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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)</b>	DATE <b>February 1999</b>
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<b>BUDGET ACTIVITY</b> <b>2 - Applied Research</b>	<b>PE NUMBER AND TITLE</b> <b>0602601A Combat Vehicle and Automotive Technology</b>
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COST ( <i>In Thousands</i> )	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	62141	39208	39749	41625	43743	45771	50679	53313	Continuing	Continuing
DC05 Armor Exploratory Development	6176	6650	8453	9026	9004	9716	10452	11069	Continuing	Continuing
DC84 AC84	1879	461	0	0	984	984	1965	2943	Continuing	Continuing
AH39 Voice Instructional Device	2810	0	0	0	0	0	0	0	0	2810
AH58 Joint Robotic Development Program on Ground Vehicle Survivability	4216	2980	0	0	0	0	0	0	0	7216
AH72 ADAD on Bradley Stinger Fighting Vehicle	3747	0	0	0	0	0	0	0	0	3747
AH77 Advanced Automotive Technology	22702	18653	16646	16664	16593	16614	16888	16909	Continuing	Continuing
AH82 Non-Ozone Depleting Substance Technology	2273	1342	0	0	0	0	0	0	0	3627
AH91 Tank and Automotive Technology	12717	9122	14650	15935	17162	18457	21374	22392	Continuing	Continuing
BH74 Simulation Laboratory	5621	0	0	0	0	0	0	0	0	5621

**A. Mission Description and Budget Item Justification:** This Program Element (PE) advances technologies for affordable and effective ground combat and tactical vehicles. Emphasis is placed on technologies needed for vehicles that are more mobile, affordable, versatile and highly survivable for the post Cold War era. New technologies are needed to achieve more deployable advanced armored vehicles that reflect the Army's need to lighten the force while retaining the ability to survive in diverse, worldwide environments and missions. The majority of the funds in this PE are contained in three projects, AH91, which supports a number of technical thrusts aimed at solving warfighting needs; DC05, which addresses armor technology; and AH77, which funds the National Automotive Center (NAC). The NAC leverages commercial industry's large investment in automotive technology research and development and pursues shared technology programs that are focused on benefiting military ground vehicles. The NAC manages the U.S. Army Tank-Automotive Research, Development and Engineering Center's (TARDEC) Small Business Innovation Research (SBIR) budget and executes selected SBIR projects. The NAC also is a principal Army conduit for DoD Dual Use Application Program and has leveraged over \$50M of industry funding. This PE also supports efforts to identify and evaluate non-ozone depleting fire suppressant alternatives to Halon 1301 for combat vehicles.

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<p>Work in this PE is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Ground and Sea Vehicle Defense Technology Area Plan</p> <p>(DTAP). The PE is managed by the TARDEC, 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. There is no unnecessary duplication of effort within the Army or DoD. The project is coordinated with the Marine Corps office within the Naval Surface Warfare Center and ground vehicle developers within the Departments of Energy, Commerce and Transportation, and the Defense Advanced Research Projects Agency (DARPA).</p>				
<b>B. Program Change Summary</b>				
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (FY 1999 PB)	60162	40107	35403	35639
Appropriated Value	62112	39562		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-1950	-354		
b. SBIR / STTR	-1172			
c. Omnibus or Other Above Threshold Reductions	-386			
d. Below Threshold Reprogramming	+3537			
e. Rescissions				
Adjustments to Budget Years Since <u>FY 1999 PB</u>			+4346	+5986
Current Budget Submit (FY 2000 / 2001 PB)	62141	39208	39749	41625
<p>Change Summary Explanation: Funding - FY 2000 – Increase reflects restructure of funding for proper execution of armor/anti-armor technology programs (+2971) and restructured funding for international cooperative R&amp;D programs in the combat vehicle and automotive technology area (+1375).</p> <p>FY 2001 – Increase reflects restructure of funding for proper execution of armor/anti-armor technology programs (+3707), restructured funding for international cooperative R&amp;D programs in the combat vehicle and automotive technology area (+1279), and increase for wheeled combat vehicles (+1000).</p>				

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COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
DC05 Armor Exploratory Development	6176	6650	8453	9026	9004	9716	10452	11069	Continuing	Continuing
<p><b>Mission Description and Justification:</b> This project lays the technical foundation to solve critical armor deficiencies and improve the survivability of ground combat vehicles against increasingly lethal anti-armor weapons and mines. Supporting the ultimate objective of lighter, more deployable, more survivable vehicles, the emphasis is on armor technologies that will be compatible with current and emerging combat systems (e.g., Abrams, Bradley, Crusader, Future Scout and Cavalry System). The project also develops low-burden solutions to the protection of tactical vehicles in war and operations other than war focusing on appliqué armor for small arms and land mine protection. Armors developed under this project have been applied to tactical vehicles, and this type of technology can be directly attributed to saving lives of U.S. Army soldiers in Bosnia. This project develops armor technologies to complement innovative non-armor survivability techniques such as laser protection described in project AH91 in this PE. Within the broader field of armor development, this project focuses technology on the weight, space, performance, and cost ranges appropriate to ground combat