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

**June 2001**

BUDGET ACTIVITY
**3 - ADV TECHNOLOGY DEV**

PE NUMBER AND TITLE
**0603005A - Combat Vehicle and Automotive Advanced Tech**

| | COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 197092 | 166571 | 193858 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 221 | COMBAT VEH SURVIVABLTY | 19915 | 28063 | 32160 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 440 | ADV CBT VEHICLE TECH | 127692 | 84933 | 15745 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 441 | COMBAT VEHICLE MOBILTY | 7931 | 7410 | 14732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 497 | COMBAT VEHICLE ELECTRO | 5625 | 2969 | 5616 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 502 | HAECO II | 5727 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 506 | METAL MATRIX COMPOSITES | 6682 | 7927 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 515 | ROBOTIC GROUND SYSTEMS | 0 | 1746 | 9300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 532 | ABRAMS ENGINE | 4773 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 533 | TECHNOLOGY TRANSFER CENTER | 7636 | 4954 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 539 | MOBILE PARTS HOSPITAL | 2864 | 7927 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53B | FUEL CELL AUX POWER UNITS FOR LINE HAUL TRUCKS | 0 | 2972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53C | NATIONAL AUTOMOTIVE CENTER - UNIV INNOVATIVE RSCH | 0 | 2972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53D | NATIONAL AUTOMOTIVE CNTR & WARFIGHTING BATTLE LABS | 0 | 3963 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53E | IMPACT TRUCK PROGRAM | 0 | 4954 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53F | NAC STANDARD EXCHANGE OF PRODUCT MODEL DATA | 0 | 2972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53G | FUTURE COMBAT SYSTEMS (FCS) | 0 | 0 | 111560 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 540 | IMPROVED HMMWV RESEARCH | 5727 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C66 | DC66 | 2520 | 2809 | 4745 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:**
**PLEASE NOTE: This administration has not addressed FY2003-2007**

requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

The goal of this Program Element (PE) is to mature and demonstrate new and improved combat vehicle and automotive technologies to enable transformation of the Army to the Objective Force. Future Combat Systems (FCS), the Army's top priority S&T program, is the primary emphasis of work funded in this PE to support Army Transformation. A large portion of the funds in this PE support the collaborative Army/Defense Advanced Research Projects Agency (DARPA) FCS program and providing support for the FCS analysis function of the Objective Force Task Force. Starting in FY 2002, these funds have been placed in a new project, 53G, in this PE. A Memorandum of Agreement signed by the Army and DARPA in February 2000 delineates the approach, funding and responsibilities. The Army vision calls for strategic dominance across the spectrum of operations. This spectrum of likely operations demands a force that is deployable, agile, versatile, lethal, survivable and sustainable. In addition to system demonstrations, like FCS, this PE supports the following enabling component technology areas: survivability (e.g., Full Spectrum Active Protection (FSAP)), mobility (including a new engine demonstration initiative with a goal to double the power density of a comparable commercial engine to meet FCS power, size, and weight constraints), and intra-vehicular digital electronics. It also integrates diverse vehicle technologies developed by the Army, other DoD agencies and industry. These technologies are demonstrated in coordination with Army warfighter organizations through vehicle component and system level technology demonstrations. In addition to FCS, system level demonstrations also include the Future Scout and Cavalry System (FSCS) Advanced Technology Demonstration (ATD), a cooperative US/United Kingdom program. FSCS ATD will be completed in July FY02 with a robust demonstrator provided by each contractor team to assess the warfighting capabilities of the advanced technology incorporated into the FCS design. The FSCS ATD program is viewed by the US Army as a technology carrier for FCS and, possibly, for the Interim Brigade Combat Team. In coordination with the UK, the Army will extend the FSCS program from its planned completion in July 2002 to April 2003 to further test and demonstrate FSCS technologies that may transition to FCS. This PE is managed by the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), a subordinate organization of the Tank-Automotive and Armaments Command (TACOM), located in Warren, MI. This program adheres to Tri-Service Reliance Agreements on advanced materials; fuels and lubricants; and ground vehicles; with oversight and coordination provided by the Joint Directors of Laboratories. Work in this program element is related to and fully coordinated with PE 0602601A (Combat Vehicle and Automotive Technology). Furthermore, the project is coordinated with the Marine Corps office through the Naval Surface Warfare Center; the Naval Research Lab; Air Force Armaments Command; and with other ground vehicle developers within the Departments of Energy, Commerce, Transportation, and DARPA. 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 TACOM-TARDEC. New projects have been established for Congressional special interest programs not associated with existing programs within this PE. These new projects include the following topics: Metal Matrix Composites, Technology Transfer Center, Mobile Parts Hospital, Fuel Cell Auxiliary Power Units for Line Haul Trucks, National Automotive Center (NAC) - University Innovative Research, NAC and Warfighting Battle Labs, Improved Materials and Powertrain Architecture for 21st Century Trucks (IMPACT), and NAC Standard Exchange of Product Model Data. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

