Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	83.299	85.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	168.790
H80: *Survivability And Lethality Technology*	-	83.299	75.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	158.790
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	0.000	10.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
* PE 0602141A (Lethality Technology)
* PE 0602143A (Soldier Lethality Technology)
* PE 0602145A (Next Generation Combat Vehicle Technology)
* PE 0602147A (Long Range Precision Fires Technology)

A. Mission Description and Budget Item Justification

This PE investigates and evaluates materials and technologies, and designs and develops methodologies and models required to enable enhanced lethality and survivability. Project H80 focuses on applied research of lightweight armors and protective structures for the Soldier and vehicles; kinetic energy active protection; crew and components protection from ballistic shock and mine-blast; insensitive propellants/munitions formulations; novel multi-function warhead concepts; affordable precision munitions design; techniques, methodologies, and models to analyze combat effectiveness and identify potential technology vulnerabilities; and technologies, methods, and tools for injury prediction of vehicle occupants during under-body blast events.

Work in this PE makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences) / Project H42 (Materials and Mechanics) and Project H43 (Research In Ballistics); and utilizes emerging materials from PE 0602105A (Materials Technology) and applies it to specific Army platforms and the individual Soldier applications.

The work in this PE complements and is fully coordinated with efforts in PE 0602120A (Sensors and Electronic Survivability), PE 0602303A (Missile Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602716A (Human Factors Engineering Technology), PE 0602786A (Warfighter Technology), PE 0603125A (Combating Terrorism-Technology Development), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*

This work is performed by the United States Army Futures Command.

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	85.309	75.541	75.850	-	75.850
Current President's Budget	83.299	85.491	0.000	-	0.000
Total Adjustments	-2.010	9.950	-75.850	-	-75.850
• Congressional General Reductions	-0.042	-0.050			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	10.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.968	-			
• Adjustments to Budget Years	-	-	-75.850	-	-75.850

Change Summary Explanation

FY19 increase related to Congressional add of $10 Million
FY20 increase related to Science and Technology restructuring

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*	Project (Number/Name) H80 / *Survivability And Lethality Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	83.299	75.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	158.790

Note

In Fiscal Year (FY) 2020 this Project is being realigned with continuity of effort to:
Program Element (PE) 0602141A Lethality Technology
* Project AH5 Projectile and Multi-Function Warhead Technologies
* Project AH6 Disruptive Energetics and Propulsion Technologies
* Project AH7 Lethal and Scalable Effects Technologies
PE 0602143A Soldier Lethality Technology
* Project AZ5 Soldier Protection Technology - Vulnerability
PE 0602145A Next Generation Combat Vehicle Technology
* Project BG6 Advanced Concepts for Active Defense Technology
PE 0602147A Long Range Precision Fires Technology
* Project AH4 Precision and Coop Weapons in a Denied Env Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs and develops materials, methods and models that provide Soldier protection by enhancing survivability and lethality. Specific technology and research thrusts include: lightweight armors and protective structures; crew and component protection from ballistic shock and/or mine-blast; insensitive high energy propellants/munitions to increase lethality and reduce propellant/munitions vulnerability to attack; novel kinetic energy (KE) penetrator concepts to maintain/improve lethality; novel multi-function warhead concepts to enable defeat of a full-spectrum of targets (anti-armor, bunker, helicopter, troops); techniques, methodologies and models to analyze combat effectiveness and identify potential vulnerabilities in current and emerging technologies; and technologies, methods, and analysis tools for injury prediction of vehicle occupants during under-body blast events.

This Project supports efforts in the Army Science and Technology Ground, Lethality, Command, Control, Communications and Intelligence (C3I), and Soldier Portfolios.

