C66: DC66	5.157	.672	2.444						Continuing	Continuing

A. Mission Description and Budget Item Justification

The purpose of this project is to conduct resesarch on classified efforts. The details of these efforts may be provided to appropriately cleared individuals upon request.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Classified efforts	5.157	.672	2.444	
Total	5.157	.672	2.444	

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 221	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
221: COMBAT VEH SURVIVABLTY	44.207	37.401	22.437						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project matures and demonstrates survivability technologies such as advanced armors, active protection systems (APS), and safety devices. Armors are currently being developed to meet program thresholds and move towards ground combat/tactical vehicle objectives. Additionally, this project focuses on integrating and demonstrating active protection technologies and vision protection to defeat optical attacks. This project looks at the combination of survivability technologies that enable entire protection suites to provide greater survivability than armor alone.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, Michigan; Army Research Laboratory (ARL), Aberdeen Proving Ground, Maryland; Armaments Research, Development, and Engineering Center (ARDEC), Picatinny, New Jersey; and the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville.

B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Vision Protection: This effort matures and demonstrates treatments to optical systems that provide protection from frequency-agile laser weapons. In FY08, completed construction of breadboard targeting system and conducted tests of the fire control camera breadboard for optical and laser protection performance and fabricated protection system for navigation camera. In FY09, complete and validate performance of agile laser protection in future force combat vehicle-type navigation camera and optical fire control breadboards. In FY10, will integrate agile laser protection into a prototype medium range EO/IR sensor; will integrate agile laser protection into a combat vehicle driver's camera. Related work is also being performed in program elements 0602120A, 0602705A, 0602786A and 0602712A.	5.556	3.737	2.499	
Active Protection Systems (APS) against Kinetic Energy (KE): This effort conducts essential trade studies, technical evaluations, and demonstrations of APS components/subsystems designed for protection against KE penetrators. In FY08, integrated matured components into Future Force combat vehicle architecture and hardware for the KE AP system; integrated ARDEC's warhead and fuse package with a missile interceptor being developed at AMRDEC; updated the	17.240	9.652	3.748	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
System Engineering Plan (SEP), Test & Evaluation Master Plan (TEMP), systems architecture, system and component specifications and interfaces; managed and conducted KE APS component testing of warhead, fuse, and interceptor. In FY09, update component and system design specifications and finalize all system interfaces; complete integration support of ARDEC's warhead and fuse package and AMRDEC's interceptor; and test warheads in support of KE APS final demonstration. In FY10, will support final KE APS demonstration with interceptor/system testing, demonstration, and analysis; and will complete component and system design specifications and finalize all system interfaces. Related work is also being conducted under program elements 0602624A, 0603004A, and 0603313A.				
Small Business Innovative Research/Small Business Technology Transfer Programs.	.000	.678	.000	
Armor/Mine Protection: This effort integrates and tests advanced ballistic protection including smart and ceramic armors, advanced composite and laminate structures, and advanced transparent armor formulations. In FY08, matured near-term opaque and transparent armors that defeat RPGs and developed design guidance for future Medium Tactical and Combat Vehicle mine protection; demonstrated initial mine kit designs; developed and demonstrated spin-out armor/transparent armor/RPG protection; and furthered the development of vehicle-level mine response modeling and simulation (M&S) to include vehicle kinematics (motion) response. In FY09, accelerate maturation and demonstration of combat and tactical wheeled vehicle armor recipes and improved mine kit designs against objective threats while reducing armor weights; and further the development of vehicle-level mine response M&S tools to include crew/occupant response to support system level analysis.	9.469	12.590	.000	
High Performance Lightweight Track(Blast Mitigation): This effort improves lightweight track durability and survivability. In FY10, will use M&S to perform blast event analysis on two high performance lightweight track prototypes; and will incorporate analysis results to optimize track design for mine blast/IED survivability. This effort done in coordination with related efforts in PE 0603005A projects 441 and 497.	.000	.000	2.022	
TWV Survivability: This effort focuses on maturing and demonstrating viable integrated survivability suites that can be tailored to meet current and future threats for light, medium, and heavy tactical wheeled vehicles. In FY08, finalized component maturation and initial designs for demonstration vehicle(s); continued to integrate suite designs and conducted studies to determine the impact of various survivability suites on vehicle weight, volume, and power. In FY09, conduct extensive tests on an expanded set of integrated survivability suites on demonstration vehicle(s) to verify and validate	11.942	10.744	10.619	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology	PROJECT NUMBER 221