| **B. Program Change Summary** | FY 2000 | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|---|
| Previous President's Budget (FY2001 PB) | 130525 | 148114 | 117403 | 0 |
| Appropriated Value | 131941 | 168114 | 0 | |
| Adjustments to Appropriated Value | 0 | 0 | 0 | |
| a. Congressional General Reductions | 0 | 0 | 0 | |
| b. SBIR / STTR | -3322 | 0 | 0 | |
| c. Omnibus or Other Above Threshold Reductions | -511 | 0 | 0 | |
| d. Above Threshold Reprogramming | 65894 | | 0 | |
| e. Below Threshold Reprogramming | 3995 | 0 | 0 | |
| f. Rescissions | -905 | -1543 | 0 | |
| Adjustments to Budget Years Since FY2001 PB | 0 | 0 | 76455 | |
| Current Budget Submit (FY 2002/2003 PB ) | 197092 | 166571 | 193858 | 0 |

Change Summary Explanation: Funding - FY 2001: Congressional adds were provided for FCS (+46000)( project 440), Composite Armored Vehicle (+4000) (project 440), Silicon Carbide Research (+8000) (project 506), Combat Vehicle and Automotive Technology Weight Reduction (+5000) (project 533), Mobile Parts Hospital Technology (MPHT) Program (+8000) (project 539), Fuel Cell Auxiliary Power Units (+3000) (project 53B), National Automotive Center (NAC) University Innovative Research (+3000) (project 53C), Warfighting Battle Labs (+4000) (project 53D), Improved Materials & Powertrain Architecture for 21st Century Trucks-IMPACT (+5000) (project 53E), and Advanced Combat Vehicle Technology Program (+3000) (project 53F).

The Future Scout & Cavalry Systems (FSCS) ATD was zeroed (-69000)( project 440), but the Congress approved Army reprogramming of FY 2000 funds for the ATD.

(+46000) (project 440) This one-year Congressional add was provided to reduce risk and accelerate the FCS program.

These funds were allocated as follows to support the Army/DARPA collaborative FCS program and key enabling technologies: FCS contractor augmentations (16000), Joint Virtual Battlespace modeling and simulation effort (15800), additional DARPA Netfires contractor (6700), Turbo Fuel Cell Engine (3300), Full Spectrum Active Protection (2000), and Command, Control, Communications and Computers/Intelligence, Surveillance and Reconnaissance Study and Assessment (1000). 1200 was rescinded by Congress.

- (+8000) (project 506) This continues several Congressional adds to develop, test and qualify metal matrix track shoes. No additional funding is required to complete this project.

- (+5000) (project 533) This one year Congressional add develops an extensive ballistic data base on aerospace aluminum-lithium alloys and demonstrates scale-up of Friction Stir Welding technology on a full size, full engineering and manufacturing detail advanced aluminum combat vehicle hull and turret structures for improved ballistic performance and manufacturing producibility.

- (+8000) (project 539) This is the second Congressional add to demonstrate a mobile manufacturing capability to produce automotive parts. No additional funding is required to complete this project.

- (+3000) (project 53B) This one-year Congressional add will evaluate reformer based, diesel fueled fuel cell auxiliary power units (APUs) for military and commercial utilization. No additional funding is required to complete this project.

- (+3000) (project 53C) This one-year Congressional add will develop automotive analysis tools. No additional funding is required to complete this project.

- (+4000) (project 53D) This one-year Congressional add will develop a synthetic collaborative environment to conduct real-time User/Developer design analyses. No additional funding is required to complete this project.

- (+5000) (project 53E) This one-year Congressional add will develop and validate technologies for next generation trucks. No additional funding is required to complete this project.

- (+3000) (project 53F) This one-year Congressional add will supplement 0603005A, project 440 task by fabricating large structural test sections and components for integration into an Integrated Hybrid Structure. No additional funding is required to complete this project.

FY 2002 - Funds were added: for unmanned ground vehicles (5000) to increase their autonomy (Project 515); for competitive demonstration of high power density engines for FCS (Project 441) (10000); to demonstrate active protection while moving (Project 221) (3000); and to further mature FSCS technology to reduce risk for FCS (Project 440) (5000).

Funding increases in FY 2002/2003:
FY 2002 (+29500) and FY2003 (+65000) in project 53G to fully fund Army share of collaborative Army/DARPA FCS program in accordance with the MOA. FY 2002 (+3447) and FY 2003 (+7109) in project 221 funds added to demonstrate full spectrum active protection on the move (versus stationary only). FY 2002 (+20478) and FY 2003 (+38946) in project 53G to increase competition and reduce risk by maintaining second FCS contractor team, and to provide operating resources for the Objective Force Task Force. A one-year NetFires effort is funded in PE 0603313A at 10000; the remaining Army funds for NetFires are in PE 0603005A.