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

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Underbody Blast & Occupant Protection	1.443	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: This effort investigates and designs tools, techniques, and technologies for protection against mine/improvised explosive device (IED) blast threats, ballistic shock mitigation, and fuel/ammunition fires to enable survivability of current and future platforms.			
Title: Low Cost Hyper-Accuracy Munition Technologies ***Description:*** This effort designs advanced components/subsystems to enable a broad spectrum of future affordable direct and indirect fire precision munitions. The focus is on a multidisciplinary approach to munition systems design by coupling physics-based models of interior ballistics, launch dynamics, flight mechanics, and high-gravitational force guidance, navigation, and control technologies. The goal is for smaller, cheaper and lighter munition components enabling low-collateral-damage precision munitions for future asymmetric operations in military operations in urban terrain (MOUT).	3.624	-	-
Title: Disruptive Energetics and Propulsion Technologies ***Description:*** This effort investigates, evaluates, models, and informs the selection of propulsion and energetic materials and technologies to validate novel energetic materials concepts (such as nano-structural and insensitive) that exploit managed energy release required for improving the effectiveness and reducing the vulnerability of future gun/missile systems and warheads. This effort builds on disruptive energetic materials discovery efforts in PE 0601102A (Defense Research Sciences) / Project H43 (Research in Ballistics) to synthesize new materials with energy content up to ten times that of Research Department Explosive. ***FY 2019 Plans:*** Develop scale-up capability of multiple classes of disruptive energetic materials, testing and performance evaluation of disruptive energetic materials; develop computational methodology to model/predict behavior for energetic materials in explosives and propellants composites at extreme conditions; develop mechanisms for modeling the gas-phase chemistry associated with the combustion of solid propellants; develop technologies to extend the range and velocity of small, medium and large caliber projectiles. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602141A (Lethality Technology) / Project AH6 (Disruptive Energetics and Propulsion Technologies) in FY20 as part of financial restructuring.	8.222	7.902	-
Title: Lethal and Scalable Effects Technologies ***Description:*** This effort identifies and models preferred options to reduce energy/mass required to defeat emerging armor threats and to provide multi-purpose capabilities for revolutionary future lethality. In addition, this effort investigates technology options for scaling warhead lethality to enhance urban Warfighting capabilities including control of collateral damage. ***FY 2019 Plans:***	5.569	6.336	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Explore new materials and architectures to reduce the weapon mass required to launch and deliver lethal mechanisms; experimentally demonstrate the ability to modify high energy muzzle blast fields; explore warhead concepts that can simultaneously defeat multiple targets. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602141A (Lethality Technology) / Project AH5 (Projectile and Multi-Function Warhead Technologies) and Project AH7 (Lethal and Scalable Effects Technologies) in FY20 as part of financial restructuring.			
Title: Survivability/Lethality Analyses ***Description:*** This effort devises state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats against future weapon systems. ***FY 2019 Plans:*** Design and develop new analytical methodologies and models to assess the highest priority new foreign and American technologies with the highest likelihood of affecting the ballistic survivability of Soldiers and fielded and developmental Army system; conduct experiments to characterize high resolution, time dependent penetration and failure mechanisms in ballistic events and will exploit for applied mechanism that can be used in future Army systems; continue to investigate energy-efficient penetrator and warhead concepts for direct-fire, distributed, and cooperative lethality scenarios; develop deeper understanding of the science associated with non-lethal incapacitation. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.	7.318	6.424	-
Title: Multi-Threat Armor Formulations and Designs ***Description:*** This effort devises and matures multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats. This research is coordinated with PE 0602601A (Combat Vehicle and Automotive Technology) and PE 0603005A (Combat Vehicle and Automotive Advanced Technology). ***FY 2019 Plans:*** Mature promising multi-threat armor designs utilizing hybrid electromagnetic armor (EMA)/energetic technologies; verify results both computationally and experimentally. ***FY 2019 to FY 2020 Increase/Decrease Statement:***	18.640	19.101	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.			
Title: Adaptive and Cooperative Protection Technologies ***Description:*** This effort pursues a holistic approach toward achieving significant weight reduction and defeat of future threats by utilizing real-time information, combined with threat knowledge, to provide ever-increasing protection. This approach includes integrating individual vehicle capabilities of armor, underbody blast protection, active protection systems, and advanced soft kill methods into one solution to maximize survivability and minimize weight for combat and tactical vehicles. ***FY 2019 Plans:*** Will conduct computational and experimental research to mature/optimize promising adaptive armor designs. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.	6.238	11.909	-
Title: Ballistic and Blast Protection for Dismounted Soldiers ***Description:*** This effort develops unique physics-based models to understand the deflection and stress wave interactions with the human during the complex target interactions between threats and personal protective equipment. Use this knowledge framework to develop low technology readiness level Personal Protective Equipment concepts that are informed by the human effects during impact and blast events. ***FY 2019 Plans:*** Investigate the physics of failure for emerging threats utilizing high definition experiments to identify phenomena and calibrate the ballistic models; finalize injury models for soft and hard tissues for ballistic impact. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology ? Vulnerability) in FY20 as part of financial restructuring.	6.545	6.134	-