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
the level of protection achieved, system durability and the impact of the added weight, volume, and power on vehicle performance; complete analysis tool to simulate the effects of mine blast impacts on vehicle and crew; and develop, fabricate, and integrate advanced armors. In FY10, will begin tactical platform active protection prototype system fabrication; will conduct live fire blast and ballistic testing; mobility/durability tests on demonstration vehicles will also be conducted; will assess emerging technologies against current and emerging threats to update optimal suites of integrated survivability technologies; will integrate suite options and deliver test report, lessons learned, and recommendations to ground combat and tactical vehicle developers. Related work is also being performed under program elements 0602601A, 0602618A, and 0602105A.				
Armor Integration: This effort integrates and demonstrates passive, reactive, and electromagnetic technologies for use in active protection armor applications to defeat objective and emerging KE and CE threats. In FY10, will mature passive and reactive armor solutions from PE 0602601/Project C05 and PE 0602618A that defeat objective and emerging threats.	.000	.000	1.215	
Vehicle Integration Laboratory: This effort provides for continuous improvements to ground vehicles to include technology trades, integration, concepts and configuration management designs. In FY10, will develop M&S framework to assess system integration impacts for emerging technologies (i.e. advanced engines, suspensions, survivability technologies) for ground combat and tactical vehicle platforms; will begin lifetime environmental and stability studies of laser protection systems for tactical and ground combat vehicles.	.000	.000	2.334	
Total	44.207	37.401	22.437	

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 441	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
441: COMBAT VEHICLE MOBILTY	42.452	40.027	47.041						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project matures and demonstrates advanced mobility and electric technologies for propulsion, power, and electrical components and subsystems. Mobility technologies are being developed to meet program thresholds and move towards ground combat/tactical vehicle objectives. Additionally this program looks at the integration of mobility technologies to enable lightweight, agile, deployable, fuel efficient, and survivable ground vehicles.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in conjunction with Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs.	.000	1.057	.000	
Power and Thermal Management: This effort demonstrates power and thermal management components and control strategies to meet objective tactical and combat vehicle power requirements. In FY09, mature and demonstrate intelligent power management components and control strategies on system/demo platform. In FY10, will mature and demonstrate advanced intelligent (learn and adaptive) power management components and control strategies on a system platform; and will test, evaluate and demonstrate power and thermal management systems in a relevant laboratory environment. This effort is done in coordination with efforts in 0602601A.	.000	2.706	5.010	
Fuel Cell Power: This effort develops a fuel cell technology as an auxiliary power unit for providing electrical power to combat vehicles. In FY10, identifies ground vehicle system power requirements and space available for fuel cell applications; will create system layout map and perform modeling and simulation; and will begin identifying and testing of fuel cell system components.	.000	.000	4.606	
JP-8 Reformation for Alternative Power Sources:	3.739	.000	.000	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology	PROJECT NUMBER 441