systems: protection of combat and tactical vehicles against such threats as kinetic energy projectiles, explosively formed penetrators, chemical energy warheads, and blast and fragments from land mines. This project draws upon products from Army Research Laboratory programs (e.g., PE 0602618A (Ballistic Technology) project AH80 and PE 0602105 (Materials) project AH84 as well as innovative armors from industry, facilitating the application of armor products from those programs to Army systems. Starting in FY00, Project H81 in PE 0602618A was terminated and funds were transferred from that project to DC05 to better focus armor research. The consolidation of funds from project AH81 into DC05 explains funding growth from FY99 to FY00. In addition to development of specific armor concepts, the project includes supporting work in armor materials, bringing together the collective expertise of the Department of Defense, the Department of Energy, and industrial and academic sources. Supporting work also includes development and refinement of armor performance models to assess armor configurations against different threats with sufficiently high fidelity to make their implementation in vehicles feasible and affordable. Other government agencies include: Jet Propulsion Lab, Pasadena, CA; National Institute of Standards and Technology (NIST), Gaithersburg, MD.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2126 - Developed hybrid reactive armor concept for light weight future combat vehicle systems. <ul style="list-style-type: none"> <li>- Demonstrated light weight flank ballistic protective systems for scout class vehicles.</li> <li>- Demonstrated an advanced overhead protection technology integrating threat defeat with combat vehicle requirements for vision systems and vehicle hatches.</li> </ul> </li> <li>• 1900 - Developed medium caliber kinetic energy (KE) defeat system and structures for protection for medium and heavy class combat vehicles. <ul style="list-style-type: none"> <li>- Developed improved smart armor KE threat defeat sensor to support technology selection for future combat systems.</li> </ul> </li> <li>• 1100 - Developed and validated analytical methods for design of ceramic armors with maximum energy dissipation for defeat of KE threats. <ul style="list-style-type: none"> <li>- Validated armor penetration mechanics model augmented to include energetic armor effects to shorten design cycle and reduce test costs.</li> </ul> </li> <li>• 1050 - Conducted component demonstrations on a tactical wheeled vehicle to include advanced mine protection.</li> </ul> <p>Total 6176</p>										
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<p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1600 - Demonstrate smart armor package defeating KE threats with 35% weight saving, providing the technological basis for protection of lighter vehicles against medium caliber automatic cannon-fired penetrators.</li> <li>• 1307 - Create an armor virtual prototyping system which will use modeling and simulation to shorten the design cycle and reduce the development cost of future vehicles and of armor upgrades to existing vehicles.             <ul style="list-style-type: none"> <li>- Validate methods for ceramic armor design using analytical models to extend the capabilities of the virtual prototyping system.</li> <li>- Demonstrate 25% reduction in typical test cost for armor design through use of the virtual prototyping system.</li> </ul> </li> <li>• 1050 - Complete assessment of electrodynamic armor defeat mechanisms which may offer significant operational benefits for combat vehicles.</li> <li>• 950 - Demonstrate combined armor/signature control configurations.</li> <li>• 1600 - Complete fabrication and demonstration of a prototype wheeled vehicle module for the protected transport of troops in an environment of small arms and mine threats such as was the case in Bosnia and Somalia.             <ul style="list-style-type: none"> <li>- Complete and test survivability appliquéés for tactical vehicles.</li> </ul> </li> <li>• 143 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 6650</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1400 - Develop armors for medium caliber KE threats that are 50% more space efficient than the 1996 state of the art, making possible more compact and deployable combat vehicles.</li> <li>• 1500 - Define and develop lightweight armor systems against a spectrum of threats faced by vehicles in the 18-40 ton weight range.</li> <li>• 1200 - Characterize the debris produced by KE and chemical energy (CE) threats which have been disrupted by prototype Active Protection Systems (APS), to provide the foundation for the lightweight armors that will complement APS to protect combat vehicles.</li> <li>• 1000 - Define, through simulation and component test, the structural and material requirements for integrated multifunctional armor/structure systems that will dramatically reduce the weight of combat systems.</li> <li>• 1500 - Integrate armor configurations from 0602618A/AH80 and material and structure technology from 0602105A/AH84 into multiple armor/structure systems for demonstration in FY 2001.</li> <li>• 1478 - Complete a second generation suite of kit components for increasing the survivability of tactical wheeled vehicle occupants against the small arms and mine threats.</li> <li>• 375 - In partnership with United Kingdom (UK), develop a set of design tools to investigate unique electro-dynamic defeat of anti-armor threats technology constructs for combat vehicle upgrades and concepts.</li> </ul> <p>Total 8453</p>		
