Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army												Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	89.852	67.232	70.450	-	70.450	69.169	75.717	74.564	76.019	0.000	523.003
C05: *Armor Applied Research*	-	22.842	21.428	21.492	-	21.492	17.205	17.141	17.924	18.259	0.000	136.291
H77: *National Automotive Center*	-	15.347	17.977	12.094	-	12.094	12.423	14.929	15.288	15.594	0.000	103.652
H91: *Ground Vehicle Technology*	-	26.663	27.827	36.864	-	36.864	39.541	43.647	41.352	42.166	0.000	258.060
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

A. Mission Description and Budget Item Justification

This Program Element (PE) researches, designs, and evaluates combat and tactical vehicle automotive technologies that enable the Army to have a lighter, more survivable, more mobile and more deployable force. Project C05 investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), hit avoidance, kill avoidance, safety, sensors, counter-measures, instrumentation, and survivability packaging concepts to achieve superior survivability/protection for Soldiers and military ground vehicles. Survivability technologies will be designed for integration into/with the Modular Active Protection System (MAPS). Project H77 funds the National Automotive Center (NAC), which was chartered by the Secretary of the Army to conduct shared government and industry, or "dual use", technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Project H91 designs, matures, and evaluates a variety of innovative and enabling technologies in the areas of electrical power, thermal management, propulsion, mobility, power for advanced survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy-enabled systems, and other component technologies to enhance the mobility, power and energy, and reduce the logistic chain of combat and tactical vehicles. This PE executes the Army's Combat Vehicle Prototyping (CVP) program to mature, integrate, and demonstrate ground vehicle leap ahead technologies in support of future combat vehicles.

Work in this PE is related to, and fully coordinated with, PEs 0602105A (Materials Technology), 0602618A (Ballistics Technology, Robotics Technology), 0602705A (Electronics and Electronic Devices), 0602716A (Human Factors Engineering Technology), 0603005A (Combat Vehicle and Automotive Advanced Technology), 0603125A (Combating Terrorism - Technology Development), 0603734 (Military Engineering Advanced Technology), and 0708045A (Manufacturing Technology).

Work in this PE is coordinated with the United States Marine Corps, the Naval Surface Warfare Center, and other ground vehicle developers within the Defense Advanced Research Projects Agency (DARPA) and the Departments of Energy, Commerce, and Transportation.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy in New combat vehicle, Armor, Robotics/Autonomy.

The Ground Portfolio technology investments are creating a layered vehicle protection suite including Active Protection (Hard-Kill and Soft-Kill) capabilities supported by robust advanced armor (Enhanced Survivability).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*

Work in this PE is performed by the Army Research Development and Engineering Command (RDECOM)

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	67.959	67.232	68.826	-	68.826
Current President's Budget	89.852	67.232	70.450	-	70.450
Total Adjustments	21.893	0.000	1.624	-	1.624
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	25.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.475	-			
• Adjustments to Budget Years	-0.601	-	1.624	-	1.624
• FFRDC	-0.031	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: T31: *NAT'L AUTO CENTER APP RES INIT (CA)*		
Congressional Add: *Program Increase - Alternative Energy Research*	15.000	-
Congressional Add: *Program increase*	10.000	-
Congressional Add Subtotals for Project: T31	25.000	-
Congressional Add Totals for all Projects	25.000	-

Change Summary Explanation

FY17 Congressional increase in T31 Nat'l Auto Center App Res Init

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) C05 / *Armor Applied Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
C05: *Armor Applied Research*	-	22.842	21.428	21.492	-	21.492	17.205	17.141	17.924	18.259	0.000	136.291

A. Mission Description and Budget Item Justification

This Project investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), improved situational awareness, hit avoidance, kill avoidance, safety, sensors for blast, crash and rollovers, instrumentation and survivability packaging concepts to achieve superior survivability/protection for Soldiers and ground combat and tactical vehicles. Survivability/protection technologies are being investigated to meet anticipated ground combat and tactical vehicle survivability objectives. Additionally, this project focuses on analysis, modeling, and characterization of potential survivability solutions that could protect against existing and emerging threats. This analysis is used to aid in the identification of technologies to enter maturation and development in Program Element (PE) 0603005A, Project 221.