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
This effort matures JP-8 reformer and desulphurization technologies so that JP-8 can utilized as a fuel source for fuel cells used in future military vehicle power applications. In FY08, integrated JP-8 reformer to transportable system and interfaced with fuel cell; optimized key components to make system transportable.				
Advanced Lightweight Track: This effort improves and optimizes lightweight segmented band track technology through utilization of high performance elastomers and component design with the goal of improving track durability and survivability. In FY08, integrated and evaluated performance of the new segmented band track and hybrid steel track on demonstrator vehicles under field conditions with focus on durability and mobility. In FY09, fabricate Hybrid Lightweight Track and conduct vehicle test for durability, mobility, and survivability capabilities to demonstrate a sufficient technology maturity for transition to Future Force manned ground vehicles. In FY10, will mature, fabricate and conduct preliminary vehicle testing of competing advanced lightweight track systems; and will continue development, and testing of an advanced track tensioner. This effort done in coordination with related efforts in PE 0603005A, projects 221 and 497.	3.849	.976	1.968	
Pulse Power: This effort matures and demonstrates compact components and subsystems that enable significantly improved survivability and lethality applications. In FY08, completed development of vehicle-ready version of the 100kW power supply for the Solid State Laser (SSL) to include development, integration and test of high power-density batteries with the Pulse Forming Networks (PFN)/Battery box; improved Electromagnetic (EM) Gun Switch with Silicon Carbide (SiC) based devices; increased High Energy Density (HED) capacitor's life by 25 percent; and increased energy density of HED capacitors to 2.0 J/cc. In FY09, develop active cooling for the High Energy Laser (HEL) pulse power supply allowing greater operational time and increase power/weight efficiency by 40 percent; and develop high voltage-reversal capacitors with extended durability and increased capacity. In FY10, will demonstrate Second Generation SiC based technology at threshold metrics defined by Future Force concepts; will refine the Programmable Pulse Power Supply for field testing at threshold metrics; and will refine designs for active cooling Programmable Pulse Power Supply for HEL.	4.422	3.932	5.047	
Advanced Hybrid Electric Vehicle Components:	3.457	.000	.000	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
This effort advances HEV component technology for increased combat and tactical vehicle mobility, efficiency and mission capability without increasing vehicle weight or volume. In FY08, demonstrated advanced HEV-based modular drive train systems consisting of power sources and energy storage devices under different architectures in the propulsion lab, with focus on developing effective thermal management system architectures and power management control strategies that can be applied to next generation tactical vehicles; and matured and demonstrated system architecture designs for improving reliability, safety, and power consumption strategies.				
Hybrid Electric Vehicle Demonstration and Assessment: This effort refines and demonstrates the maturity of HEVs for military applications, and develops modeling and simulation tools to predict fuel economy and performance characteristics. In FY08, continued analysis and testing of HEVs and modeling and simulation (M&S) excursions to expand lessons learned from military utility assessment and conducted additional experiments and performance tests. The demos also helped update HEV designs and applications to TWVs. In FY09, continue analysis and demonstration of HEVs to focus on M&S excursions with actual demonstrations to validate models and expand lessons learned to quantify fuel economy and performance of Hybrid Demonstrator Vehicles; conduct additional testing on HEVs designed with various architectures.	4.683	4.159	.000	
Ground Systems Power Evaluation: This effort matures and demonstrates power and energy components for propulsion, control systems, communications, life support, electric weapons, and protection systems. In FY10, will demonstrate high temperature power electronics, advanced motors and generator systems; will mature advanced diesel engines for JP8 compatibility and increased thermal efficiency; and will mature and demonstrate components, including traction motor inverters, energy converters and motor generator concepts in integrated hybrid electric (HE) systems for wheeled vehicles.	.000	.000	2.936	
Hybrid Electric Vehicle (HEV) Propulsion and P&E System Integration Lab (SIL): This effort matures and demonstrates power and energy component technologies and assesses HEV performance benefits and burdens. In FY08 completed integration of advanced traction drive into the prototype combat vehicle chassis; optimized architecture for best thermal management; continued reducing electromagnetic interference (EMI) through filtering, shielding, and grounding; and continued to update power and energy mission profiles. In FY09, upgrade electronic architecture and thermal management system on the prototype combat vehicle chassis for continued evaluation in a space constrained vehicle environment; and utilize user-developed scenarios to establish baseline performance of prototype combat vehicle chassis and integrated hybrid electric propulsion system.	4.355	7.046	4.431	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY10, will support testing of HEV components and hybrid electric system for combat platforms; will perform thermal management tests of components that increase heat the transfer capabilities of onboard power electronics, and perform evaluation of high temperature power electronics.				
JP-8 Fuel Cell Reformer System: This effort identifies and demonstrates fuel cell technology, that when integrated with a JP-8 reformer, creates an APU. In FY10, will update JP-8 reformer system layout map and mature system process models; will identify all JP-8 reformer components and technologies that will be used; and will begin reformer component characterization to ensure operational parameters will be met. This effort is done in coordination with efforts in 0602601A.	.000	.000	4.281	
Fuel Efficiency ground vehicle Demonstrator (FED): This effort focuses on demonstrating the viability of achieving significant decreases in fuel consumption without sacrificing tactical vehicle performance or capability. In FY08, used modeling and simulation that exploits advanced materials and construction techniques to design a tactical wheeled vehicle significantly lighter and more fuel efficient than the HMMWV with comparable or improved mobility and survivability; identified potential high pay-off lightweight/fuel efficient designs and components (such as electric/ hybrid electric propulsion systems, high energy density-high efficiency engines, advanced power units, fuel cells, advanced batteries, lightweight armors, electric motors, lightweight/durable suspensions, and energy efficient tires); and select the best design. In FY09, perform extensive model and simulation to identify opportunities to implement technologies. Begin detail design of demonstrator(s) using the identified technologies. In FY10, will complete design of demonstrator(s); and will begin fabrication/integration of the demonstrator(s), and if necessary conduct subsystem testing.	9.295	9.191	4.898	
Propulsion-Prime Power: This effort provides propulsion and power technologies for tactical wheeled vehicles. In FY08, completed and verified system level models of the suspension and propulsion systems; designed TWV engine and fuel injection system for JP-8 operation; and mature Magneto-Rheological (MR) Suspension on Stryker Mobile Gun System (MGS).	8.652	7.782	8.010	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology	PROJECT NUMBER 441