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<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2039 - Demonstrate armor systems with 30% greater weight efficiency than the 1996 state of the art against horizontal KE and CE threats, and the capability back up an APS; these armor systems will provide vehicles in the 18-40 ton range with the survivability required by the future battlefield.</li> <li>• 2000 - Develop and demonstrate top attack armor systems to complement future APS with 30% greater weight efficiency than the 1996 state of the art.</li> <li>• 2200 - Demonstrate a series of integrated multifunctional armor/structure systems against the heavy machine gun threat that will offer 25% improved weight efficiency over the Composite Armored Vehicle (CAV), at a projected production cost less than 1.5 times that of the CAV, providing improved survivability at an affordable cost.</li> <li>• 2408 - Develop armor/structure systems with 30% improved efficiency against medium caliber KE and CE threats for demonstration in FY02.</li> <li>• 379 - In partnership with UK, develop a set of design tools to investigate unique electro dynamic defeat of anti-armor threats technology constructs for combat vehicle upgrades and concepts.</li> </ul> <p>Total 9026</p>		
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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>					PROJECT <b>AH39</b>	
COST <i>(In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH39 Voice Instructional Device	2810	0	0	0	0	0	0	0	0	2810
<p><b><u>Mission Description and Justification:</u></b> This Congressionally directed program, managed by the National Automotive Center, funded the design, development and testing of a Voice Instructional Device (VID) for use with fuel tankers, the Palletized Loading System and M1022A1 Dolly Wheeled Hydraulic System. VID is an audio device that can be used by maintenance personnel to perform inspection or hands free repair procedures.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2810 - Completed the FY 97-funded concept exploration and requirements survey effort with updated prototype VID sets and selected field demonstrations.</li> </ul> <p>Total 2810</p> <p><b>FY 1999 Planned Program:</b> Project not funded in FY 1999.</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY 2000.</p> <p><b>FY 2001 Planned Program:</b> Project not funded in FY 2001.</p>										
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BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>				PROJECT <b>AH58</b>		
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH58 Joint Robotic Development Program on Ground Vehicle Survivability	4216	2980	0	0	0	0	0	0	0	7216
<p><b>Mission Description and Justification</b> This Congressionally directed project develops and demonstrates components for robotic and semi-robotic military vehicles which are not specific to any single system. This project integrates vehicle survivability, mobility, intra-vehicular digital electronics, and integration of diverse vehicle technologies developed by the Army, other DoD laboratories and industry. It focuses on two critical areas of deficient performance in robotic and semi-robotic vehicles: mobility and navigation. High priority components are (1) "smart" running gear (e.g., integral in-hub electric drive, tire inflation control, active shock absorption, etc., and sensors for motor torque, wheel velocity, etc.), (2) semi-autonomous navigation (e.g., machine perception hardware and software for terrain characterization, obstacle detection and crossing or avoidance, path selection, and remote operator interface). Improved survivability is a natural by-product of removing the crew from the vehicle which greatly removes the need for armor, and reduces vehicle size to present a smaller target. Robotics has payoffs for manual systems as well by reducing crew workload. Work on this project is consistent with and fills a gap in the Joint Service Unmanned Ground Vehicle Master Plan. The project will also develop a Systems Integration Laboratory (SIL) to assess the compatibility of robotic/semi-autonomous vehicle locomotion and navigation sub-systems, to assess net vehicle performance, to design interfaces, and to optimize/harmonize the performance and characteristics of the subsystems. FY98 Intelligent Mobility Robotics contracts were awarded to Utah State University, Logan, UT; General Dynamics Land Systems, Muskegon, MI; Turing Associates, Ann Arbor, MI; and Tennessee State University, Nashville, TN. This project will be completed in FY99.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2143 - Developed a modular "smart" running gear and demonstrated smart running gear unit scaled for a 2,500 lb. vehicle. <ul style="list-style-type: none"> <li>- Tested and evaluated multi-wheel central command , control and coordination.</li> <li>- Optimized modular electric motor power, size and efficiency.</li> <li>- Developed alternative power efficient distribution systems.</li> </ul> </li> <li>• 2073 - Completed final demonstration and simulation of full scale components. <ul style="list-style-type: none"> <li>- Completed design of a 4,300 square feet Systems Integration Laboratory (SIL) which will house a Modeling &amp; Simulation Lab, a Hot Bench and Test Integration Room, and a Supervised Navigation Test Area. The SIL will be constructed at US Army TACOM-TARDEC in FY99.</li> <li>- Completed development of instrumentation for a reconfigurable remote vehicle operator station for modular robotic technology platforms.</li> <li>- Supported the OSD funded Joint Robotics Program (JRP) Demo III unmanned ground vehicle demonstration.</li> </ul> </li> </ul> <p>Total 4216</p>										
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PROJECT <b>AH58</b>		