This Project supports Army science and technology efforts in the Ground Maneuver portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Armor Development:	9.682	11.025	9.942
Description: The objective of this effort is to design, integrate and validate performance of advanced armor systems to defeat single and multiple chemical energy (CE) and kinetic energy (KE) emerging threats for combat and tactical vehicles. These systems include base armor (small arms / medium caliber, opaque and transparent B-kits), applique armor (passive / reactive / active multi-threat C-kits), multifunctional armor, and adaptive and cooperative armors. This effort coordinates with PEs 0602618A and 0603005A.			
FY 2018 Plans: Mature attachment designs for subsystem integration of advanced passive and reactive armor technologies; verify performance of subsystem integration design for advanced passive and reactive armor technologies through finite element modeling; investigate various adaptive armor solutions in relevant environment; begin the design of adaptive armor subsystem for system integration.			
FY 2019 Plans: Will mature design of adaptive armor subsystem for system integration; will complete experiments on system attachments to validate component integration; will use the integration experiment results to identify and design the desired attachment approach for follow-on integration of those technologies; will verify performance of subsystem integration design for adaptive armor			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
technologies through experimentation and finite element modeling; will begin design and development of hybrid multi-threat armor subsystem. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in design time resulting in reduced need for program funding			
Title: Blast Mitigation: ***Description:*** This effort designs, fabricates and evaluates advanced survivability and protection capabilities, tools and technologies to improve protection against vehicle mines, improvised explosive devices (IEDs) and other underbody threats and crash events. This effort also designs and evaluates technologies purposed for protecting the occupant such as seats and restraints. Blast and crash mitigation technologies are further investigated and matured in such areas as active and passive exterior/hull/cab/kits, interior energy absorbing capabilities for seats, floors, restraints, sensors for active blast mitigating technologies and performance evaluation, modeling and Simulation (M&S), experimentation and instrumentation. This effort coordinates with PEs 0602618A and 0603005A. ***FY 2018 Plans:*** Designing subsystem concepts for integration of armor and Modular Active Protection System (MAPS) surrogate hardware; validate design of subsystem components required for integration of seats, restraints, flooring and structures through structural and blast analysis; mature WIAMan certification test procedures based on test results. ***FY 2019 Plans:*** Will develop and document best practices (multi-material, cost-conscious, lightweight design) for optimization of structural subsystem technologies that will provide platform ballistic protection. Will complete individual component performance testing of seats, restraints, flooring, and structures. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in Experiment time	2.734	2.932	2.557
Title: Synergistic Vehicle Protection Technologies: ***Description:*** This effort investigates and integrates advanced synergistic survivability technologies and simulation tools to provide enhanced protection for ground vehicles while minimizing overall system burdens. Synergistic survivability technologies such as, armor and active protection, offer the potential of non-linear survivability improvements. The modular approach facilitates trade-offs between protection, payload, performance, cost drivers and performance of vulnerability assessments throughout the life cycle of a system. Provides quantifiable metrics for development of requirements and evaluation of concept feasibility in the development of survivable combat systems.	2.002	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Improved Situational Awareness for Ground Platforms	6.842	5.608	4.615
Description: This effort investigates situational awareness (SA) technologies and architectures to improve occupant and vehicle survivability in all conditions and environments to include degraded visual environments (DVE) for ground vehicles. This effort also investigates and analyzes electronic architectures to enable the efficient integration of DVE systems such as intra-vehicle data and video networks, SA input/output devices, and associated software architectures and interfaces. This effort coordinates with PEs 0603005A, 0602709A, and 0603710A. ***FY 2018 Plans:*** Validate increased SA in DVE to enable indirect vision driving maneuverability, driving aids to reduce accidents & threat detection to improve survivability. Improve operational tempo (OPTEMPO) in DVE to maintain OPTEMPO and decrease occupant injury. Optimize aviation capabilities provided by the Degraded Visual Environment Mitigation (DVE-M) program to provide a complete sensor that is scalable to the mission and vehicle family. ***FY 2019 Plans:*** Will mature increased local SA components in DVE using scalable low cost Local Situational Awareness (LSA) sensors and a digital video architecture system. Will investigate advanced vehicle crew stations with scalable Warfighter-Machine Interface (WMI), augmented reality and crew aids. Will conduct experiments to validate decreased visual latency, increased SA, increased target detection, and increased OPTEMPO in DVE. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in hardware needed for experimentation			
Title: Vision Protection	1.582	1.863	-
Description: This effort investigates and develops protection materials, concepts, and devices to protect vehicle occupants' eyes, vehicle cameras and electro-optical fire control systems against emerging laser threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto vehicle cameras and electro-optical systems to prevent lasers from destroying sighting systems, disabling cameras that provide situational awareness, and damaging or disorienting Warfighter vision. Coordinated work is also being performed in PEs 0602120A, 0602705A, 0602712A and 0603005A. ***FY 2018 Plans:*** Conduct experiments to mature protected day cameras for near-term threat protection; design and mature concepts for future systems to protect against current and future laser threats; improve laboratory capability to enable integration and testing of vision protection concepts on ground vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This effort is ending in FY 18 to adjust for other higher priority efforts			
Title: Protection for Autonomous Systems ***Description:*** This effort investigates and develops materials, concepts, and devices to protect autonomous systems against emerging threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto autonomous systems to prevent disabling or destroying sensors, electronics, and mechanical components, or physical exploitation of subsystems. This effort coordinates with PEs 0602618A and 0603005A. ***FY 2019 Plans:*** Will investigate concepts for protection of autonomous systems in forecasted operational environments. Will identify technologies that address projected threats and hazards. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start program	-	-	2.500
Title: Active Defense Technologies ***Description:*** This effort investigates, analyzes, and designs active hard-kill (physical countermeasure) and soft-kill (non-kinetic countermeasure such as electronic jamming or spoofing) protection Active Protection System (APS) components for future integration onto tactical and combat vehicle platforms. This effort also investigates, designs, and development active, modular components and controls for APS vehicle protection and associated architectures and interfaces. This effort is coordinated with efforts in PEs 0602601A, 0602618A, 0603004A, 0603270A, 0603313A, and 0604115A. ***FY 2019 Plans:*** Will investigate and analyze future hard-kill and soft-kill active defense concepts for use with combat vehicles. Will investigate and design modular components according to architecture and interface requirements. Will develop and assess advanced soft-kill technologies that will defeat higher-level and emerging threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start program	-	-	1.878
Accomplishments/Planned Programs Subtotals	22.842	21.428	21.492