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **221** |

| COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 221 COMBAT VEH SURVIVABLTY | 19915 | 28063 | 32160 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project demonstrates the advanced vehicle protection technologies needed for a force that is survivable across the full spectrum of operations. As combat systems become smaller and lighter to provide the necessary strategic and tactical mobility, providing adequate protection without reliance on heavy armor is one of the greatest technological and operational challenges. The solution involves developing and integrating an optimal suite of protection approaches such as armor, active protection systems (APS), signature reduction, jammers, and decoys. Advanced component technologies for APS that provide protection against threat munitions (e.g., guided and unguided anti-armor munitions) will be integrated, demonstrated and provided to Future Combat Systems (FCS) contractors for incorporation into their designs. Initial APS efforts have been focused on demonstrating the technologies needed for a system that is effective against Chemical Energy (CE) munitions (e.g., anti-tank guided missiles with shaped charge warheads). The ultimate goal is a Full Spectrum Active Protection (FSAP) system which will provide hemispherical survivability against CE threats, plus large caliber tube launched Kinetic Energy and top attack threats. Survivability technologies that are integrated and demonstrated in the laboratory and the field under this project include those technologies transitioned from the following program elements: 0601102A, 0602270A. Major contractors include: United Defense Limited Partnership, San Jose, CA; Sanders, a Lockheed Martin Company, Nashua, NH; TRW, Redondo Beach, CA; Hughes Danbury, Danbury, CN; General Dynamics Land Systems, Warren, MI; Chang Industries, Salt Lake City, UT & Laverne, CA; New Mexico Tech, Socorro , NM; IST, Goleta, CA, Aerojet, Azusa, CA. This program supports the Objective Force transition path of the Transformation Campaign Plan TCP.

**FY 2000 Accomplishments**

- 1547 - Provided program management for APS technology maturation, advanced survivability technologies integration, and other government agency/user/test support.
- 17873 - Completed detailed survivability system design.
  - Performed APS development and subsystem testing under contract with United Defense Limited Partnership (UDLP).
  - Conducted integration of all sensors and countermeasures; tested system in Systems Integration Laboratory (SIL).
  - Demonstrated physical system integration on vehicle test bed mockup; integrated software into vehicle electronic architecture and verified functionality/safety; exercised overall system in SIL.
- 495 - Purchased threat munitions and test assets for integration testing.

Total 19915

**FY 2001 Planned Program**

| | | |
|---|---|---|
| • | 1462 | - Provide program management for APS technology maturation and advanced survivability technologies integration and other government agency/user/test support. |
| • | 15147 | - Conduct APS development and testing of advanced technologies under contract with UDLP; complete APS component integration. |
| | | - Conduct vehicle system integration and complete final checkout. |
| | | - Conduct system and subsystem performance testing; verify functional integration, sensor fusion, and countermeasure performance. |
| • | 818 | - Mature APS radar design and investigate advanced tracking radar technologies for FCS. |
| • | 193 | - Procure test munitions for system testing. |
| • | 4825 | - Design and fabricate extended range sensor capability to detect and track KE threats for FSAP system. |
| | | - Design and fabricate KE defeat countermeasure warheads compatible with a rocket delivery system. |
| | | - Prepare a Coordinated Test Plan. |
| • | 4825 | - Evaluate emerging signature management technologies utilizing survivability optimization modeling to reduce combat vehicle detection probabilities. |
| | | - Conduct an initial test evaluation of emerging signature management technologies to quantify performance. |
| • | 793 | - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs. |
| Total | 28063 | |

**FY 2002 Planned Program**

| | | |
|---|---|---|
| • | 12352 | - Conduct testing to demonstrate defeat of Anti-Tank Guided Missiles, Rocket Propelled Grenades and smart munitions with the survivability system integrated on a surrogate platform. |
| | | - Provide APS hardware, software and design for use in development of a FSAP suite applicable to FCS. |
| | | - Develop final report and video summarizing all testing and accomplishments of the program; develop design guides for vehicle PM use. |
| • | 388 | - Perform distributed interactive simulation for combat fidelity testing and user evaluation. |
| • | 1564 | - Provide program management for APS development and advanced survivability technologies integration and other government agency/user/test support. |

**FY 2002 Planned Program (Continued)**

- 897 - Conduct field testing to evaluate performance of integrated survivability system.
- 5512 - Test and demonstrate tracking radar sensor technology for FSAP KE detection and tracking.
  - Conduct range tests of FSAP KE countermeasure warheads against multiple horizontal and overhead threats.
  - Locate and obtain threats for coordinated test and evaluations.
  - Integrate countermeasure and sensor subsystem models for FSAP performance simulations.
- 5000 - Conduct full scale breadboard testing to quantify field performance and validate signature modeling predictions.
  - Develop virtual models of vehicle integration concepts to predict signature management performance.
  - Mature advanced signature management to prepare for FY 2004-2005 full scale performance testing.
- 6447 - Design and develop control algorithms and platform stabilization hardware for APS on-the-move demonstration.
  - Initiate hardware build of stabilization units.
  - Conduct preliminary testing of stabilization hardware configuration.