<p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"><li>• 2604 - Upgrade contractor's 100lb. robotic vehicle to include z-axis omni-directional steering capability for complete 6-degree of freedom electric wheel control.</li><li>- Improve contractor's existing 1000 lb. robotic vehicle intelligent path planning and control algorithms conditions.</li><li>- Demonstrate scalability of both (100 lb. and 1000 lb.) weight class UGVs to Demo III and man-portable robot applications and follow-on programs.</li><li>- Complete construction of the robotic vehicle SIL for technology test and evaluation.</li><li>• 298 - Participate in Simulation Based Acquisition demonstration for the Total Life Cycle (SIM-TLC).</li><li>• 78 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.</li></ul> <p>Total 2980</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY 2000.</p> <p><b>FY 2001 Planned Program:</b> Project not funded in FY 2001.</p>		
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<i>COST (In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH72 ADAD on Bradley Stinger Fighting Vehicle	3747	0	0	0	0	0	0	0	0	3747
<p><b><u>Mission Description and Justification:</u></b> This Congressionally directed program funds investigation into and demonstration of one or more air defense alerting devices applicable to Bradley Stinger air defense vehicles, Avenger, Linebacker and Light Armored Vehicle-Air Defense.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 1670 - Purchased ADAD system and contracted system technical support.</li> <li>• 1000 - Designed ADAD interface with Bradley Linebacker system and performed integration into a test bed.</li> <li>• 1077 - Designed instrumentation for laboratory and initiated field testing to ADAD at White Sands Missile Range.</li> </ul> <p>Total 3747</p> <p><b>FY 1999 Planned Program:</b> Project not funded in FY 1999.</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY 2000.</p> <p><b>FY 2001 Planned Program:</b> Project not funded in FY 2001.</p>										
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<i>COST (In Thousands)</i>	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH77 Advanced Automotive Technology	22702	18653	16646	16664	16593	16614	16888	16909	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project funds the National Automotive Center (NAC), which leverages commercial industry's large investment in automotive technology research and development and initiates shared technology programs that are focused on benefiting military ground vehicle systems. The NAC, located at the Tank-Automotive and Armaments Command (TACOM), is part of the Tank-Automotive Research, Development and Engineering Center (TARDEC). The NAC serves as the catalyst linking industry, academia and government agencies for the development and exchange of automotive technologies. The NAC executes collaborative research and development (R&amp;D) contracts, cooperative agreements, and other initiatives to leverage commercial industry's investment in well-defined, high return-on-investment areas tied to key Army science and technology objectives for advanced land combat. The NAC focuses collaborative R&amp;D contracts on key military automotive technology thrust areas to include: mobility, electronics, propulsion, logistics, safety and environmental protection with the goal of (a) improving the performance and endurance of ground vehicle fleets, and (b) reducing ground vehicle design, manufacturing, production, and operating and support costs. Two-way industry/government technology transfer is pursued under Cooperative Research and Development Agreements (CRADAs). The NAC also leverages DoD Dual-Use Application Program (DUAP) resources. Industry joint investment under the NAC DUAP programs exceeds \$50M. The activities of the NAC are supported by other government agencies via a linkage created under Memoranda of Agreement, and oversight is provided by a Senior Advisory Board which includes representation from appropriate program executive offices and program managers, the User, the Army staff, the U.S. Marine Corps and OSD. These linkages permit the NAC to consolidate the collective expertise of federal government departments such as Energy, Transportation and Commerce and other DoD agencies. The NAC performs basic research in PE 0601104A, project BH73 (NAC). The NAC also manages the TARDEC Small Business Innovation Research (SBIR) budget, and executes selected SBIR projects. Major contractors include: ARCCA, Inc.; Penns Park PA; FOCUS: Hope, Detroit, MI; Polymer research Corporation, Brooklyn, NY; University of Texas, Austin, TX; Environmental Institute of Michigan, Ann Arbor, MI; Oshkosh Truck Corporation, Oshkosh, WI; Lockheed Martin Inc., Lexington, MA; Rocky Research Inc., Boulder City, NV; USCAR-PNVG/Ford, Dearborn, MI; Cummins Engine Company, Columbus, IN; ICRC Energy Inc., Oakton, VA; Radian, Inc., Alexandria, VA; Baum, Romstedt Technology Research Corp. (BRTRC Inc.), Fairfax, VA; TASC. Inc, Reading, MA; Southwest Research Institute, San Antonio, TX; Hughes Aircraft, Arlington, TX; Electronic Data Systems, Troy, MI; University of Wisconsin, Madison, WI; University of Iowa, Iowa City, IA; Evans and Southerland Inc., Salt Lake City, UT; AB Technologies, Alexandria, VA; Lockheed Martin Control Systems, Johnson City, N.Y.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 7241 - Developed and demonstrated advanced commercial automotive technologies to include: adaptive cruise control; anti-lock braking; active suspension; protective coatings; composite trailer decking; virtual product development enhancements; driver/vehicle interface; micro-auxiliary power units; integrated seat design; tire monitoring; and ceramic coatings for engine components.</li> <li>- Provided \$2M in FY98 funds in the Metal Matrix Composites program to match the \$2M in funding provided in Title III funding.</li> </ul>										