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H77 / *National Automotive Center*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	15.347	17.977	12.094	-	12.094	12.423	14.929	15.288	15.594	0.000	103.652

A. Mission Description and Budget Item Justification

This Project funds the National Automotive Center (NAC), which was chartered by the Secretary of the Army to conduct shared government and industry (dual use) technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Primary thrusts for this activity include advanced power and energy technologies for tactical and non-tactical ground vehicles, electric infrastructure and alternative energy for installations and bases, vehicle networking and connectivity to maximize overlap between commercial and military requirements. Active outreach to industry, academia and other government agencies develops new thrust areas for this Project to maximize shared commercial and government investment.

This Project supports Army science and technology efforts in the Ground Maneuver portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy in New Combat Vehicle, Armor, Robotics/Autonomy. The Ground Portfolio technology investments are maturing powertrain technologies to provide a fuel efficient engine/powerplant capability that is common across the fleet to reduce fuel, training, maintenance and parts requirements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Power, Energy and Mobility:	4.017	4.391	4.410
Description: This effort investigates dual use power, energy, and mobility technologies leveraging commercial and academic investment to military application. This effort focuses on technologies such as lightweight composite materials, electrification of engine accessories, alternative fuels, hybrid vehicle architectures, and compact electrical power generation in order to maximize common investment to meet Army ground vehicle requirements. This work is done in conjunction with Program Elements (PEs) 0603005A and 0603125A.			
FY 2018 Plans: Continue to investigate new computer-aided engineering tools for vehicle batteries that can accurately predict the combined structural, electrical, and thermal responses to military usage conditions. Continue to investigate new computer-aided engineering tools for vehicle engines that accurately model fuel injection spray, cavitation within fuel injectors, flash boiling, spray/wall interaction, super critical fuel injection, in-cylinder radiation and heat transfer, engine knock and soot emissions. Continue to investigate alternate integrated starter generator motors that achieve the required power and torque densities without Rare-Earth materials. Continue to collaborate with automotive industry and Department of Energy in fuel cell technology maturation.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will continue to leverage commercial and academic investments into dual use power, energy, and mobility technologies. Will investigate advances in battery design and safety. Will conduct fuel-cell experimentations, in order to mature component designs, and investigate alternative base fuels. Will research into electrification of parasitic powertrain and vehicle loads that promise weight savings in addition to more efficient use of onboard power. Will identify feasible material options to reduce weight and \or increase structural integrity which would improve mobility in areas such as: aluminum, composites, joining technologies, and design optimization. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase in needed funding from FY 18 to FY 19 results primarily from an anticipated increased need of investigation in battery design.			
Title: Dual Use Technologies: ***Description:*** This effort investigates, researches and evaluates ground vehicle technologies with both military and commercial applications such as renewable energy technologies, electrical power management between vehicles and the grid, alternative fuels, new human machine interfaces, and advanced vehicle networking, automation, and secure communication (telematics). This effort maximizes commercial technology investment for military applications in line with the National Automotive Center's Charter. Collaborations with industry, universities and other government agencies on standards writing for joint applications will facilitate this activity. This work is done in conjunction with PE 0603005A. ***FY 2018 Plans:*** Continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Continue dual use collaborative investigations of military & commercial ongoing open vehicle architecture standards, electrification standards, autonomous systems technologies and integration, vehicle security engineering best practices, and communication systems integration challenges through collaborative mechanisms such as the Society of Automotive Engineers, Automation Alley, the Center for Automotive Research (CAR), and the HTUF. Conducting integration of autonomy systems on international vehicles and demonstrate an autonomous convoy with advanced vehicle behaviors. ***FY 2019 Plans:*** Will research ground vehicle technologies with both military and commercial applications. Will conduct experiments with innovative human machine interfaces, advanced vehicle networking, and vehicle automation technologies. Will focus on vehicle security engineering best practices that prevent detriment to crew and vehicles from cyber-attacks. Will research of autonomy systems on coalition international vehicles. Will further the advancement of tactics, training, and procedures (TTPs) for inclusion of	11.330	13.586	7.684