Total 32160

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **440** |

| COST (In Thousands) | | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 440 | ADV CBT VEHICLE TECH | 127692 | 84933 | 15745 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project demonstrates the operational potential, technical feasibility and maturity of advanced combat vehicle technologies through integrated demonstrations (e.g., subsystems, systems, and system of systems). Two major initiatives are funded by this project, the FSCS ATD and the initial funding for the collaborative Army/DARPA FCS program as described in the Memorandum of Agreement (MOA) signed February 2000. Starting in FY 2002 Army funds for the Army/DARPA FCS effort have been transferred from this project to project 53G to give them better visibility. Funds for FCS are also contained in PE 0602601, Project HH7, for FY 2001-2002. See project 53G for a description of the FCS program. The objectives of work performed under this project are to demonstrate innovative concepts and combat vehicle configurations, enabling technologies and integration techniques, yielding hardware technology demonstrations, computer simulations and full-scale demonstrations to accomplish a more rapid and seamless transition of advanced technologies into systems applications. All demonstrations include user and developer teaming in field and/or laboratory environments. The FSCS ATD integrates advanced technologies, including sensors, survivability, mobility technologies and communications into a robust vehicle platform. Two consortia, SIKA and Lancer, are operating under firm fixed price contracts awarded by the United Kingdom. Congress zeroed the Army's FY 2001 request for the FSCS ATD without prejudice. In September 2000, the Congress approved reprogramming of FY 2000 funds in the amount of $65.894M for the FSCS Program. Technologies and lessons learned about integration of FSCS technologies on a C-130 transportable platform are important to reduce risk and accelerate development and fielding of the FCS. FSCS ATD will be completed in July FY02 with a robust demonstrator provided by each contractor team to assess the warfighting capabilities of the advanced technology incorporated into the FCS design. The FSCS ATD program is viewed by the US Army as a technology carrier for FCS and, possibly, for the Interim Brigade Combat Team. This program supports the Objective Force transition path of the TCP.

**FY 2000 Accomplishments**

- 18719
  - Evaluated the affordability of hardware and software alternatives and system concepts for FSCS.
  - Completed sub-system and system trade studies to define cost effective hardware configurations for FSCS.
  - Developed simulations and virtual prototypes for FSCS.
  - Conducted UK Ministry of Defense/US Department of Defense System Design Reviews
- 26272
  - Procured hardware and fabricated sub-system assemblies for FSCS.
  - Assembled System Integration Laboratories (SILs) for FSCS.

**FY 2000 Accomplishments (Continued)**

- Performed sub-system testing and evaluation for FSCS.
- Conducted analysis of survivability design alternatives for FSCS.

• 5699
- Performed Cost as an Independent Variable (CAIV) analysis and trade studies for FSCS.
- Completed analysis to support refinement of Combined Operational Requirements Document for FSCS.
- Completed Cooperative Analysis of Alternatives (CAA) to support 3-Star affordability review of FSCS.
- Continued support and participation in Government/contractor IPTs.

• 2898
- Continued modeling and simulation concepts in support of FSCS ATD contractor efforts.
- Investigated application of Joint Tactical Radio System (JTRS) to FSCS.

• 22894
- Perform FSCS trade studies and cost effective alternatives for FSCS for completion in FY 2001.
- Provide affordability data for US/UK 3-Star affordability review of FSCS in FY 2001.
- Incorporate simulation and virtual prototyping results into FSCS development process for completion in FY 2001.
- Perform subsystem and SIL fabrication for FSCS for completion in FY 2001.

• 43000
- Perform fabrication and integration of FSCS demonstrator vehicles for completion in FY 2001.
- Perform fabrication and evaluation of survivability designs for FSCS for completion in FY 2001.
- Perform subsystem test and evaluation for FSCS for completion in FY 2001.
- Perform system shakedown test and evaluation efforts for FSCS for completion in FY 2001.

• 5312
- Initiated collaborative Army/DARPA FCS program containing two major efforts per the MOA , (1) core FCS design/build/demonstration, (2) joint Army/DARPA enabling technologies. Awarded four Section 845 Agreements for the core FCS effort to teams: Full Spectrum, Focus Vision, Gladiator and Boeing to develop system concepts, modeling and simulation, and support government experiments to develop concepts of operations (CONOPS).