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<p><b>FY 1998 Accomplishments: (continued)</b></p> <ul style="list-style-type: none"> <li>• 3474 - Designed and developed automotive technologies under Dual-Use Application Program (DUAP); projects included: next-generation light truck; smart diagnostics and repair; heavy truck powerpack enhancements; active braking; low-cost infrared imaging sensors; fuel-fired heating, ventilation, air conditioning; advanced fuel injection; recycled polymer and synthetic component materials processing; alloy engine mono-block; lightweight diesel engine; optimized motor and controller; soft-switching inverters; enhanced crash protection.</li> <li>• 1204 - Completed Congressional directed add to increase rated horsepower of a MACK E9 diesel engine by 50%, from 500 HP to 750 HP, while controlling emissions; integrated the engine into a Palletized Loading System (PLS) truck for in-vehicle demonstrations.</li> <li>• 4816 - Completed Congressional directed add to investigate integration of advanced commercial technologies into the remanufacture of the 6.2 liter High Mobility Multipurpose Wheeled Vehicle (HMMWV) diesel engine to reduce dependence on obsolete commercial components, increased use of off-the-shelf current state-of-the-art commercial parts and technologies to improve fuel economy, noise reduction and exhaust emissions; reviewed failure data, performed modeling of potential technical approaches, developed 3D models of basic and redesigned engine configurations and designed and integrated engine changes for new parts.</li> <li>• 3010 Congressional directed add for a Government/University effort to assess and develop promising alternative vehicle propulsion technologies such as natural gas, fuel cell power sources, electric drive systems and other propulsion technologies for military applications; began technical work to demonstrate critical diesel fuel reforming technology for use with fuel cell power systems on a Class 8 commercial truck chassis equipped with a hybrid electric drive system.</li> <li>• 1365 - Completed preliminary demonstration of state-of-the-art high output military vehicle diesel engine technologies that will improve fuel efficiency and performance. <ul style="list-style-type: none"> <li>- Demonstrated a portable blend/filtration system for waste engine oil reutilization for military ground vehicles.</li> </ul> </li> <li>• 1592 - Integrated and demonstrated flat panel display, navigation system, and interactive diagnostic computer into "smart truck" demonstrator. <ul style="list-style-type: none"> <li>- Completed planning for the integration of key advanced commercial automotive technologies (engine, brakes, air conditioning, diagnostics, crash protection) into the light and heavy wheeled vehicle demonstrators.</li> </ul> </li> </ul> <p>Total 22702</p> <p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 13788 - Under the Dual-Use Application Program (DUAP), develop and demonstrate series and parallel hybrid electric drive, engine injection system and supercharger design improvements, improved engine configurations, and advanced lightweight materials; new simulation tools in a distributed interactive environment for real world simulation of ground vehicle operation and analysis of man-machine interface.</li> <li>• 4000 - Integrate key commercial automotive technologies (engine, brakes, air-conditioning, diagnostics, crash protection) into light and heavy wheeled demonstrators and engine, air-conditioning, diagnostics technologies into tracked vehicle demonstrator.</li> </ul>		
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PROJECT <b>AH77</b>		
<ul style="list-style-type: none"> <li>- Integrate commercial computer aided (CAD) components within the automotive based product development software framework (APDF).</li> </ul>		
<b>FY 1999 Planned Program: (continued)</b>		
<ul style="list-style-type: none"> <li>- Build, test and validate redesigned 6.2 L engine, implement changes based on testing results, build two engines, integrate redesigned engine into the HMMWV.</li> <li>- Demonstrate critical diesel fuel reforming technology for use with fuel cell power systems on a Class 8 commercial truck. chassis equipped with a hybrid electric drive system.</li> </ul>		
•	420	- Participate in Simulation Based Acquisition demonstration for the Total Life Cycle (SIM-TLC).
•	445	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.
Total	18653	
<b>FY 2000 Planned Program:</b>		
•	12646	- Develop and demonstrate, under DUAP, technologies to improve fuel efficiency through engine research, hybrid -electric FMTV, Class 8 parallel hybrid electric line haul truck, manufacturing innovation through man-in-the-loop simulation and collaborative design, development of the virtual distributed collaborative environment and creating a vehicle and heavy vehicle equipment virtual proving ground, and enhancing soldier safety through the development of the personal visualization environment.
		- Perform HMMWV vehicle endurance tests with reconfigured 6.2L engine, perform producibility study, conduct O&S cost assessment and analysis.
•	4000	- Integrate key commercial automotive technologies (engine, brakes, air conditioning, diagnostics, crash protection) into the light and heavy wheeled demonstrators and engine, air conditioning, diagnostics technologies into the tracked vehicle demonstrator.
Total	16646	
<b>FY 2001 Planned Program:</b>		
•	12664	- Develop and demonstrate automotive technologies under the Dual-Use Application Program (DUAP) in the areas of fuel efficiency, vehicle modernization, manufacturing, automotive logistics and maintenance improvement.
•	4000	- Integrate key commercial automotive technologies (engine, brakes, air conditioning, diagnostics, crash protection) into the light and heavy wheeled demonstrators and engine, air conditioning, diagnostics technologies into the tracked vehicle demonstrator.