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
autonomous systems and studies on vehicle networking and cyber security. Will mature concepts to increase logistics fleet affordability and reduce logistics footprint through autonomy. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Ending National Automotive Center (NAC) investment in vehicle architecture and electrification standards.			
Accomplishments/Planned Programs Subtotals	15.347	17.977	12.094

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H91 / *Ground Vehicle Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H91: *Ground Vehicle Technology*	-	26.663	27.827	36.864	-	36.864	39.541	43.647	41.352	42.166	0.000	258.060

A. Mission Description and Budget Item Justification

This Project designs, develops, and evaluates a variety of innovative enabling technologies in the areas of vehicle concepts, virtual prototyping, electronic controls, electrical power, thermal management, propulsion, mobility, survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy-enabled systems, and other component technologies for application to combat and tactical vehicles.

This Project supports Army science and technology efforts in the Ground Maneuver portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Combat Vehicle Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Pulse Power:	3.568	-	-
Description: This effort focuses on growing compact, high frequency/high energy/high power density components and devices for several advanced electric-based survivability and lethality weapon systems. Technologies include direct current (DC) to DC chargers, high energy batteries, pulse chargers, high density capacitors, and solid state switches. This effort is coordinated with Program Elements (PEs) 0603005A and 0602705A.			
Title: Propulsion and Thermal Systems:	5.895	6.466	5.995
Description: This effort researches, designs and evaluates high power density engines and transmission systems needed to offset increasing combat vehicle weights (armor), improved fuel economy (fuel cost & range), and reduced cooling system burden (size, heat rejection). This effort also researches and matures thermal management technologies and systems including heat energy recovery, propulsion and cabin thermal management sub-systems to utilize waste heat energy and meet objective power and mobility requirements on all ground vehicles. Lastly, this effort maximizes efficiencies within propulsion and thermal systems to reduce burden on the vehicle while providing the same or greater performance capability. This effort is coordinated with PE 0603005A.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Mature advanced heat exchanger, efficient fan, and waste heat recovery system into advanced thermal management system. Mature advanced thermal management system concept design in preparation of integration into advanced combat vehicle propulsion system. ***FY 2019 Plans:*** Will conduct experiments on advanced heat exchanger, efficient fan, and waste heat recovery system in the advanced thermal management system. Will validate advanced thermal management system design. Will improve the component and system design based on test results. Will complete subsystem testing of high power density engine and transmission. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in experiments			
Title: Power Management Technologies: ***Description:*** This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to Direct Current (DC) inverters, DC-DC converters, solid state circuit protection, power distribution, and automated control of complete power systems. Special emphasis has been placed on developing high temperature capable power electronics, leading to the use of Silicon Carbide (SiC) in the above technologies. This effort coordinates with PE 0603005A. ***FY 2018 Plans:*** Complete testing of Gallium Nitride (GaN) and SiC based leap-ahead electrical power system in the SIL to troubleshoot issues in preparation for future combat vehicle integration. Continuing environmental, EMI, reliability performance, and other testing of vehicle power architecture system components and software to prepare for future combat vehicle testing. ***FY 2019 Plans:*** Will validate power architecture control software functionality in order to confirm power quality, prioritization and optimization algorithms that maximize available power on the vehicle. Will validate environmental, EMI, reliability performance, and other testing of high operating temperature vehicle power architecture system Silicon Carbide components and software to ensure readiness for future combat vehicle testing. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced due to less experimentation needed	2.225	2.685	2.671
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components: ***Description:*** This effort researches, develops and evaluates technologies to increase onboard vehicle electric power to enable vehicle systems such as advanced survivability systems, situational awareness systems, advanced computing, and the Army network. This effort researches, designs and evaluates high temperature and efficient power generation components to provide	1.488	0.750	0.318