- Initiated Army/DARPA FCS Enabling Technologies efforts in Robotic Unmanned Ground Vehicle, Maneuver Command and Control Communications, Maneuver Beyond-line-of-sight (BLOS) Networked Fires Weapon and BLOS Surveillance and Targeting System per MOA; awarded contract for the development of NETFIRES loitering attack and precision attack munitions; initiated a program in autonomous UAV development for perching sensors and communication relays in all weather; initiated a program to look through the canopy LADAR image reconstruction and target recognition technology development.

**FY 2000 Accomplishments (Continued)**

- 2898 - Completed Congressional add, integrated Composite Armored Vehicle technology with aerospace metals into non-traditional structural approaches for a light weight "tracks-over-wheels" chassis.

Total 127692

**FY 2001 Planned Program**

- 7197 - Provide Army's share of funds in support of Army/DARPA FCS concept development for four contractor teams (7752 in PE 0602601A, Project HH7, also supports this effort).
  - Continue develop metrics for evaluation of Objective Force performance; design and demonstrate force-level simulation capability for Objective Force.
  - Conduct technical and operational experimentation in support of system design concepts; demonstrate use of and complete architecture for Integrated Data Environment (IDE).
  - Conduct technology and operation trade-assessments to determine optimum design for each systems concept.
- 28272 - Provide Army's share of funds in support of Army/DARPA FCS enabling technologies as follows:
  - Netfires: produce system prototypes.
  - Autonomous Navigation (Preceptor): Award Section 845 agreement; produce robotic surrogates for testing in FY 2002.
  - Unmanned Ground Vehicle Program: Award ten (10) Section 845 agreements to investigate/study concepts for unmanned ground vehicles.
  - Laser Radar (LADAR) Through Canopy (Jigsaw): Award Section 845 agreement to develop technical approaches for producing a LADAR that can see through canopies.
- 3963 - Complete Congressional special interest program to demonstrate hybrid structure/armor concepts for achieving chassis weight reductions while sustaining high protection levels.
- 45501 - Reduce technical and schedule risk for FCS program by increasing the competition for ideas by the Army/DARPA FCS contractors, increase funds for critical Army enabling technologies, and bolster modeling and simulation to support the Army/DARPA FCS program as follows:
  - Augment Army/DARPA FCS contractor teams.
  - Perform government modeling and simulation to support FCS program.
  - Demonstrate additional, competing Netfires concept.
  - Complete Congressional special interest program to demonstrate turbo fuel cell engine

**FY 2001 Planned Program (Continued)**

- Conduct government C4ISR architecture study and analysis.

Total 84933

**FY 2002 Planned Program**

• 10745 - Conduct combined US/UK user test of FSCS ATD demonstrator vehicles.

- Conduct combined US/UK evaluation and analysis of FSCS ATD demonstrator vehicles and prepare final report.

• 5000 - Continue testing FSCS components and demonstators.

Total 15745

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **441** |

| COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 441 COMBAT VEHICLE MOBILTY | 7931 | 7410 | 14732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project matures and tests vehicle mobility technologies that that will provide lighter, agile, deployable, and more fuel efficient ground combat vehicles needed for FCS and the Army Transformation to the Objective Force. The principal elements of these mobility demonstrations are: active and semi-active suspensions, hybrid-electric drive, and lightweight track. Because commercial engines lack the necessary power density for the power, space and weight constraints of FCS, and fuel cells are not expected to be sufficiently mature for FCS fielding, the Army will demonstrate high power density engines starting in FY02. This competative program will seek to double the power density (horsepower per cubic foot) of a comperable, state-of-the-art, commercial engine. Military requirements for vehicle mobility are unique because of: (1) the need for a stable ride at high speeds (above 20 miles per hour) over cross country terrain for weapon targeting on the move, crew comfort and endurance and accomplish the maneuver-dominant warfare, (2) the need for compact and light vehicle systems to reduce vulnerability of detection, acquisition and attack by enemy weapons, enhanced deployability and reduced logistics burden (e.g., fuel), (3) the need to protect vehicle subsystems under armor (e.g., complicates design of air intake and exhaust systems). Hybrid-Electric drive offers unique capabilities, such as improved performance, silent operation and vehicle design flexibility; however, it presents new challenges, especially in power electronics thermal management. Army efforts in hybrid electric drive have leveraged two joint Army/DARPA programs, Combat Hybrid Power System (CHPS) and the Electric Drive Vehicle Demonstration Program. CHPS successfully transitioned to the Army in FY 2000 with the objective of designing, maturing and testing a robust ground vehicle electrical power architecture in a systems integration laboratory that will support the FCS program. Government partners include: Army Research Laboratory (ARL), Aberdeen Proving Ground, MD; Waterways Experiment Station, Vicksburg, MS; Army Research Laboratory, Adelphi, MD. Major contractors include: General Dynamics Land Systems Muskegon Operations, Muskegon, MI; Pentastar, Huntsville, AL; SAIC, San Diego, CA; United Defense Limited Partnership, San Jose, CA; Michigan Technological University, Houghton, MI; General Electric, Schenectady, NY; and Cadillac Gage Textron, New Orleans, LA. This program supports the Objective Force transition path of the TCP.