Total	16664	
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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>					PROJECT <b>AH82</b>	
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH82 Non-Ozone Depleting Substance Technology	2273	1342	0	0	0	0	0	0	0	3627
<p><b><u>Mission Description and Justification:</u></b> This project demonstrates environmentally and toxicologically acceptable replacements for Halon 1301 in fire suppression systems in crew occupied compartments of ground combat vehicles. Due to the ozone depleting potential of Halon 1301, the Clean Air Act of 1990 and DoD Directive 6050.9 require that alternate extinguishing agents be identified to maintain current crew and vehicle survivability and supportability. Testing will be performed to meet Tier 1-3 Army Surgeon General and Environmental Protection Agency requirements. Object of this project is to identify and evaluate non-ozone depleting fire suppression substances for application to military vehicles. Investments to date have been successful in identifying two agents suitable for ground vehicle engine compartments. This project complements the DoD Next Generation Fire Suppression Technology Program to identify materials more suitable than currently available alternatives for vehicle crew compartments. System development contractors include Santa Barbara Dual Spectrum, Goleta, CA; Primex Aerospace, Redmond, WA; Pacific Scientific, Duarte, CA; and Walter Kidde Aerospace, Wilson, NC. Alternative agents are purchased from DuPont Inc., Deepwater, NJ and Great Lakes Chemical, Lafayette, IN.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 852 - Continued performance testing of alternative agents.</li> <li>• 861 - Conducted research in fire suppression principles, modeling, and instrumentation under DoD Next Generation Fire Suppression Technology Program.</li> <li>• 560 - Continued tier 3 (long term; up to three years, multiple exposure) chronic toxicology studies for 8 alternative agents. <ul style="list-style-type: none"> <li>- Developed system design guidelines for alternative agents.</li> <li>- Conducted toxicology studies of break-down products determined in the preliminary tier 2 studies for 8 alternative agents.</li> </ul> </li> </ul> <p>Total 2273</p> <p><b>FY 1999 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 977 - Continue performance testing of 6 selected alternative fire extinguishing systems. <ul style="list-style-type: none"> <li>- Complete long-term toxicology studies initiated in previous year.</li> </ul> </li> <li>• 342 - Complete system design guidelines to integrate selected agent and delivery system into affected vehicles. <ul style="list-style-type: none"> <li>- Complete breakdown product studies of 8 alternative agents.</li> </ul> </li> <li>• 23 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 1342</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY00.</p>										
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		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>	
<p><b>FY 2001 Planned Program:</b> Project not funded in FY01.</p>		

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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>					PROJECT <b>AH91</b>	
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH91 Tank and Automotive Technology	12717	9122	14650	15935	17162	18457	21374	22392	Continuing	Continuing
<p><b>Mission Description and Justification:</b> This project provides innovative vehicle concepts and component technologies leading to product improvements to fielded equipment and to the development of advanced systems that will enable the Army to maintain superiority to fight and survive against diverse threats. Conceptual designs, virtual prototyping, and performance analyses and battlefield wargaming of ground vehicle systems identify promising emerging technologies in support of approved and emerging U.S. Army Training and Doctrine Command (TRADOC) requirements. They also quantify benefits, burdens and trade-offs related to ground vehicle applications. The project includes eight areas: (1) vehicle concepts; (2) mobility; (3) integrated survivability; (4) vehicle electronics (VETRONICS) and intra-vehicle digitization; (5) advanced vehicle structures; (6) simulation/analysis; (7) military fuels and lubricants; and (8) water purification technology. Technology initiatives are being pursued to address advanced mobility, survivability and lethality requirements of lighter, digitized, more deployable vehicles. Activities are closely coordinated through the Army Training and Doctrine Command's Mounted and Dismounted Battlespace Battle Labs; Program Executive Office for Ground Combat and Support Systems; and the Army Research Laboratory (ARL), and the Defense Advanced Projects Research Agency (DARPA). This coordination increases opportunities for transition of advanced technologies into ground vehicles. Tank and automotive virtual prototyping provides seamless sharing of databases/engineering models, allowing more rapid and efficient integration, assessment and transfer of DoD and commercial vehicle technologies. Vehicle electronics will be based on adapting commercial electronic standards and architectures for combat vehicle battlefield unique requirements. The survivability technologies, which include non-armor approaches such as signature reduction, countermeasures, active protection, and damage reduction, complement, but do not duplicate, work performed under the armor exploratory development project (DC05) in this PE. Other government agencies include: Defense Advanced Research Projects Agency, Arlington, VA; Oakridge National Laboratory, Oakridge, TN; Red River Army Depot, Texarkana, TX. Major contractors include: Cadillac Gage Textron, New Orleans LA; Soucy International, Drummondville, Quebec; Pentastar, Huntsville, AL; Michigan Technological University, Houghton, MI; United Defense Limited Partnership, San Jose, CA; University of Texas, Arlington, TX; Oakland University, Rochester Hills, MI; Gonzales Engineering, Troy, MI; Boeing Corporation, St. Louis, MO; University of Dayton Research Center, Dayton, OH; Monterey Technologies Inc., Monterey, CA; DCS Corp, Alexandria, VA.; Texas Instruments, Dallas, TX; Southwest Research Institute, San Antonio, TX; Separation Systems Inc., San Diego, CA, Scientific Systems, Boston, MA; University of California, Berkley, CA.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>4725 - Developed multiple vehicle concepts and performed technology surveys and assessments in support of TRADOC Integrated Concept Teams (ICTs) and Army Integrated Idea Team (IIT); concepts were used to establish requirements, determine payoffs and set technology development goals.             <ul style="list-style-type: none"> <li>- Performed subsystem integration assessments for advanced technology for future combat vehicles and develop refined concepts based on emerging combat vehicle requirements.</li> </ul> </li> </ul>										