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY09, test and evaluate hybrid electric components for tactical wheeled vehicle application; modify, optimize, and evaluate performance of commercially available engines to enable JP-8 fuel usage; demonstrate, and refine Magneto-Rheological Suspension on Stryker MGS; and perform suspension proof-of-principle (POP) test on Stryker. In FY10 will complete performance and durability testing of modified commercial diesel engines; will integrate and evaluate compact advanced high power density, high operating temperature, components on vehicle platforms; will ruggedize MR suspension hardware and software for endurance testing on Stryker; and will perform vehicle Endurance Testing.				
Non-primary Power Sources (NPS): This effort demonstrates component technologies for energy storage and generation. In FY09, perform laboratory assessment of several advanced high energy/power density battery systems to gauge their suitability for final NPS hardware; and demonstrate advanced power generation technologies to meet NPS requirements. In FY10, will integrate power generation and energy storage system into advanced power and energy vehicle architecture system; and will demonstrate improved engine-off vehicle performance on system demonstrator for silent watch. This effort is done in coordination with efforts in PE 0602601A.	.000	3.178	5.854	
Total	42.452	40.027	47.041	

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 497	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
497: COMBAT VEHICLE ELECTRO	12.686	7.435	7.513						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project matures, integrates, and demonstrates vehicle electronics hardware (displays, sensors, communications systems, and vehicle command/control/driving mechanisms) and software that result in increased crew efficiencies, performance, and/or reduced crew size, and reductions in vehicle maintenance costs. The project advances open system architectures for ground combat vehicles that allow more efficient crew stations to be adapted for a variety of ground platforms. Technical challenges include: increased levels of automation for both manned and unmanned systems, advanced user interfaces that support improved/increased span of control for robotic operations, and collaborative vehicle operations, workload management, reliability of driving aids and commander's decision aids, and embedded simulation for battlefield visualization and fully integrated virtual test/evaluation. Additionally this project matures and demonstrates mobility technologies that reduce the weight as well as the operation and sustainment of ground vehicles.

This work is performed in conjunction with Robotics Collaboration effort described in project 515. The Robotics Collaboration and Intelligent Secure Mobility Work (ISM) work is performed in close cooperation with the Army Soldier Battle Lab.

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP).