**FY 2000 Accomplishments**

- 3292 - Configured and installed an optimized preview sensor on High Mobility Multipurpose Wheeled Vehicle (HMMWV) for active suspension; installed compressible fluid suspension on HMMWV for improved cross-country mobility.
  - Evaluated and selected electric drive components of CHPS for installation on a mobility testbed.
  - Fabricated and began testing of lightweight band track, for 25 ton vehicle, which will reduce weight, lower cost and provide for quieter combat vehicles.
  - Performed shakedown and laboratory performance testing of a compact, high efficiency mechanical transmission.

**FY 2000 Accomplishments (Continued)**

| | | |
|---|---|---|
| • | 2689 | - Transferred the CHPS SIL and Virtual Prototype from DARPA to U.S. Army TARDEC.<br>- Updated the DARPA CHPS Virtual Prototype models based upon information obtained from SIL assessments.<br>- Completed the DARPA CHPS program by demonstrating the feasibility of a hybrid architecture in the completed SIL . |
| • | 1950 | - Began integration of advanced components (e.g., high power/high energy pulse forming network, flywheel, high temperature/fast response converters and advanced high energy density batteries) for assessment in the CHPS SIL. |
| Total | 7931 | |

**FY 2001 Planned Program**

| | | |
|---|---|---|
| • | 2706 | - Install, test, and refine low bandwidth, compressible fluid, active suspension to enable increased combat vehicle mobility and speed over cross-country terrain.<br>- Complete model validation of differential torque steer and mature the control architecture enabling volume-efficient wheeled combat vehicles.<br>- Complete design of advanced high efficiency mechanical transmission enabling reduced vehicular fuel consumption and increased transmission power density.<br>- Fabricate turbocharger, high temperature tribology componentry, cold start system and fuel injection system for application to commercial diesel engines for combat vehicles.<br>- Mature band track with enhanced mine resistant characteristics. |
| • | 2924 | - Mature new system level and component level vehicle power requirements based on the Future Combat Systems (FCS) characteristics. Allocate these requirements down to a vehicle hybrid electric power architecture.<br>- Using the CHPS virtual prototype modeling tools, design vehicle-specific hybrid electric architecture.<br>- Build advanced componentry for incorporation into CHPS SIL architecture which to support the FCS designs. |
| • | 1621 | - Test advanced components (e.g., high power/high energy pulse forming network, flywheel, high temperature/fast response converters and advanced high energy density batteries) for performance assessment in CHPS SIL. |
| • | 159 | - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs. |
| Total | 7410 | |

**FY 2002 Planned Program**

| | | |
|---|---|---|
| • | 4732 | - Test advanced components of CHPS hardware on a mobility test bed to demonstrate robustness and fuel efficiency for combat vehicles. |
| | | - Finalize new system level and component level vehicle power requirements based on results of CHPS SIL testing and experimentation. |
| | | - Finalize vehicular requirements incorporating results of CHPS SIL experimentation representing state of the art validated and fully optimized vehicle hybrid electric power architecture. |
| | | - Finalize advanced componentry design and integrate into vehicular architecture reflecting potential FCS configuration. |
| • | 10000 | - Initiate demonstration of at least two competing high power density engines to meet FCS power, size, and weight constraints (i.e., twice the horsepower per cubic foot and half the weight of comperable commercial engines). |
| Total | 14732 | |

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **497** |

| COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 497 COMBAT VEHICLE ELECTRO | 5625 | 2969 | 5616 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project provides key enabling technologies required to transform the Army to the rapidly deployable Objective Force. It develops and demonstrates intra-vehicle electronics hardware and software technologies that will yield increased crew efficiencies and performance or reduced crew size, and advances open systems architectures for ground vehicle weapon systems. Current efforts leverage semi-autonomous robotics technologies (e.g., automated driving) for application to manned systems to reduce crew work load. Efforts will culminate in an FY 2004 vehicle demonstration of the ability to perform crew functions associated with fighting, performing reconnaissance and carrying troops for a two-man crew vehicle. Goals include a 30% reduction in software cost, a 10 times increase in architecture throughput, and full mission rehearsal via embedded simulation that will be relevant to the FCS. Major contract efforts will include: DCS Corp, Alexandria, VA; Oasis, Troy, MI; and RST, Westminster, MD. This program supports the Objective Force transition path of the TCP.