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>	PROJECT <b>AH91</b>
<b>FY 1998 Accomplishments: (continued)</b>		
<ul style="list-style-type: none"> <li>- Conducted an evaluation and refined the virtual prototyping architecture, verifying the ability to reduce development time, cost and testing requirements when used in place of traditional development methods; initiated immersive ergonomic interactive solid models with rapid feedback in multiple databases.</li> </ul>		
<ul style="list-style-type: none"> <li>• 4692</li> </ul>	<ul style="list-style-type: none"> <li>- Integrated roll control to semi-active suspension for a scout class vehicle to increase vehicle speed, and platform stability; tested band track at increased roadwheel unit loading; developed band track components for vehicle applications in the 25 ton weight class and investigated mine resistant track technology.</li> <li>- Completed a contracted study to define technology for combat vehicle diesel engine and propulsion system and proposed methods for propulsion system volume reduction; completed single cylinder engine component redesign; completed high temperature synthetic lubricant test; fabricated single cylinder ceramic coated piston test (Army part of US-Japan cooperative research agreement).</li> <li>- Completed demonstration of an innovative water purification technology to improve flow rate, shelf life, increased temperature and pH range and chlorine tolerance.</li> </ul>	
<ul style="list-style-type: none"> <li>• 2974</li> </ul>	<ul style="list-style-type: none"> <li>- Performed study of optimum survivability suites for a scout class vehicle that led to the initial design of an integrated signature-ballistic side armor system.</li> <li>- Demonstrated feasibility of a fiber bundle periscope, completed optical system design using holographic diffuser, and performed laboratory analysis of laser limiting materials provided by U.S. Army Natick Research, Development and Engineering Center.</li> <li>- Developed three-dimensional (3D) audio, voice recognition and headtracker concept alternatives for future integration into mobile reduced crew testbed.</li> </ul>	
<ul style="list-style-type: none"> <li>• 326</li> </ul>	<ul style="list-style-type: none"> <li>- Completed the NAC managed Congressional add for Focus: HOPE for advanced material manufacturing process effort; demonstrated design and development of the machine cell required to support production of diesel engine components for Army ground vehicles.</li> </ul>	
Total	12717	
<b>FY 1999 Planned Program:</b>		
<ul style="list-style-type: none"> <li>• 1078</li> </ul>	<ul style="list-style-type: none"> <li>- Perform concept analysis for combat and combat support vehicle systems, with emphasis on a medium weight strike force, in support of the development of emerging operational requirements.</li> </ul>	
<ul style="list-style-type: none"> <li>• 4059</li> </ul>	<ul style="list-style-type: none"> <li>- Develop electric actuator for active suspension units; evaluate semi-active suspension potential via simulation for improved ride and platform stability with roll control in 25 ton combat vehicle class; support development of increased durability nitrile rubber track and determine optimal mine resistant track technology.</li> <li>- Identify and down select fuel energy enhancement material; screen and test fuel additives.</li> <li>- Conduct high temperature lubricant evaluations on a multi-cylinder engine; conduct high temperature, high nickel alloy head material and coated piston test on high temperature capable single cylinder engine; leveraging with international cooperative research and development funds, conduct high power density test on a technology screening engine (Army part of US-Japan cooperative research agreement).</li> </ul>	
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>	PROJECT <b>AH91</b>
<ul style="list-style-type: none"> <li>• 3291 - Demonstrate retrofittable wide angle optical viewing system design which can incorporate laser limiting materials.</li> </ul>		
<b>FY 1999 Planned Program: (continued)</b>		
<ul style="list-style-type: none"> <li>- Develop family of new, hybrid structures concepts and candidate integrated signature-ballistic armor system for light and medium weight future vehicle systems with detectability and real density reductions; establish baseline vehicle concepts, defense zones, and zone specific design criteria.</li> <li>- Determine constraints, performance requirements, and analyze unique active protection hemispherical and KE countermeasures for universal threat application.</li> <li>- Evaluate concept alternatives for voice recognition, 3D audio, and indirect vision driving; select approach, and conduct detailed design for future integration into mobile reduced crew testbed.</li> </ul>		
<ul style="list-style-type: none"> <li>• 694 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul>		
Total 9122		
<b>FY 2000 Planned Program:</b>		
<ul style="list-style-type: none"> <li>• 6242</li> </ul>	<ul style="list-style-type: none"> <li>- Perform concept studies of combat and combat support systems ranging from near term mods to existing systems to mid and far term advanced systems in support of the development of emerging operational requirements documents and tech development; perform technology assessments and subsystem integration studies for future combat vehicles in support of the U.S. Army Training and Doctrine command and Headquarters.</li> <li>- Develop advanced alternative vehicle platform concepts and perform associated analysis for novel vehicle concepts that provide very high strategic and tactical mobility.</li> </ul>	
<ul style="list-style-type: none"> <li>• 3486</li> </ul>	<ul style="list-style-type: none"> <li>- Design and fabricate wheeled vehicle semi-active suspension; conduct field testing of the Electromechanical Suspension System (EMS) installed in the HMMWV to evaluate active suspension under strenuous cross country conditions including steering and braking at high speeds; use the field test data to fully tune vehicle handling algorithm for safe cross country operations.</li> <li>- Conduct multi-cylinder engine dynamometer endurance testing on candidate energy enhancement materials; conduct engine emissions testing on candidate energy enhancement materials; initiate engine-fuel-lubricant compatibility evaluations with candidate energy enhancement materials.</li> <li>- Initiate Phase II evaluations of JP 8+100; conduct dynamometer test to assess impact of +100 fuel additive in ground engines, initiate investigation of JP 8+100 effect to particle size distribution.</li> </ul>	