Work in this project is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in conjunction with Army Research Laboratory - Human Resources Engineering Directorate (ARL-HRED), Aberdeen, MD.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Robotics Collaboration: This effort matures and demonstrates common scalable user interface software for crew stations, operator control units, and small Soldier portable devices. In FY08, refined task timelines and models in the Intelligent Systems Behavior Simulator (ISBS) environment based on Soldier evaluations and experimental data; finalized design and integration of scalable interface software and intelligent agents into mounted and dismounted system hardware and performed capstone Soldier operational field demonstrations in militarily significant combat scenarios in urban environments capturing all relevant performance data.	12.686	.000	.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs.	.000	.186	.000	
Improved Mobility and Operations Performance through Autonomous Technologies: This effort matures indirect vision technologies to provide the Soldier with full hemispherical situational awareness in closed hatched vehicle operations. In FY09, define the mobility & situational awareness performance/limitations of current indirect vision systems; conduct task and workflow analysis for the mobility and local situational awareness tasks of a vehicle crew; identify key cueing technologies for Soldiers that are dismounting to provide local situational awareness; analyze existing crewstations and software for a baseline mobility and situational awareness task workload experiment; and support design and analysis of two experiments on eye-tracking technologies for operational environments. In FY10, will design and develop enhanced crewstations and software based on mobility and local situational awareness tasks and workload; will design local situational awareness warfighter machine interface for dismounting Soldiers and conduct experiment to assess impact of dismount information tools on local situational awareness; will integrate enhanced crewstation 360/90 Day/Night local situational awareness, assisted mobility, and soldier monitoring/state classification technologies with surrogate platform; and will analyze experiments to capture physiological and physical data from mounted soldiers in operational environments.	.000	6.277	6.524	
Enhanced Vehicle Technologies to Improve Lightweight Track Reliability: This effort will improve/optimize lightweight segmented band track technology through utilization of high performance elastomers and design with the goal of improving track durability. In FY09, analyze data of Failure Mode and Effects Criticality Analysis (FMECA) for High Performance Light-weight Track and a representative current force or baseline legacy counterpart. Analyze data gaps to identify possible sensors and/or indicators that assist in determining the state of health of components/subsystems that are primary cost drivers of track systems. In FY10, will validate a track system diagnostic model to verify dynamic loads and effects of changes in the system; will collect track system vehicle test data and investigate features and conditions in the data that correlate to failure modes; and will perform a limited correlation exercise between diagnostic model, bench test, and track system test data to assess ability to predict system behaviors and / or failures. This effort done in coordination with related efforts in PE 0603005A projects 221 and 441.	.000	.972	.989	
Total	12.686	7.435	7.513	

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology	PROJECT NUMBER 497

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 515	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
515: ROBOTIC GROUND SYSTEMS	9.164	10.149	10.151						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project matures and demonstrates unmanned ground vehicle technologies. The main focus is on integrating and demonstrating in relevant environments sensor technologies, perception hardware and software, and robotic control technologies that enable Unmanned Ground Vehicle (UGV) systems to maneuver on- and off-road at militarily significant speeds with minimal human intervention, thereby enabling the Soldier to perform other mission tasks. Challenges addressed include: obstacle avoidance, overcoming perception limitations, intelligent situational behaviors, command and control by Soldier operators, frequency of human intervention, operations in adverse weather, and robots protecting themselves and their surroundings from intruders. Mature technologies are incorporated in UGV technology demonstrators so that performance can be evaluated for tactical maneuver and sustainment applications.

Work done in this project is complementary to the Robotics Collaboration effort described in project 497 and the Robotic Vehicle Control Architecture effort described in 53G.