Title: Warrior Injury Assessment Manikin (WIAMan) ***Description:*** This work develops an improved demonstrator blast test manikin, data acquisition system, and injury prediction methods and tools that incorporate new medical research and which provides an improved capability to measure and predict skeletal injuries for vehicle occupants during under-body blast events. ***FY 2019 Plans:***	6.292	3.919	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Complete injury biomechanics testing and injury assessment reference curves; validate finite element model for Generation-1 ATD for risk assessment capabilities; complete injury analysis tool development. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.			
Title: Vulnerability Assessment of Technologies ***Description:*** This effort reviews high-priority developmental technologies in the context of current and emerging threats, identifies tradeoffs, and develops risk reduction strategies to promote the development of technologies that are "threat ready?. State-of-the-art vulnerability assessment methodology and tools are applied across a broad spectrum of threats in order to investigate potential vulnerabilities and identify mitigation options early in the materiel development cycle.	8.686	-	-
Title: Active Protection Modeling and Technologies ***Description:*** This effort supports the development of Active Protection System (APS) technologies and common architecture to reduce vehicle weight while significantly increasing protection against current and emerging advanced threats by reducing reliance on armor through other means such as sensing, warning, and active countermeasures. The APS common architecture will provide adaptable APS solutions that can be integrated across Army vehicle platforms as required. This research includes the development of new modeling and simulation capabilities along with supporting experimental and theoretical approaches to enable active protective systems. This effort includes integrated information (e.g., battlefield geography, threat launch detection and tracking) and intelligence to inform protection optimization, requiring collaboration across multiple Army organizations.	5.253	-	-
Title: Swarming Weapons Technologies ***Description:*** This effort develops concepts for simultaneous and assured delivery of multiple lethal payloads at extended ranges to challenging (e.g., moving) targets in constrained and contested environments (such as highly dynamic and mixed personnel environments, and Global Positioning System denied environments) through the use of highly collaborative teaming and distributed intelligence, perception, estimation, and control theories and technologies.	4.618	-	-
Title: Multi-scale Materials Modeling for Force Protection ***Description:*** This effort develops computational tools for the design of terminal ballistic concepts and material-specific properties to enable novel penetrator-target interactions. Multi-scale materials models developed in previous 6.1 (Basic Research) programs are transitioned to simulation framework suitable for impact and penetration modeling. This approach includes fusing materials and mechanisms to maximize survivability and minimize weight for combat and tactical vehicles. ***FY 2019 Plans:***	0.851	0.864	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Perform limited V&V assessments of computational capability; transition ALEGRA and ALE3D models to Sandia and Livermore National Labs; develop 2d generation models. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.			
Title: Emerging Overmatch Technologies ***Description:*** This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination. ***FY 2019 Plans:*** Explore advanced protection and lethal mechanisms to enable the next generation combat vehicle and small autonomous systems; seek to model operational effects based on laboratory/range experiments. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY20 funds realigned to PE 0602145A (NGCV Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) as part of financial restructure.	-	2.194	-
Title: Precision and Cooperative Weapons in Denied Environments ***Description:*** The goal of this research is to deliver weapon payloads in more extreme environments (e.g., speed, time, size, survivability, number of agents) against complex, evolving threats (e.g., evading, hiding, counter-measured). Research focuses on understanding and enabling weapons technologies in the areas of vehicle design, control mechanisms, algorithms, embedded processing, and onboard sensing for multi-agent systems with limited, potentially-hostile guidance feedback information. ***FY 2019 Plans:*** Conduct free-flight computational and experimental investigation of enhanced open-loop control maneuver technologies in subsonic regime; study structural response of control mechanism technologies for extremely high-G (>60kGs) launch survivability; investigate gun-launched morphing airframe technologies using computational and experimental methods; validate anchored and unanchored localization technologies for navigation in denied environments on low-speed vehicle in flight experiments and on high-speed vehicle in high-fidelity simulation. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AH4 (Precision and Coop Weapons in a Denied Env Tech) in FY20 as part of financial restructuring.	-	9.058	-
Title: FY 2019 SBIR / STTR Transfer	-	1.650	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	83.299	75.491	-

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 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*				Project (Number/Name) HB1 / *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	0.000	10.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000

Note

Congressional increase.

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Congressional Increase	-	10.000	-
Description: Congressional increase. ***FY 2019 Plans:*** Congressional increase. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Congressional Increase in FY19.			
Accomplishments/Planned Programs Subtotals	-	10.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A