<ul style="list-style-type: none"> <li>• 2922</li> </ul>	<ul style="list-style-type: none"> <li>- Develop optical hardware for retrofittable wide angle optical viewing system which can incorporate laser limiting materials.</li> <li>- Analyze/optimize concept alternatives for ballistic and structural loads and project weight savings for each and complete the demonstration and optimization of an integrated signature-ballistic side armor system and transition hardware designs into future vehicle programs; define alternative structural design concepts for each zone; conduct preliminary design analysis; define alternative armor attachments and integrate candidate zone design concepts into alternative "hybrid" vehicle designs.</li> <li>- Conduct initial active protection countermeasure and sensor field evaluations based on FY99 analysis.</li> </ul>	
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 1999</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>	PROJECT <b>AH91</b>
<p align="center">- Evaluate concept alternatives for semi-autonomous driving using robotics technology, select approach, and define architecture for integration into mobile reduced crew testbed.</p>		
<p><b>FY 2000 Planned Program: (continued)</b></p>		
<ul style="list-style-type: none"> <li>• 2000</li> </ul>	<p>- Continue to develop, test and characterize advance materials including ceramics, high temperature combustion optimization, low heat rejection technology, and advanced friction and wear phenomena (cooperative project with Japan).</p>	
<p>Total</p>	<p>14650</p>	
<p><b>FY 2001 Planned Program:</b></p>		
<ul style="list-style-type: none"> <li>• 7130</li> </ul>	<p>- Perform concept studies, and associated analysis of combat and combat support systems ranging from near term modifications of existing systems to mid and far term advanced systems in support of the development of emerging operational requirements documents and tech development.</p>	
<ul style="list-style-type: none"> <li>• 3250</li> </ul>	<p>- Develop Future Infantry Vehicle (FIV) virtual prototype and perform detailed assessments in mobility, survivability, lethality, deployability and cost to prepare for follow-on tech demo in FY02 (Program supports TRADOC approved Mission Needs Statement (MNS) and TRADOC Heavy Forces Modernization Plan.</p>	
<ul style="list-style-type: none"> <li>• 2403</li> </ul>	<p>- Install and test wheeled vehicle semi-active suspension; complete electromechanical active suspension algorithm refinement for wheeled vehicles and investigate electromechanical active suspension application for hyper-mobility in combat vehicles.</p>	
<ul style="list-style-type: none"> <li>• 1152</li> </ul>	<p>- Continue engine-fuel-lubricant compatibility evaluations with candidate energy enhancement materials, enhance lubricants products to operate successfully with energy enhancement material, initiate field testing of energy enhanced materials; expand dynamometer tests to address other engine types; investigate onboard vehicle coalescer/filter to work with +100 additive complete particle size investigation.</p>	
<ul style="list-style-type: none"> <li>• 2000</li> </ul>	<p>- Demonstrate retrofittable wide angle optical viewing system incorporating laser limiting materials.</p>	
<ul style="list-style-type: none"> <li>• 2000</li> </ul>	<p>- Conduct simulations to determine viable system concept designs and complete active protection component countermeasure and sensor field evaluations.</p>	
<ul style="list-style-type: none"> <li>• 2000</li> </ul>	<p>- Evaluate/validate performance levels via component structural and ballistic tests; perform preliminary structural and weight analysis of candidate "hybrid" vehicle designs; develop preliminary structural and ballistic performance with small element tests.</p>	
<ul style="list-style-type: none"> <li>• 2000</li> </ul>	<p>- Design and develop Commander's Graphical User Interface (GUI) for semi-autonomous driving for future integration into mobile reduced crew testbed.</p>	
<p>Total</p>	<p>15935</p>	

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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602601A Combat Vehicle and Automotive Technology</b>					PROJECT <b>BH74</b>	
COST (In Thousands)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
BH74 Simulation Laboratory	5621	0	0	0	0	0	0	0	0	5621
<p><b>Mission Description and Justification:</b> This Congressionally directed program funded the completion of a modernization program of the Physical Simulation Laboratory at the U.S. Army Tank-Automotive Research, Development and Engineering Center. This effort integrated the virtual proving ground into the laboratory environment for engineering development and Synthetic Theater of War (STOW) exercises. This capability enabled the motion bases to be networked to the simulation community, allowing high fidelity interactive experiments for the evaluation of engineering related issues and soldier/machine interfaces. Through this upgrade, program managers of ground combat and support, combat mobility, and tactical vehicles have a simulation facility to determine battlefield effectiveness using fewer prototypes. Other elements of the work effort resulted in (1) upgrading hydraulic power supply and its cooling loop (cooling tower) which are necessary to provide the required oil pressure and flow to the motion bases, (2) improvements to existing tactical vehicle durability simulators, and (3) a military vehicle mass and inertia measurement device. The effort improved hardware/soldier-in-the-loop simulation using motion bases, an upgraded and more reliable hydraulic power supply, and more accurate tactical vehicle dynamics models. This effort has been completed, therefore, the Army has not budgeted any out-year funding.</p> <p><b>FY 1998 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 3050 - Completed installation and integration of real-time motion base simulation technology into existing motion based simulator to enhance realism . - Conducted demonstrations of weapon and soldier in the loop simulations for vehicle program managers.</li> <li>• 1756 - Completed installation of hydraulics and cooling system for multiple simulators.</li> <li>• 815 - Completed installation of tactical vehicle characterization fixture for better model fidelity.</li> </ul> <p>Total 5621</p> <p><b>FY 1999 Planned Program:</b> Project not funded in FY 1999.</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY 2000.</p> <p><b>FY 2001 Planned Program:</b> Project not funded in FY 2001.</p>										
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