The approach builds upon, complements, and does not duplicate previous and ongoing investments conducted under the Joint Robotics Program Office and the Defense Advanced Research Projects Agency, in program element (PE) 0602601A, project H91 (Ground Vehicle Technology) and by the Army Research Laboratory (ARL) PE 0602618A (Ballistics Technology).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI, in collaboration with the Army Research Laboratory (ARL), Adelphi and Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Near Autonomous Unmanned Systems: This effort matures automated tactical behaviors and self security systems that allow unmanned vehicles to perform intelligent tactical maneuvers. In FY08, completed integration and evaluation of tactical behavior algorithms; completed entire suite of tactical behaviors and vehicle self-security system and conducted capstone Soldier-in-the-loop field experiments in a militarily relevant environment and scenarios.	4.717	.000	.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Robotics Collaboration: This effort develops the tools, techniques, and autonomy to maximize mounted and dismounted control of ground and air unmanned systems. In FY08, integrated Soldier-robot teaming and safe-operations algorithms into hardware, conducted Soldier-field demonstration in relevant environment and provided engineering support to the Robotic Vehicle Control Architecture technologies program technical efforts.	4.447	.000	.000	
Small Business Innovative Research/Small Business Technology Transfer Programs.	.000	.285	.000	
Robotic Vehicle Control Architecture (RVCA) Technology: This effort develops UGV end to end control architecture to reduce future technology integration risk and demonstrates the viability of autonomous operations in a relevant environment. In FY09, integrate a prototype Autonomous Navigation System (ANS) onto the UGV platform to test and measure system capabilities; conduct a soldier operational experiment; and finalize platform system development and update with latest software interfaces. In FY10, will finalize RVCA hardware/software designs and interfaces and complete all updates to the Autonomous Platform Demonstrator and will perform engineering evaluations and Soldier operational exercises on the Autonomous Platform Demonstrator to test/measure system capabilities.	.000	4.400	5.266	
Safe Operations of Unmanned systems for Reconnaissance: This effort demonstrates perception, control and tactical behavior technologies to safely conduct urban operations. In FY09, evaluate baseline behaviors that enable Unmanned Ground Vehicles (UGVs) to safely navigate around people and other vehicles in a realistic military testing environment; evaluate specialized classification algorithms for sensor and algorithm fusion; evaluate machine learning and adaptive tactical behaviors; investigate situational awareness and operational procedures to assure safe UGV employment across anticipated missions; assist in the development of UGV safety and testing procedures; and investigate and evaluate modeling and simulation (M&S) tools to evaluate perception/ control algorithms and human-robot interaction. In FY10, will provide quantitative performance data based on demostrations that enable development of Techniques, Tactics and Procedures; will develop mission focused tactical behaviors; and will develop and conduct initial warfighter assessment and engineering evaluations including evaluation of combined mobility/mission workload for UGVs and Unmanned Air Vehicles (UAVs).	.000	5.464	4.885	
Total	9.164	10.149	10.151	

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C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 53D	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
53D: NAC Demonstration Initiatives (CA)	37.873	52.227	.000						Continuing	Continuing

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Thermal Management System	3.092	2.326	.000	
Advanced Thermal and Oil Management Controls	1.545	.000	.000	
High Strength, Powder Metal Gears for Vehicle Transmissions	2.511	.000	.000	
Next Generation Non-Tactical Vehicle Propulsion	1.545	.000	.000	
Hydraulic Hybrid Vehicles (HHV) for the Tactical Wheeled Fleet	.966	.776	.000	
Advanced Composites Development for Light Weight, Low Cost Transportation Systems Using 3+ Extruder	3.092	2.326	.000	
Improved HMMWV Tactical Shelter Project	.967	.000	.000	
Special Operations Vehicle - Lightweight, Armored, Hybrid, Power Generating,Tactical Vehicle	1.546	1.939	.000	
Novel Onboard Hydrogen Storage System Development	2.319	.776	.000	
Next Generation Manufacturing Technologies for Defense Supply Chain	3.092	.000	.000	
Military and Interstate Commercial Truck Component Weight Reduction Program	2.319	.000	.000	
Tactical Wheeled Vehicle Structures for Improved Survivability and Performance	3.864	7.745	.000	
Tactical Wheeled Vehicle Composite Component Weight Reduction Program	2.319	.000	.000	
Armor Ready Composite Cab Transition	2.899	.000	.000	
Diesel Hybrid-Electric Utility Vehicles	1.932	.000	.000	
Field Deployable Fleet Hydrogen Fueling	2.319	.000	.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Fuel Cell Cost Reduction Research	1.546	.000	.000	
Wireless Analysis and Visualization Engines for Sensors (WAVES)	.000	.775	.000	
Enhanced Military Vehicle Maintenance System Demo Project with Anniston Army Depot and Auburn Univ	.000	1.550	.000	
Base Security Systems	.000	1.163	.000	
Joint Combat Support Trailer	.000	3.100	.000	
Alternative Energy Research	.000	19.376	.000	
N-STEP-Enabled Manufacturing Cell for Future Combat Systems	.000	2.325	.000	
Next Generation Non-Tactical Vehicle Propulsion	.000	1.550	.000	
Advanced Drivetrains for Enhanced Mobility and Safety	.000	1.550	.000	
Advanced Digital Hydraulic Hybrid Drive System	.000	1.938	.000	
C4ISR Auxiliary Power Unit (APU) for Soldier Tactical Applications	.000	1.550	.000	
SBIR/STTR	.000	1.462	.000	
Total	37.873	52.227	.000	