**FY 2000 Accomplishments**

- 1558 - Completed fabrication and integrated crew stations into testbed.
- 1944 - Completed soldier testing of crew station demonstrator to provide feedback on indirect vision, voice recognition, three-dimensional audio.
- 896 - Integrated synchronized Modular Semi-Automated Forces (MODSAF) and after action review functionality into an embedded simulation system.
- 487 - Performed soldier training on advanced technologies crew stations in crew station SIL.
- 740 - Completed analysis of FCS mission profile and workload to derive requirements for multi-mission (Fight, Scout, Carrier and Unmanned System) crew stations.

Total 5625

**FY 2001 Planned Program**

- 638 - Conduct vehicle test bed data reduction and analysis; identify lessons learned for application to reduced volume crew stations to meet FCS deployability requirements.
- 1934 - Design advanced architecture reduced volume crew stations, incorporating semiautonomous driving and embedded simulation system.
- 344 - Participate in Future Combat Command and Control experiment at Mounted Maneuver Test Facility (Fort Knox, KY) to allow for early FCS experimentation of multi-mission crew stations/systems.
- 53 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 2969

**FY 2002 Planned Program**

- 1250 - Define semi-autonomous driving interface for integration into mobile reduced crew testbed.
- 900 - Adapt cognitive decision aids for ground systems for integration into mobile reduced crew testbed.
- 750 - Mature route planning software for integration into mobile reduced crew testbed.
- 1822 - Complete SIL to allow early evaluation of advanced crew station, electronics architecture and embedded simulation technologies by FCS contractors.
- 894 - Implement testbed architecture in SIL.

Total 5616

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **515** |

| COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 515 ROBOTIC GROUND SYSTEMS | 0 | 1746 | 9300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project has been specifically focused at providing a near-term unmanned system technology to the FCS program. The project funds technological maturation and demonstration of unmanned follower technologies required for multiple, potential tactical and logistics applications. Near-term efforts are oriented toward: (1) demonstrating technologies required for systems to move autonomously over terrain at militarily significant speeds, (2) maturing the technologies for transition to FCS and (3) conducting system of systems field experimentation to allow Warfighter and FCS contractor evaluation of the technologies. The Army's approach builds upon previous and ongoing investments, such as the Demo III program being conducted under the Joint Robotics Program Office with the ARL. The main effort funded in the project is the Robotic Follower Advanced Technology Demonstration (ATD). Additionally, the Army is investing on improving the flexibility and utility of unmanned ground vehicles (UGVs) by applying advanced technologies and algorithms to decrease the frequency of human intervention and direct control and implementing a robotic leader initiative for scout/reconnaissance missions. Technologies proven in robotic demonstrations are expected to be transferable to other unmanned platforms as well as manned platforms to reduce operator workload. This project was established by the Army in recognition of the increasing maturity of robotics technology, growing User interest in unmanned platforms, and an urgent need to make the force lighter, more agile strategically and tactically and more survivable. This program supports the Objective Force transition path of the TCP.

**FY 2000 Accomplishments**

Project not funded in FY 2000.

**FY 2001 Planned Program**

- 627 - Perform analysis of leader follower robotics technologies and supporting operational concepts.
- 582 - Identify baseline and standard architecture for intelligent control of baseline vehicle demonstrator.
- 485 - Develop modeling and simulation capability to support robotics technology analysis for platform integration.
- 52 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 1746

**FY 2002 Planned Program**

- 529 - Model sensors, representative terrain and ARL autonomous mobility algorithms.
- 500 - Complete development of intelligent control architecture.
- 950 - Implement Demo III autonomous mobility algorithms as baseline.
- 900 - Design unmanned follower control interface for manned lead vehicle.
- 1421 - Perform system integration for field demonstration at Technology Readiness Level (TRL) 5 in FY 2003.
- 5000 - Demonstrate perception and control technologies to allow UGVs to operate in a tactical environment with less frequent human intervention than the Robotic Follower.
  - Develop a robotic lead vehicle for a FCS scout mission demonstration.
  - Equip robotic lead platform with Recon sensors for User evaluation.