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
increased electrical power and reduced thermal loads using high operating temperature switching devices and advanced electrical generation components such as integrated starter generators and integrated starter alternators. This effort also researches, designs and evaluates advanced control techniques for power generation components to make these systems more efficient, increase electrical power output and reduce thermal loads. This effort is coordinated with PE 0603005A. ***FY 2018 Plans:*** Complete testing of integrated starter generator system in brass board configuration. Begin analysis and system design optimization on an advanced combat vehicle propulsion system. ***FY 2019 Plans:*** Will complete analysis and system design optimization on an advanced combat vehicle propulsion system. Will evaluate the increase in onboard vehicle power availability and fuel efficiency with no negative impact to vehicle mobility. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in needed components for experimentation			
Title: Advanced Non-Primary Power Systems: ***Description:*** This effort researches, investigates, conducts experiments and validates Auxiliary Power Units (APUs) technologies such as modular/scalable engine based APUs, fuel cell reformer systems to convert JP-8 to hydrogen, sulfur tolerant JP-8 fuel cell APUs and novel engine based APUs for military ground vehicle and unmanned ground systems. This effort also determines inputs for APU interface control documents, as well as investigates solutions for reducing APU acoustic signature for silent operation during mounted surveillance missions. This effort investigates the use of small engines and JP-8 fuel cell systems for use as prime power solutions for unmanned ground systems. ***FY 2018 Plans:*** Investigate advanced APU to verify performance, control strategy and advanced noise control. Continue to optimize active noise cancellation, isolation and muffling to decrease auditory detection during mounted surveillance missions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Ending work in Advanced Non-Primary Power Systems as a result is priority adjustments	1.398	1.327	-
Title: Elastomer Improvement Program: ***Description:*** This effort researches, formulates and tests new elastomer (rubber) compounds for vehicle track systems to increase track system durability, reduce track system failures and reduce Operations & Sustainment (O&S) costs related to premature track system failures.	0.265	0.662	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Formulate final compounds for selection and inclusion on the advanced running gear demonstration platform. Mold compounds for the track pad, bushing and road wheels. Perform final laboratory evaluations on selected finished product compounds and then produce quantity for demonstrator evaluations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program ending			
Title: Intelligent Systems Technology Research: ***Description:*** This effort investigates improved operations of manned platforms through the application of sensing and autonomy technologies developed for unmanned systems such as maneuver and tactical behavior algorithms, driver assist techniques, autonomy kits, advanced navigation and planning, vehicle self-protection, local situational awareness, advanced perception, vehicle and pedestrian safety, active safety, and robotic command and control. This effort is coordinated with efforts in PEs 0602120A, 0602784A, 0603005A, and 0603734A. ***FY 2018 Plans:*** Continue to design and develop the Warfighter Machine Interface for scalability and driver/crew aids. Mature the increased reliability of robotic technologies to produce trust and confidence of autonomous vehicles. Improve standardized data collection tools and methodologies to mature Department of Defense (DoD) ground robotic requirements, development, technology investments and procurement decisions. Conduct experiments to validate that these tools and technologies are increasing our capabilities of protecting the force, reducing burden on soldiers, and mission command & tactical intelligence. ***FY 2019 Plans:*** Will develop advanced vehicle behaviors to transition to autonomy-enabling kits for tactical wheeled vehicles in leader-follower convoy operations. Will continue to develop and design common user interfaces and open architecture design. Will continue to research automation software and algorithms, increased robotic reliability and autonomous testing methodologies and procedures. Will continue to advance capabilities to enable operations in increasingly challenging environments like off-road terrain and reduced communication areas. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Hardware components needed for experimentation account for increased costing	9.350	9.917	10.005
Title: Energy Storage: ***Description:*** This effort investigates novel advanced ground vehicle energy storage devices such as advanced chemistry batteries and ultra capacitors for starting, lighting, and ignition and silent watch requirements for powering vehicle electronics and communications systems with main engine off. Develop and test energy storage devices to meet harsh military requirements that	2.474	2.520	2.536