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

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APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 53G	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
53G: FUTURE COMBAT SYSTEMS (FCS)	5.509	11.952	.000						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds FCS technologies. When mature, technologies such as armor, active protection system components, power and energy components, and unmanned systems, developed under this project are transitioned into the FCS acquisition program to enable objective capabilities. Current efforts are to demonstrate an Autonomous Platform Demonstrator (APD). The APD effort will develop a large scale, greater than 9 tons, hybrid electric Unmanned Ground Vehicle (UGV). This large sized UGV will integrate, and demonstrate advanced mobility technologies such as: hybrid electric drive systems, suspension systems, and lightweight chassis technologies. This effort supports and collaborates with the Robotic Vehicle Control Architecture program (Project 515) and is critical to effectively evaluate large scale high speed UGVs in a mobile tactical network. This project ends in FY09. Continuing efforts will transition to Project 515. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY08, designed the software architecture for the control of UGVs by Soldier operators, designed and developed the mission execution, computer operating environment, and vehicle management hardware and software as well as sensor management and fusion software for platform and payload control. This work was peformed in coordination with efforts in project 515.	5.509	.000	.000	
In FY09, finalize control architecture designs for the control of UGVs by Soldier operators; finalize designs and finish development of the mission execution, computer operating environment, vehicle management, sensor management and fusion hardware and software for UGV control and integrate components onto the vehicle platform in preparation for engineering evaluations. Related work is also being conducted in the Robotic Vehicle Control Architecture Technology effort in project 515.	.000	11.617	.000	
Small Business Innovative Research/Small Business Technology Transfer Programs.	.000	.335	.000	
Total	5.509	11.952	.000	

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
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D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2a, PB 2010 Army RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 2040 - Research, Development, Test & Evaluation, Army/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603005A Combat Vehicle and Automotive Advanced Technology					PROJECT NUMBER 533	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
533: Ground Vehicle Demonstrations	85.238	104.016	.000						Continuing	Continuing

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Administrative Database Error	3.219	.000	.000	
Hybrid Electric (Heavy Truck) Vehicle	.000	2.325	.000	
Michigan Technological University's Project for Diverse Sensing for Synergistic Force Protection in Urban Threat Environments	.000	.775	.000	
Ground Vehicle Integration Technologies	.000	2.325	.000	
Advanced Hybrid Electric Vehicle Technologies for Fuel Efficient Blast Protected Vehicle	.000	1.163	.000	
Fire Shield	.000	3.100	.000	
Power and Energy Research Equipment Upgrades	.000	5.812	.000	
Advanced Performance Transparent Armor for Tactical Wheeled Vehicles	.000	1.163	.000	
Model-Based Engineering Environment	.000	.775	.000	
Lithium Ion Battery Exchange Program	.000	2.325	.000	
Medium Sized Unmanned Ground Vehicles Platform	.000	1.938	.000	
MRAP Supportability System (MSS)	.000	3.875	.000	
Light Weight Medical Evacuation Unit	.000	1.550	.000	
End-to-End Vehicle Survivability Technology	.000	1.550	.000	
FCV Advanced Suspension System	.000	1.550	.000	