Total 9300

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - ADV TECHNOLOGY DEV** | **0603005A - Combat Vehicle and Automotive Advanced Tech** | **53G** |

| COST (In Thousands) | | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 53G | FUTURE COMBAT SYSTEMS (FCS) | 0 | 0 | 111560 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:** This project funds the Army's share of the cost shared Army/DARPA collaborative FCS program. This project was established by means of a zero sum transfer of funds from project 440 to separate this project to provide better visibility to this high priority program. DARPA is the executive agent and the majority of the funds in this project are provided to and executed by DARPA in accordance with the MOA signed in February 2000. Under terms of the MOA, the Army committed to provide the following funding: $107M (FY 2002), $122M (FY 2003), $114M (FY 2004) and $111M (FY 2005) for a single contractor demonstration of three of the FCS functions and cost sharing of selected Army/DARPA FCS enabling technologies in Robotic Unmanned Ground Vehicle, Maneuver Command and Control Communications, Maneuver Beyond-line-of-sight (BLOS) Networked Fires Weapon, and BLOS Surveillance and Targeting System. In addition, the Army will provide full funding for demonstration of the other four functions that will make up the entire system-of-systems of the Army/DARPA FCS program. This program responds to a draft Mission Needs Statement issued by the U.S. Army Training and Doctrine Command and the Army Vision. FCS is the centerpiece of the Army's strategy to achieve the Objective Force. It is a multi-functional, system of systems that will be capable across the full spectrum of operations. The Army plans to field FCS in this decade. The program is now in the concept design phase with four Section 845 Agreements in place (funded in Project 440 and PE 0602601A, project HH7). The four teams are: Full Spectrum Team, The Boeing Company, Gladiator Consortium, and FoCus Vision Consortium. In May 2002, DARPA will modify this agreement to select two or more team(s) to continue the development of a final design of their FCS concepts. This modification will expand the efforts to define the details of each of their concepts and provide detailed architectures for Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), software and hardware, and draft plans for logistics support, environmental issues, training, and production (e.g. long lead items, processes). In April 2003, the Army Leadership will make a decision on the technical readiness of one or more of the designs to enter into a final design, build and demonstration phase, and, given an affirmative decision, DARPA will issue a modification to their Other Transaction 845 for up to two Contractor Teams for this final design, system architectures, building of functional demonstrators, and the delivery of detailed design of selected components. Concepts and architectures must be detailed and implementation plans ready to execute. During this final design, integration of the demonstrators, and the demonstration itself, it will be necessary to work concurrently with still developing technology packages to integrate the necessary capabilities into the demonstrator. The system of systems capability will be demonstrated by FY 2006 through a series of demonstrations in conjunction with modeling and simulation. The contractor(s) will be expected to demonstrate the complete set of system of system functionalities and how all the capabilities will be successfully integrated together both hardware and software.
Contractors supporting the FCS program are:
Full Spectrum Team - SAIC, United Defense, SPL, VRI, Omnitech Robotics, LMI, SRI International, ITT Industries, CEM, Northrop Grumman
The Boeing Company - NID, WB&B, VRI, Signature Research, Rockwell Science Center, NIST, Krauss-Maffei Wegmann (KMW)
Gladiator Consortium - IITRI AB Tech Group, Carnegie Mellon, Lockheed Martin, CSC, Battelle, TRW
Focus Vision Consortium - General Dynamics Land Systems, SRI International, Halliburton Company, Coates & Jarratt, Inc

., Raytheon, Honeywell, Electrical & Computer Engineering, Maxwell Technologies, Carnegie Mellon, WB&B, Sensis Corporation, BAE Systems, Aurora, Sensor.com
The final product will be a system of systems that will meet the Army's transformation goals to be strategically and logistically superior in all aspects and will support the Objective Force transition path of the TCP.

**FY 2000 Accomplishments**

Program funded in Project 440

**FY 2001 Planned Program**

Program funded in Project 440

**FY 2002 Planned Program**

- 28586 - Funds Army's share of Army/DARPA collaborative FCS core program as follows:
  - Perform FCS tradeoff and technology analyses; develop detailed cost, schedule, performance objectives; recompete prime contractors for preliminary design phase.
  - Complete force level modeling and simulation efforts to support FCS concepts/Objective force employment and downselect decisions.
  - Complete evaluation of Army/DARPA FCS initial objective force concepts.
  - Select Army/DARPA FCS prime contractors to begin detailed designs of selected demonstrators.
- 79000 - Fund Army's share of the Army/DARPA FCS enabling technologies as follows:
  - Autonomous Navigation (Preceptor); develop detailed design of sensors and preception algorithms for autonomous vehicle designs.
  - Unmanned Ground Vehicle Program; downselect and begin detailed design of 600 Kg and 6000 Kg. unmanned ground combat vehicles.
  - Netfires; finalize missiles design and build hardware for flight test.
  - LADAR through the Canopy (Jigsaw); finalize LADAR design and begin hardware build.

**FY 2002 Planned Program (Continued)**

- 3496 - Provide Army Objective Force Task Force support for FCS analysis and program integration.
- 478 - Initial funding for the other four system functions not provided for in the MOA for Army/DARPA FCS program.

Total 111560