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
far exceed commercial requirements such as extreme temperature operation (-46 to +71C), ballistic shock and vibration, and electromagnetic interference (in accordance with MIL-STD-810G). Designs and develops advanced batteries to reduce battery volume and weight while improving battery energy and power densities within the same footprint and standardized form factor of current batteries (6T) to enhance logistics. ***FY 2018 Plans:*** Complete design and mature battery cells into modules. Design and mature battery packs built around the modules. Conduct durability and performance testing at the module level for advanced Li-ion chemistries. ***FY 2019 Plans:*** Will conduct durability and performance experimentation at the battery pack level for advanced Li-ion chemistries to validate improved energy density, starting, lighting, propulsion system ignition, silent watch, reliability, battery safety management, for military vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** increase due to Inflation			
Title: Anti-Tamper ***Description:*** This effort investigates and develops mature anti-tamper methodologies and technologies in combat and tactical vehicles. Technologies such as controllers and tactical information systems for autonomous appliques, active protection systems, and Command, Control, Communications, Computers & Intelligence (C4I), will be designed for enhanced protection against current and evolving threats. This includes: enhancing and defending technologies used to secure data in vehicle systems; defending against the threat of unwanted behavioral changes in multi-agent systems; the prevention of unauthorized control of, or denying service to a targeted platform; reverse engineering and conducting vehicle digital forensics; and responding to active attacks that have penetrated anti-tamper defenses in a platform. ***FY 2018 Plans:*** Develop measurement, analysis and verification methods to identify vulnerabilities of combat and tactical vehicle software-based technologies; capitalize on currently available virtual (Modeling & Simulation) toolsets to design and ?virtually? conduct experiments of potential safeguards and solutions of the vehicle architecture, and begin to evaluate methods and toolsets on ground vehicle hardware. Investigate applications of anti-tamper that are applicable to both current and future vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program ending	-	3.500	-
Title: Crew Station	-	-	4.775

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort focuses on crew size reduction and crew stations tailored to mission and soldier needs through the utilization of emerging human-interaction technologies, automations, machine intelligence and the provision of cohesive domain personalization to permit soldiers to achieve leap-ahead performance beyond today?s constrained ground vehicle environment. ***FY 2019 Plans:*** Will conduct experiments to provide data to improve early warning detections, reduce response times and shorten task durations for future crewstation programs. Will investigate crew size reduction to determine if the same overall performance can be produced by performing simulations to provide data, reports and analysis to the future fighting vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start that is aligned with Next Generation Combat Vehicle crew station			
Title: Unmanned Ground Systems Research ***Description:*** This effort researches, designs, and develops technologies that enable scalable integration of multi-domain teamed robotic and autonomous system capabilities supporting Army combat formations. Investigate behaviors and algorithms to mature functions that detect and classify risks and threats, reduce burden on the Soldier operator, and validate initial safety procedures for armed Unmanned Ground Vehicles (UGVs) in contested, austere and congested environments. Investigates increased situational awareness needed for a high degree of survivability and lethality for complex maneuvers. Mature government-owned autonomy architecture to enable iterative software capability upgrades for systems. Conduct experiments in static environment with multiple live and simulated manned-unmanned vehicles with evolving threats. Investigate behaviors and hardware needed to rapidly learn, adapt & reason faster than the adversary. This effort is coordinated with efforts in PEs 0602120A, 0602784A, 0603005A, and 0603734A. ***FY 2019 Plans:*** Will investigate vehicle behaviors to enable teamed robotic and autonomous systems to support specific capabilities supporting Army combat formations. Will research and design common user interfaces for remote lethality with limited targeting assist. Will research automation software and algorithms, increased robotic reliability and function, and determine certified safety procedures for soldier-operated armed UGVs. Will conduct experiments using various commercial network solutions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding was initiated in FY 19 for Combat Vehicle Robotics acceleration.	-	-	10.564
Accomplishments/Planned Programs Subtotals	26.663	27.827	36.864

C. Other Program Funding Summary ($ in Millions)

N/A

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C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) T31 / *NAT'L AUTO CENTER APP RES INIT (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

Note

Congressional increases

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for National Automotive Center applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase - Alternative Energy Research ***FY 2017 Accomplishments:*** N/A	15.000	-
Congressional Add: Program increase ***FY 2017 Accomplishments:*** N/A	10.000	-
Congressional Adds Subtotals	25.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A