Exhibit R-2a, PB 2010 Army RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Hull Humvee Protection Program	.000	1.938	.000	
Implementation of an Advanced Tactical Wheeled Armored Vehicle System	.000	2.907	.000	
Light Tactical Vehicle Ambulance Shelter	.000	2.325	.000	
Advanced Lightweight Multi-Functional Multi-Threat Composite Armor Technology	.000	2.325	.000	
Payload and Advanced Development for Next Generation Robot Platform	.000	1.938	.000	
Robotics Vehicle Secure Communications	.000	1.938	.000	
Advanced Corrosion Protection for Military Vehicles	.000	2.325	.000	
Lightweight Partial Hybrid Electric Military Transport Vehicle	.000	1.550	.000	
Applied Power Management Control and Integration	.000	.775	.000	
Stryker Second Source Tire Research	.000	.775	.000	
Plug-in Hybrid Vehicle Electrification Program	.000	3.100	.000	
Magneto-Rheological (MR) Suspensions for Tactical Wheeled Vehicles	.000	2.325	.000	
Next Generation Diesel Engine for Ground Vehicles	.000	3.876	.000	
Dynamometer Facility Upgrade Program at TARDEC	.000	3.100	.000	
SBIR/STTR	.000	2.912	.000	
Ground Vehicle Fastening and Joining Research	.773	.000	.000	
Vehicle Maintenance and Prognostics System	2.473	.000	.000	
Robotics Manipulators for Ordnance Disposal	.463	.000	.000	
Universal Diagnostic Data Management System	1.545	.000	.000	
Full Spectrum Close-In Layered Shield (FCLAS) for Thin Skinned Vehicles	1.545	.000	.000	
Lightweight Structural Composite Armor for Blast and Ballistic Protection	1.932	1.550	.000	
3-D Advanced Battery Technology	3.091	3.875	.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Lightweight Composite Armor	1.545	.000	.000	
Antiballistic Windshield Armor (AWA)	3.863	3.488	.000	
Combat Vehicle and Automotive Advanced Technology for the Antiballistic Windshield	1.990	.000	.000	
High Speed Diesel Combustion	3.091	.000	.000	
LEAN Digital Product Development	1.931	.000	.000	
Unmanned Ground Vehicle Initiative (UGVI)	11.590	11.624	.000	
Liquid Desiccant-Based Atmospheric Water Generation without Reverse Osmosis	.869	.000	.000	
Vehicle Armor Structure Development & Testing for Future Combat Systems & JT Light Tactical Vehicle	.966	.775	.000	
No Idle System (NIS)	.966	.000	.000	
Hybrid Engine Development Program for Tactical Wheeled Vehicle Fleet	7.727	.000	.000	
Battlefield Requirements Management Support System	.966	.000	.000	
On-Board Vehicle Power Management	1.545	.000	.000	
Networked Reliability and Safety Early Evaluation System (NRSEES)	1.545	.000	.000	
Vehicle Information Manager Display for Drivers (VMID)	.773	.000	.000	
Crosshairs Hostile Fire Indicating System	2.898	1.938	.000	
Active Protection Systems Initiative for the Joint Light Tactical Vehicle	2.936	.000	.000	
Center for Military Vehicle Technologies	3.941	.000	.000	
Defect-Free Commercially Viable Si/C Semiconductor Using Superlattice Technology	3.091	2.480	.000	
Rotary Multi-Fuel Auxiliary Power Unit M1A1 Abrams Tank	1.932	2.325	.000	
Tactical Rocket Propelled Grenade Airbag Protection System (TRAPS) Enhancement	1.545	.775	.000	
Development of Logistical Fuel Processors to Meet Army/TARDEC/TACOM Needs	2.704	2.713	.000	
Enhanced Directed Armor RPG Vehicle Protection System	.773	.000	.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Secure On-the-Move Information Analysis and Control for Advanced Combat Vehicles	1.545	.000	.000	
Ground Forces Readiness Enabler for Advanced Tactical Vehicles (GREAT-V)	1.545	.775	.000	
Adv Lithium Iron Phosphate Battery Sys for Army Combat Hybrid HMMW V & Other Army Vehicle Platforms	1.545	1.938	.000	
No-Idle Climate Control for Military Vehicles	1.931	1.550	.000	
Diminishing Manufacturing Sources and Material Shortages (DMSMS) Case Resolution Program	1.932	2.325	.000	
High Performance Aluminum Structures and Components	1.545	.000	.000	
Passive Walking Beam Tracked Platform UGV	.967	.000	.000	
Combat Vehicle Electrical Power-21st Century (CVEP-21)	.000	.775	.000	
Ceramic and Metal Matrix Composite (MMC) Armor Development Using Ring Extruder Technology	.000	.775	.000	
Total	85.238	104.016	.000	

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.